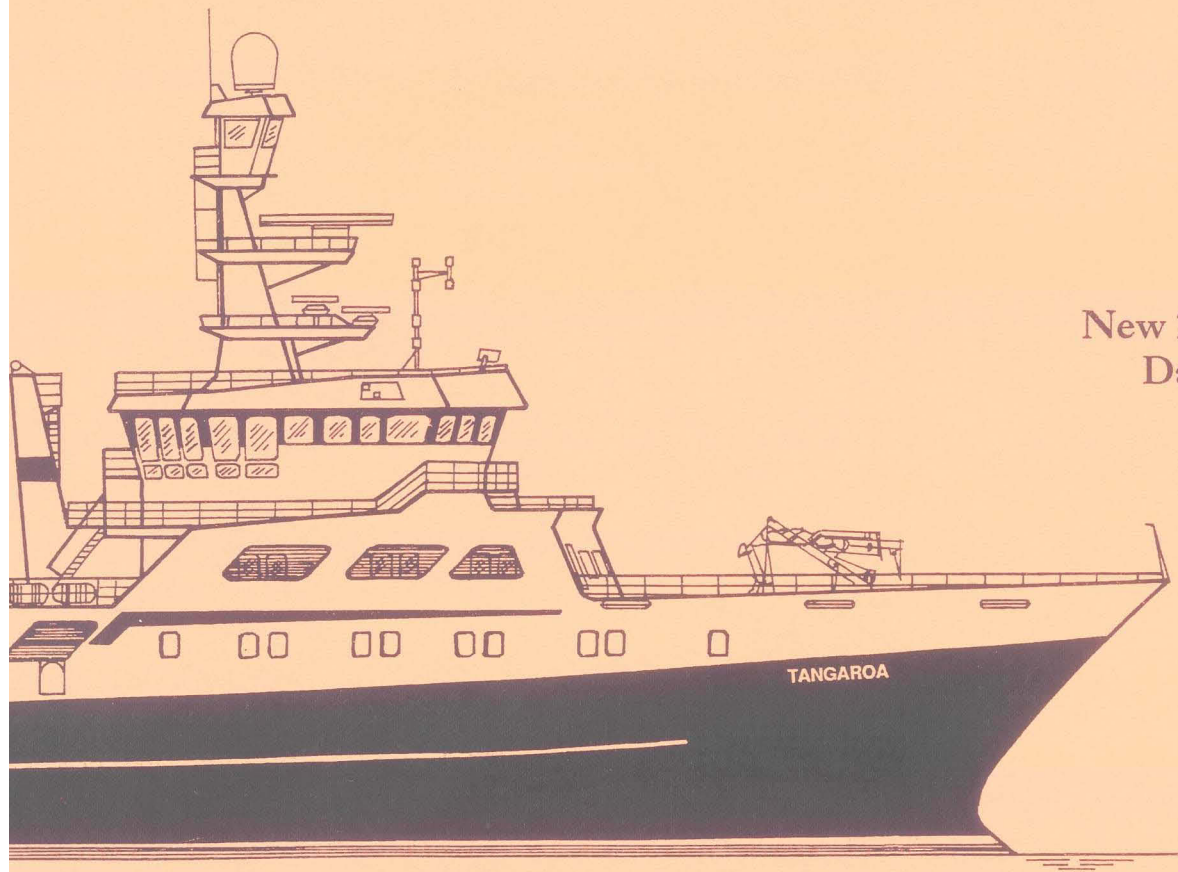


**NIWA**

*Taihoru Nukurangi*

**Trawl survey of orange roughy, black oreo, and  
smooth oreo in southern New Zealand waters,  
September-October 1994  
(TAN9409)**

Malcolm R. Clark  
Owen F. Anderson  
Dianne M. Tracey



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## Introduction

Commercial fisheries for orange roughy (*Hoplostethus atlanticus*), black oreo (*Allocyttus niger*), and smooth oreo (*Pseudocyttus maculatus*) developed in the Puysegur Bank region in 1990. Spawning aggregations of orange roughy were discovered in 1991, and the fishery increased rapidly and then declined (Table 1). The area is part of ORH 3B, and a voluntary catch level of 5000 t was agreed for the fishery from 1992 to 1993. Smaller fisheries have also developed to the south on the Macquarie Ridge (west of the Snares Islands) and near the Auckland Islands.

Stratified random trawl surveys were carried out on the Puysegur Bank using the commercial vessels *Will Watch* and *Giljanes* in July 1991 and 1992 respectively (Clark & Tracey 1992, 1993). These surveys produced extensive data on distribution, relative abundance, and biology of orange roughy and oreos, but they were not comparable for biomass estimation, and a time series of surveys using RV *Tangaroa* was planned. The first of these was carried out in August-September 1992 (Clark & Tracey 1994). The present survey was the second in the series.

## Objectives

To provide research information for the assessment of southwestern stocks of orange roughy, smooth oreo, and black oreo in the region of the Puysegur Bank, northern Macquarie Ridge, and Auckland Islands shelf by:

1. describing the distribution and measuring indices of biomass;
2. collecting biological data on size structure and reproduction for determination of prerecruit/recruited biomass, and development and timing of spawning;
3. collecting samples for defining stock structure of orange roughy and oreos in the area; and
4. measuring depths and positions for development of bathymetric charts around the Puysegur Bank, northern hills of the Macquarie Ridge, and the Auckland Islands area.

## Methods

### Survey area and design

The survey area covered 2404 km<sup>2</sup> and included the Puysegur Bank, hills on the northern Macquarie Ridge, and a hill complex north of the Auckland Islands (Figure 1). The slope west of Stewart Island was not covered because of lack of time. The strata were the same as on the first survey (Appendix 1).

The survey was of a two-phase random stratified design (*after* Francis 1984). The survey area was divided into 39 strata (Table 2) on the basis of known fish distribution and bottom bathymetry from previous surveys and commercial catch information. New random station positions were computer generated, with a minimum of three tows per stratum. Four methods were used to specify tow position, depending on the bottom characteristics of the strata.

## **Timetable of events**

*Tangaroa* sailed for the survey grounds on the evening of 23 September: fishing began on the evening of the 24th and continued until the 27th when it was necessary to steam to Dunedin for winch repairs. Fishing resumed on 9 October and the survey was completed on 23 October. The vessel returned to Wellington on 25 October. Rock dredge tows were made (in conjunction with the Institute of Geological and Nuclear Sciences) for collection of rock samples.

## **Biomass estimates**

Biomass indices were calculated by the area swept method (Francis 1981) using the Trawlsurvey Analysis Program (as at February 1995). Clark & Tracey (1992) described the formulae for calculating biomass and standard error. A constant wingspread measurement figure of 26.0 m (vulnerability of 0.23) and vertical and areal availability assumptions of 1.0 were used to estimate biomass. The recorded distance was used for distance towed. Length-weight parameters from this survey were used in biomass analysis.

Biomass has been calculated from two sets of strata: the entire survey area and the area comparable with that sampled in 1992. This equates to the entire survey area less those strata not sampled in 1992, (i.e., strata 801, 802, 803, 804, 1001, 1002. Strata 801 and 802 are excluded because they are part of a hill complex which includes strata 803 and 804).

## **Biological analyses**

### **Length frequency distribution**

Length frequency data have been scaled by percentage sampled to represent each catch, and then further scaled by stratum area and biomass to represent the total population size distribution.

### **Feeding analyses**

Data on frequency of occurrence and volume of prey have been combined into a single index (*IV*) (Vesin *et al.* 1981) to assess the relative importance of prey for orange roughy, smooth oreo, and black oreo:

$$IV = \sqrt{(\% \text{ frequency}) (\% \text{ volume})}$$

Frequency of occurrence is the number of stomachs in which a prey item was found. The volume of each prey item was assessed by eye as the proportion of stomach contents where each stomach (part-full or full) totalled 100%.

## **Biomass indices**

The biomass of orange roughy for the entire survey area was 1630 t (*c.v.* = 20%), of which 383 t (*c.v.* = 25%) was prerecruit and 1245 t (*c.v.* = 30%) recruit-sized fish (*see* Table 5).

The biomass was concentrated on west Puysegur Bank, particularly strata 230 (900–1000 m), 242 (1000–1200 m), 246 (“Hydro” and “Labrador”) and 247 (“Malcolm’s Monument”). Other important strata were 430 (east Puysegur, 900–1000 m) and 501 (“Mt Duncan”). The main areas of the commercial fishery (strata 243, 244, and 245) had relatively low catch rates and biomass.

The biomass of smooth oreo came mostly from strata 501 and 502 (“Mt Duncan” and “Porirua”) (*see* Table 6). The slope areas of Puysegur Bank contributed little. The total biomass index was 3793 t, (*c.v.* = 61%) of which 3634 t (96%) was fish of 30 cm or longer.

Black oreo biomass was also concentrated in strata 501 and 502 in the Puysegur Bank area and on hills of the Macquarie Ridge (*see* Table 7). The total survey index was 2680 t (*c.v.* = 42%).

For comparison with the 1992 survey, biomass indices were derived from 87 tows in the Puysegur Bank area (Table 9). The 1992 values are based on updated strata area calculations and differ slightly from those given by Clark & Tracey (1994).

The 1994 index for orange roughy is 17% of that for 1992, and for smooth oreo and black oreo is 39% and 23%, respectively. There is also an increase in the proportion of prerecruit fish to recruits for all species.

The high coefficients of variation of the biomass indices for smooth oreo and black oreo (Table 8) reflect the allocation of stations to optimise the results for orange roughy, rather than oreos, with the reduced survey time available.

## **Size structure**

### **Orange roughy**

In the Puysegur area fish ranged from 8 to 47 cm standard length. There was a large modal peak at 28 cm and a lesser peak at 36 cm (Figure 5). The length frequency distributions were similar for males and females.

Sample sizes from the Macquarie Ridge hills were rather small: fish lengths ranged from 9 to 46 cm, with a peak at 36 cm (both male and female) and another at 40 cm (female only) (Figure 5).

The length frequency distribution of fish from the Auckland Island hills was unimodal overall with the peak at 34–36 cm. The modal length of males was 34 cm, and of females, 38 cm. Fish ranged in length from 25 to 45 cm.

The percentage of females was similar in the Puysegur Bank and Auckland areas (49.7% and 55.2%, respectively), but was higher (68.1%) on the Macquarie Ridge hills.

### **Smooth oreo**

In the Puysegur region there were clear modes at 20, 30, and 44 cm total length (Figure 6). Size structure by sex was similar, except in the largest mode where males peaked at 41 cm and females at 48 cm.

Two main modes were dominant on Macquarie Ridge hills, 30 cm (mainly females) and 40–41 cm.

## Discussion

The design of this survey, the second in a planned time series, was based largely on that of TAN9208 with which it had to be comparable. Core strata on Puysegur Bank remained the same, but extra areas were included on the northern Macquarie Ridge (strata 803, 804) and near the Auckland Islands (1001, 1002, 1003), where the fishery has expanded in 1992 and 1994.

The survey design incorporates fishing on a number of hill features, which are treated as separate strata (*see* Clark & Tracey 1992, Clark 1994). During the survey there were no indications of rapid gear saturation, or of the net catching fish while approaching, or coming off, the bottom so the measurement of tow distance on the bottom should accurately describe catching distance, even on short tows. Short tows were made because of small and steep hills, not because of high catch rates. There were no indications of fish movement between strata.

There have been marked changes in the commercial fishery in recent years, and the quota has been reduced. Two surveys are not enough for reliable estimation of biomass and yields, but a number of major changes since the 1992 survey need to be highlighted.

1. There has been a marked decrease in the frequency of high catch rates of orange roughy on Puysegur Bank (including “Mt Duncan” and “Porirua”).

In 1992, 14 out of 75 tows had catch rates of 500–9999 kg.km<sup>-1</sup> and 1 had over 10 000 kg.km<sup>-1</sup>. In 1974, only 2 out of 73 tows were in the 500–9999 kg.km<sup>-1</sup> range.

2. The distribution of catch rates has changed. In 1992 the highest mean catch rates were on the hills (particularly “Godiva” and “Goomzy”), but these hills were not important in 1994.

The mean catch rates (kg.km<sup>-1</sup>) for each stratum were:

	1992	1994
0243 (“Alistairs”)	605	115
0244 (“Godiva”)	3 800	85
0245 (“Goomzy”)	2 550	20
0501 (“Mt Duncan”)	70	270
0502 (“Porirua”)	115	2
0247 (“Malcolm’s Monument”)	800	130

3. The biomass index for orange roughy has declined substantially, from 6630 t in 1992 to 1160 t in 1994. For fish below 30 cm total length the decline is from 5850 t to 780 t.

4. Length frequency distributions have changed. In 1992 the overall orange roughy size distribution was slightly bimodal, with a strong modal peak at 35–36 cm and a secondary mode at 26–28 cm. In 1994 the pattern was reversed, with a strong mode at 27–28 cm and a secondary peak at 35–36 cm.

Figure 8 shows length frequency distributions from the eastern side, western side, and hills of the Puysegur Bank. Both slope areas in 1994 show a decrease in the 30–40 length mode since 1992, while the size structure on the hills remained similar to that in 1992. The change in overall size is a combination of fewer large fish on the slope areas and a dramatically lower biomass on the hills.

5. Catch rates and the biomass index of oreo species have decreased. The precision of results for oreos is much lower than for orange roughy because the survey focused on orange roughy. Nevertheless, there are strong indications of decline in stock size of oreos in the Puysegur Bank area.

**Table 1: Reported catches (t) of orange roughy (ORH), smooth oreo (SSO), black oreo (BOE), and unspecified oreo (OEO) by area from 1990–91 to 1993–94 (from QMS data, ORH figures in brackets are corrected from estimated catch per tow records to total reported catch in ORH 3B from QMRs)**

Year	ORH	SSO	BOE	OEO	Total oreo
<b>Puysegur</b>					
1990–91	790 (850)	402	1 687	15	2 104
1991–92	6 592 (6900)	478	1 807	147	2 432
1992–93	4 720 (5450)	417	1 214	270	1 901
1993–94	2 381 (2675)	1 023	886	18	1 927
<b>Snares</b>					
1990–91	28	38	188	0	226
1991–92	9	99	273	0	372
1992–93	472	715	2 289	0	3 004
1993–94	37	656	1 680	9	2 345
<b>Auckland</b>					
1990–91	–				
1991–92	–				
1992–93	211	307	0	0	307
1993–94	190	163	0	27	300



**Table 3: Total catch and percentage composition by weight of the 12 most abundant species caught in the survey**

	Catch (kg)	% of total
Smooth oreo	40 558	41.2
Black oreo	22 077	22.4
Orange roughy	13 099	13.3
Smallscaled brown slickhead	6 736	6.8
Baxter's dogfish	5 057	5.1
Hoki	2 259	2.3
Leafscaled gulper shark	1 093	1.1
Longnosed velvet dogfish	915	0.9
Hake	810	0.8
Owston's spiny dogfish	694	0.7
Plunket shark	555	0.6
Ling	520	0.5
All species	98 397	

**Table 4: Total catches (kg) of the three main commercial species by area**

	Puysegur	Macquarie	Auckland
Orange roughy	8 289.6	118.7	4 690.6
Smooth oreo	4 999.9	3 160.2	32 398.2
Black oreo	4 693.1	17 378.5	5.8

**Table 6: Catch rates (all fish) and biomass of orange roughy by stratum**

Stratum	Mean catch rate (kg <sup>-1</sup> )	s.d.	Biomass (t)		
			All fish	1-29 cm fish	30 + cm fish
Puysegur					
0110	0	0	0	0	0
0210	1.3	1.8	9.2	0	9.2
0220	0	0	0	0	0
0230	0.6	1.2	1.5	0.3	1.2
0241	0.6	0.7	2.2	0.3	1.9
0242	0.5	0.8	4.5	1.0	3.5
0243	19.7	27.7	7.6	0.1	7.5
0244	20.0	37.4	5.4	0.4	5.0
0245	1.4	2.0	0.9	0.7	0.2
0246	79.0	172.1	85.1	9.8	75.3
0247	4.3	5.3	3.5	0.2	3.3
0250	0.4	0.5	6.8	0.8	6.0
0320	4.5	4.6	13.5	0.4	13.1
0410	0.3	0.5	0.9	0	0.9
0420	10.2	17.7	18.0	0.1	17.9
0430	0.2	0.2	0.5	0.5	0
0440	0.1	0.1	0.2	0.2	0
0450	0	0	0	0	0
0501	623.7	856.4	455.8	110.2	345.6
0502	425.0	836.7	114.4	0.8	113.6
Macquarie					
0801	292.1	436.7	89.9	6.7	83.2
0802	130.4	159.9	70.2	11.6	58.6
0803	676.6	739.4	260.2	14.5	245.7
0804	15.9	22.5	8.6	0.2	8.4
Auckland					
1001	416.1	54.3	224.1	0.5	223.6
1002	7 832.51	2 910.4	2 241.0	0	2 410.0
Total			3 793.1	159.4	1 244.8

**Table 8: Biomass indices (t) for orange roughy, smooth oreo, and black oreo (to nearest 10 t) for the Puysegur Bank strata in 1994 and 1992 surveys**

	1994			1992		
	Biomass	95 % range	c. v. (%)	Biomass	95 % range	c. v. (%)
Orange roughy						
All fish	1 160	610–1 710	23.7	6 630	2 950–10 320	27.7
1–29 cm	380	180–570	25.8	770	150–1 400	40.6
30–50 cm	780	330–1 230	28.7	5 860	2 670–9 040	27.2
Smooth oreo						
All fish	730	150–1 310	40.0	1 890	1 060–2 720	21.9
1–29 cm	130	10–240	44.7	90	50–120	17.6
30–60 cm	600	90–1 110	42.2	1 800	980–2 610	22.7
Black oreo						
All fish	680	0–1 370	50.7	2 950	1 490–4 440	24.6
1–29 cm	210	0–460	62.4	200	50–340	34.6
30–60 cm	470	0–960	51.5	2 750	1 350–4 150	25.4

**Table 9: Length-weight regression equations for orange roughy, smooth oreo, and black oreo by sex for the survey area\***

	Sex	LW regression	<i>n</i>	<i>r</i> <sup>2</sup>
Orange roughy	Both	$W = 6.06 \times 10^{-2} L^{2.83}$	1 042	0.96
	M	$W = 7.02 \times 10^{-2} L^{2.78}$	509	0.96
	F	$W = 6.36 \times 10^{-2} L^{2.82}$	533	0.97
Smooth oreo	Both	$W = 2.01 \times 10^{-2} L^{3.02}$	740	0.95
	M	$W = 2.60 \times 10^{-2} L^{2.94}$	332	0.97
	F	$W = 2.17 \times 10^{-2} L^{3.00}$	408	0.96
Black oreo	Both	$W = 5.83 \times 10^{-3} L^{3.36}$	482	0.94
	M	$W = 8.97 \times 10^{-3} L^{3.23}$	255	0.93
	F	$W = 4.78 \times 10^{-3} L^{3.42}$	227	0.94

\* *L*, length (cm); *W*, weight (g); *n*, samples size; *r*<sup>2</sup>, correlation coefficient.

**Table 11: Stomach states of orange roughy, smooth oreo, and black oreo examined during the survey**

State	Orange roughy		Smooth oreo		Black oreo	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Empty	392	37.7	364	49.6	114	24.0
Trace	80	7.7	35	4.8	10	2.1
Part-full	435	41.8	138	18.8	63	13.2
Full	134	12.9	18	2.5	11	2.3
Everted	0	0	179	24.4	278	58.4
<i>n</i>	1 041		734		476	

**Table 12: Major prey groups of orange roughy from the survey area\***

Prey group	Frequency		Volume		IV index	
	<i>n</i>	%	<i>v</i>	%	<i>IV</i>	<i>IV%</i>
Crustacea						
Amphipoda	110	19.3	5 705	10.0	13.9	12.1
Decapoda Natantia	133	23.4	9 750	17.1	20.0	17.3
Euphausiacea	31	5.4	1 635	2.9	4.0	3.4
Mysidacea	18	3.2	1 280	2.2	2.7	2.3
Crustacean remains	44	7.7	2 885	5.1	6.3	5.4
Mollusca						
Cephalopoda Decapoda	129	22.7	8 720	15.3	18.6	16.2
Pisces						
Macrouridae	2	0.4	200	0.4	0.4	0.3
Mesopelagic group <sup>1</sup>	55	9.7	4 705	8.3	8.9	7.7
Other groups <sup>2</sup>	13	2.3	1 015	1.8	2.0	1.7
Fish remains	238	41.8	19 410	34.1	37.8	32.7
Thaliacea						
Salpidae	3	0.5	250	0.4	0.5	0.4
Unidentified	2	0.4	200	0.4	0.4	0.3

\* *n*, number of fish with prey group; *v*, volume (sum of percentages); number of stomachs full or part full, 569.

<sup>1</sup> Includes families Paralepididae, Melamphaidae, Idiacanthidae, Myctophidae, Photichthyidae, Malacosteidae, Melanonidae, Melanostomiidae, Sternoptychidae, Astronesthidae, Stomiidae, Chauliodontidae.

<sup>2</sup> Includes families Bathylagidae, Moridae, Apogonidae, Platytrichtidae, Alepocephalidae.

**Table 14: Major prey groups of black oreo from the survey area\***

Prey group	Frequency		Volume		IV index	
	<i>n</i>	%	<i>v</i>	%	<i>IV</i>	<i>IV%</i>
Crustacea						
Amphipoda	3	4.1	12	0.2	0.8	0.7
Decapoda Natantia	4	5.4	150	2.0	3.3	3.0
Euphausiacea	2	2.7	26	0.4	1.0	0.9
Crustacean remains	6	8.1	310	4.2	5.8	5.2
Mollusca						
Cephalopoda Decapoda	7	9.5	310	4.2	6.3	5.6
Pisces						
Mesopelagic group <sup>1</sup>	3	4.1	300	4.1	4.1	3.6
Nemichthyidae	1	1.4	100	1.4	1.4	1.2
Fish remains	49	66.2	4 384	59.2	56.2	56.2
Thaliacea						
Salpidae	21	28.4	1 608	21.7	24.8	22.3
Unidentified	1	1.4	100	1.4	1.4	1.2

\* *n*, number of fish with prey group; *v*, volume (sum of percentages); number of stomachs full or part full, 74.

<sup>1</sup> Includes families Malacosteidae, Astronesthidae, Stomiidae.

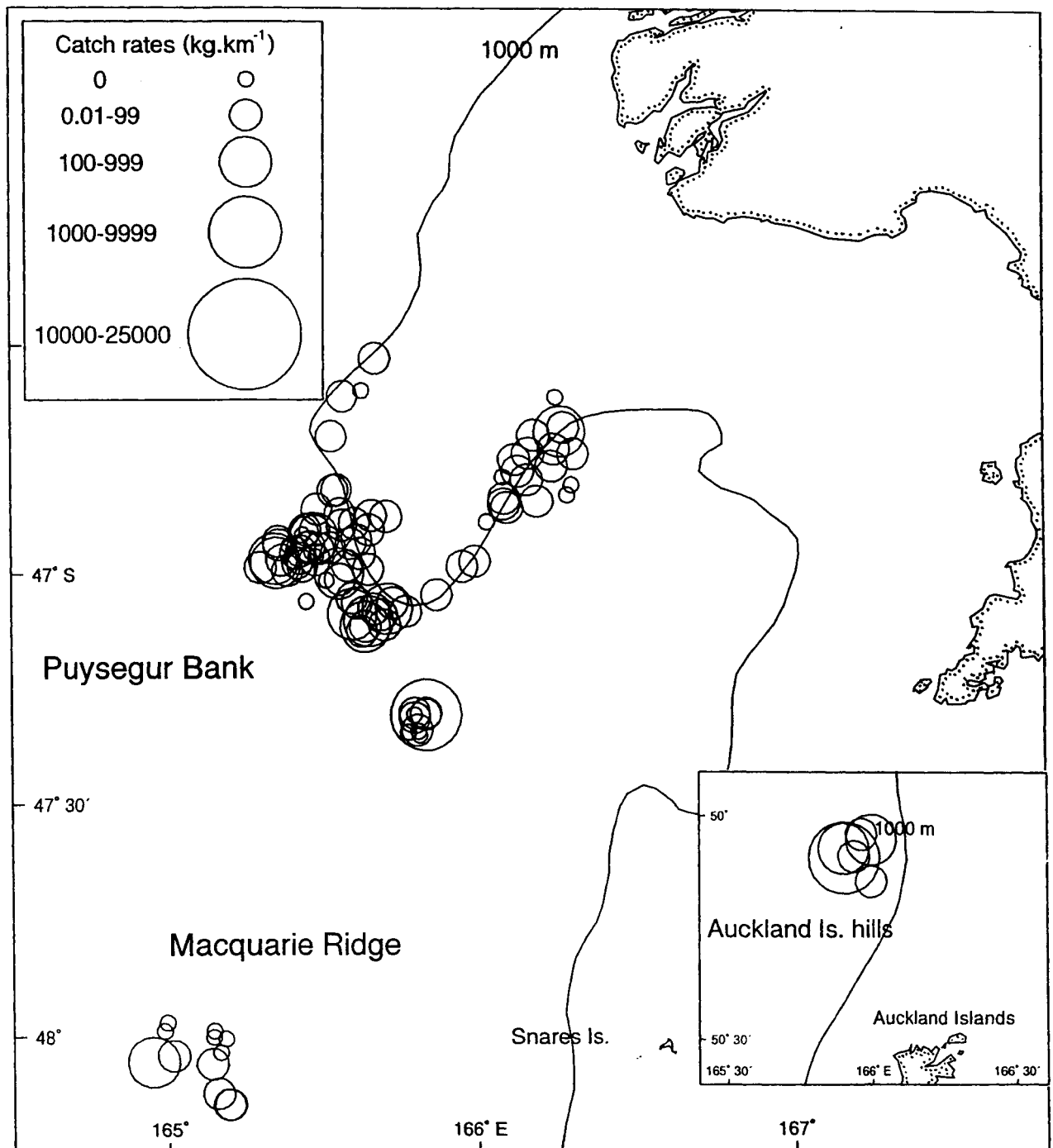


Figure 2: Catch rates of orange roughy.

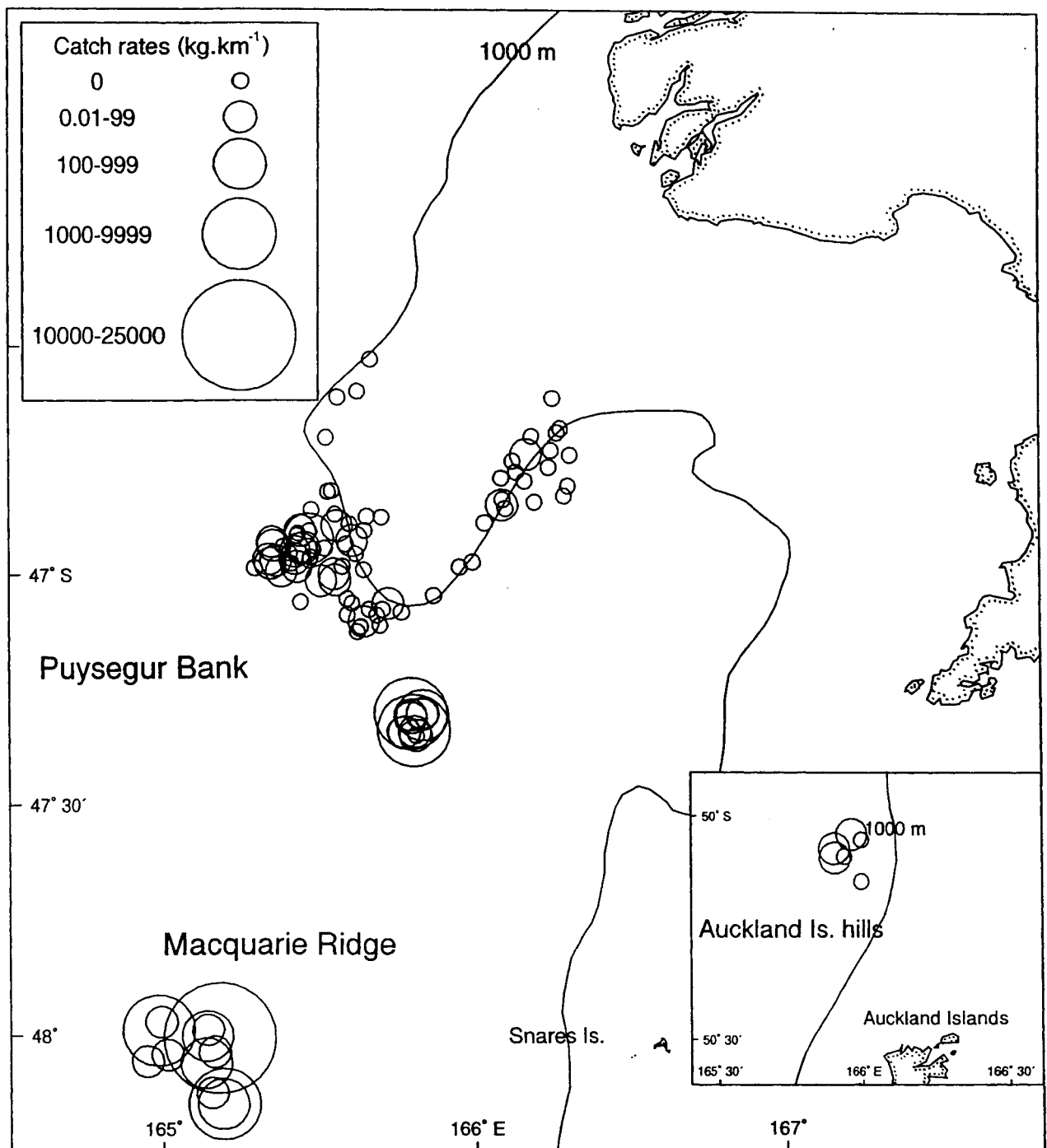


Figure 4: Catch rates of black oreo.

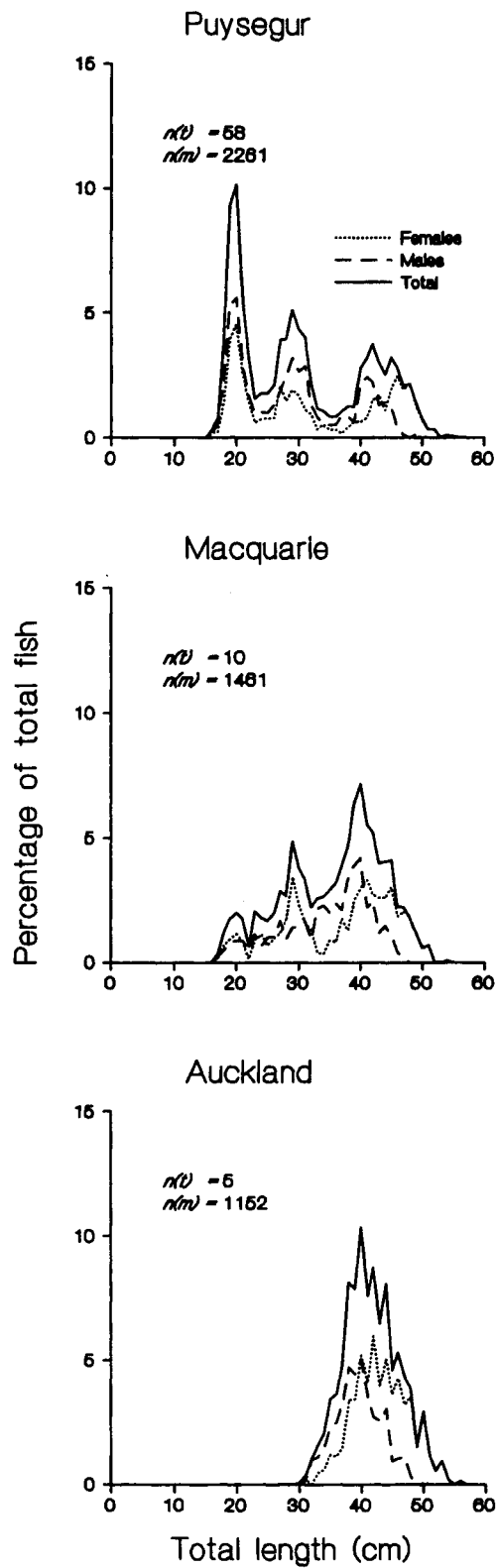


Figure 6: Length frequency distribution of smooth oreo by area (scaled to represent the total population:  $n(t)$ , number of trawls with samples;  $n(m)$ , number of fish actually measured).



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Stratified random trawl surveys were carried out on the Puysegur Bank using the commercial vessels *Will Watch* and *Giljanes* in July 1991 and 1992 respectively (Clark & Tracey 1992, 1993). These surveys produced extensive data on distribution, relative abundance, and biology of orange roughy and oreos, but they were not comparable for biomass estimation, and a time series of surveys using RV *Tangaroa* was planned. The first of these was carried out in August-September 1992 (Clark & Tracey 1994). The present survey was the second in the series.

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To provide research information for the assessment of southwestern stocks of orange roughy, smooth oreo, and black oreo in the region of the Puysegur Bank, northern Macquarie Ridge, and Auckland Islands shelf by:

1. describing the distribution and measuring indices of biomass;
2. collecting biological data on size structure and reproduction for determination of prerecruit/recruited biomass, and development and timing of spawning;
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4. measuring depths and positions for development of bathymetric charts around the Puysegur Bank, northern hills of the Macquarie Ridge, and the Auckland Islands area.

## Methods

### Survey area and design

The survey area covered 2404 km<sup>2</sup> and included the Puysegur Bank, hills on the northern Macquarie Ridge, and a hill complex north of the Auckland Islands (Figure 1). The slope west of Stewart Island was not covered because of lack of time. The strata were the same as on the first survey (Appendix 1).

The survey was of a two-phase random stratified design (*after* Francis 1984). The survey area was divided into 39 strata (Table 2) on the basis of known fish distribution and bottom bathymetry from previous surveys and commercial catch information. New random station positions were computer generated, with a minimum of three tows per stratum. Four methods were used to specify tow position, depending on the bottom characteristics of the strata.

1. For flat ground, random latitude, random longitude, tow direction parallel to depth contour (strata 110, 120, 140, 210, 220, 230, 241, 242, 250, 410–450, 610–650, 710–750).
2. Random latitude, random direction off the top of the hill (246, 801, 802).
3. Random latitude, tow directly down steep slope where it was too steep and rough to follow the depth contour (243, 320).
4. Random direction off the peak of a hill feature (244, 245, 247, 501, 502, 803, 804, 1001–1003).

All hill strata were fished several times using the methods discussed by Clark (1994). Tows on a given hill were spread over a number of days at different times of the day to give temporal and spatial components to the sampling to accurately represent fish distribution and abundance. Ridge features (running north-south) separated tows by latitude as well as direction. When a conical hill was being fished, random directions were separated by at least 20°.

Towing speed was kept at 3.0–3.5 kn: when possible tow distance was standardised to 1.5 n. miles. However, these two parameters could not be kept constant on hills and steep slopes. Hills were trawled from the peak to the base to represent the entire hill, and towing speed was lower on steep hills to maintain good bottom contact. The warp to depth ratio varied from 1.6 : 1 to 2.1 : 1, depending on bottom depth.

In several analyses, data are grouped by sub-area:

Puysegur — the Puysegur Bank region, including strata 110–450, and hills just to the south (501, 502);

Macquarie — hills of the northern Macquarie Ridge, strata 801–804;

Auckland — hills near the Auckland Islands, strata 1001–003.

## Vessel and gear specifications

RV *Tangaroa* has the following specifications: overall length, 70 m; beam, 14 m; gross tonnage, 2280 t; main engine power, 3000 kW.

The gear used was the standard rough bottom orange roughy trawl (*see* Clark & Tracey 1992), with two lengtheners, three codends, bobbin rig, and codend mesh of 100 mm. The trawl gear was set up in pinnacle mode except that 26 floats were used on the headline to maintain direct comparability with the 1992 survey. Doorspread and headline height were measured regularly.

## Treatment of catch

The catch for each tow was sorted by species, and weighed on motion-compensating scales accurate to the nearest 0.3 kg. If a large catch made weighing impractical, the greenweights of the three main species (orange roughy, smooth oreo, and black oreo) were back-calculated from the factory tray counts. Conversion factors and mean tray weights were obtained from all tows thus handled.

Samples of 100–200 orange roughy, smooth oreo, and black oreo were routinely measured and sexed. If a catch was large, several samples were taken from different parts of the net and combined to ensure that sampling was representative of the entire catch.

A further 20 fish of each of the main species were taken at random on each tow and examined in greater detail for length (mm), weight (g), sex, gonad weight (g), gonad stage, stomach fullness and digestion state, and identification of prey items. Otoliths were also collected.

## **Timetable of events**

*Tangaroa* sailed for the survey grounds on the evening of 23 September: fishing began on the evening of the 24th and continued until the 27th when it was necessary to steam to Dunedin for winch repairs. Fishing resumed on 9 October and the survey was completed on 23 October. The vessel returned to Wellington on 25 October. Rock dredge tows were made (in conjunction with the Institute of Geological and Nuclear Sciences) for collection of rock samples.

## **Biomass estimates**

Biomass indices were calculated by the area swept method (Francis 1981) using the Trawlsurvey Analysis Program (as at February 1995). Clark & Tracey (1992) described the formulae for calculating biomass and standard error. A constant wingspread measurement figure of 26.0 m (vulnerability of 0.23) and vertical and areal availability assumptions of 1.0 were used to estimate biomass. The recorded distance was used for distance towed. Length-weight parameters from this survey were used in biomass analysis.

Biomass has been calculated from two sets of strata: the entire survey area and the area comparable with that sampled in 1992. This equates to the entire survey area less those strata not sampled in 1992, (i.e., strata 801, 802, 803, 804, 1001, 1002. Strata 801 and 802 are excluded because they are part of a hill complex which includes strata 803 and 804).

## **Biological analyses**

### **Length frequency distribution**

Length frequency data have been scaled by percentage sampled to represent each catch, and then further scaled by stratum area and biomass to represent the total population size distribution.

### **Feeding analyses**

Data on frequency of occurrence and volume of prey have been combined into a single index (*IV*) (Vesin *et al.* 1981) to assess the relative importance of prey for orange roughy, smooth oreo, and black oreo:

$$IV = \sqrt{(\% \text{ frequency}) (\% \text{ volume})}$$

Frequency of occurrence is the number of stomachs in which a prey item was found. The volume of each prey item was assessed by eye as the proportion of stomach contents where each stomach (part-full or full) totalled 100%.

## Results

### Trawl station distribution

Of the 111 trawl stations completed, 105 were classified as acceptable and 6 were excluded because of poor gear performance (tows 22, 40, 48, 49, 57, and 96).

Most stations were on the western side of Puysegur Bank, with others on hill features to the south. Detailed station position and catch information is given in Appendix 2. A list of species caught during the survey is given in Appendix 3.

### Catch

A total of 98 400 kg of fish was caught during the survey. The principal species by weight were smooth oreo (41%), black oreo (22%), and orange roughy (13%) (Table 3). The main bycatch species were small scaled brown slickhead, Baxter's dogfish, hoki, and leafscaled gulper shark. The catch of other species was less than 1 t each.

The dominant species differed with area (Table 4). Orange roughy was the main catch in the Puysegur area, and black oreo and smooth oreo were markedly dominant in catches on the Macquarie Ridge and Auckland Island hills respectively.

### Distribution and catch rates

Orange roughy occurred throughout the survey area, though catch rates were variable (Figure 2). Catch of rates of over 100 kg.km<sup>-1</sup> occurred on several hill and slope areas on Puysegur Bank ("Godiva", "Alastairs", "Malcolm's Monument", "Mt Duncan"), on the Macquarie Ridge ("True Confessions"), and off the Auckland Islands ("Barbara Thomas"). Catch rates over 1000 kg.km<sup>-1</sup> were recorded only on "Mt Duncan" and "Barbara Thomas" (maximum 3000 kg.km<sup>-1</sup>).

Smooth oreo were caught in most tows. Catch rates were generally low on the western Puysegur Bank, but high on hills to the south, Macquarie Ridge, and the Auckland Islands hills (especially "Barbara Thomas" where the maximum catch rate was 22 700 kg.km<sup>-1</sup>) (Figure 3).

Black oreo were also found throughout the survey area (Figure 4). Catch rates were low throughout the Puysegur Bank shelf region and off the Auckland Islands. Catches and catch rates were high at times on the Puysegur hills ("Mt Duncan", "Porirua") and Macquarie Ridge hills ("Bob's Gun", "Fifino") (1000–1200 kg.km<sup>-1</sup>)

Catch rates by stratum for orange roughy, smooth oreo, and black oreo are given in Tables 5, 6, and 7 respectively.



## Biomass indices

The biomass of orange roughy for the entire survey area was 1630 t (*c.v.* = 20%), of which 383 t (*c.v.* = 25%) was prerecruit and 1245 t (*c.v.* = 30%) recruit-sized fish (*see* Table 5).

The biomass was concentrated on west Puysegur Bank, particularly strata 230 (900–1000 m), 242 (1000–1200 m), 246 (“Hydro” and “Labrador”) and 247 (“Malcolm’s Monument”). Other important strata were 430 (east Puysegur, 900–1000 m) and 501 (“Mt Duncan”). The main areas of the commercial fishery (strata 243, 244, and 245) had relatively low catch rates and biomass.

The biomass of smooth oreo came mostly from strata 501 and 502 (“Mt Duncan” and “Porirua”) (*see* Table 6). The slope areas of Puysegur Bank contributed little. The total biomass index was 3793 t, (*c.v.* = 61%) of which 3634 t (96%) was fish of 30 cm or longer.

Black oreo biomass was also concentrated in strata 501 and 502 in the Puysegur Bank area and on hills of the Macquarie Ridge (*see* Table 7). The total survey index was 2680 t (*c.v.* = 42%).

For comparison with the 1992 survey, biomass indices were derived from 87 tows in the Puysegur Bank area (Table 9). The 1992 values are based on updated strata area calculations and differ slightly from those given by Clark & Tracey (1994).

The 1994 index for orange roughy is 17% of that for 1992, and for smooth oreo and black oreo is 39% and 23%, respectively. There is also an increase in the proportion of prerecruit fish to recruits for all species.

The high coefficients of variation of the biomass indices for smooth oreo and black oreo (Table 8) reflect the allocation of stations to optimise the results for orange roughy, rather than oreos, with the reduced survey time available.

## Size structure

### Orange roughy

In the Puysegur area fish ranged from 8 to 47 cm standard length. There was a large modal peak at 28 cm and a lesser peak at 36 cm (Figure 5). The length frequency distributions were similar for males and females.

Sample sizes from the Macquarie Ridge hills were rather small: fish lengths ranged from 9 to 46 cm, with a peak at 36 cm (both male and female) and another at 40 cm (female only) (Figure 5).

The length frequency distribution of fish from the Auckland Island hills was unimodal overall with the peak at 34–36 cm. The modal length of males was 34 cm, and of females, 38 cm. Fish ranged in length from 25 to 45 cm.

The percentage of females was similar in the Puysegur Bank and Auckland areas (49.7% and 55.2%, respectively), but was higher (68.1%) on the Macquarie Ridge hills.

### Smooth oreo

In the Puysegur region there were clear modes at 20, 30, and 44 cm total length (Figure 6). Size structure by sex was similar, except in the largest mode where males peaked at 41 cm and females at 48 cm.

Two main modes were dominant on Macquarie Ridge hills, 30 cm (mainly females) and 40–41 cm.

In the Auckland Islands region there was a unimodal length frequency distribution with its peak at 40 cm. The smallest fish caught was 18 cm long but there were markedly fewer small fish than in the Puysegur and Macquarie Ridge areas. Females were on average 2–3 cm longer than males.

The percentage of females was similar in all three areas (Puysegur, 48.3% female; Macquarie, 52.8%; Auckland, 55.7%).

### **Black oreo**

In the Puysegur and Macquarie areas fish ranged in size from 22 to 46 cm total length (Figure 7). Puysegur fish had a unimodal distribution at 30 cm for both males and females. There was a bimodal distribution in the Macquarie region, with peaks at 30 cm and 38 cm. The latter peak was an average of the male peak at 35 cm and a female peak at 39–41 cm.

The percentage of females was similar in both areas (Puysegur, 46.9%; Macquarie, 52.2%).

Length-weight relationships for orange roughy, smooth oreo, and black oreo are given in Table 9.

### **Reproduction**

Gonad stage proportions for each species by area are shown in Table 10. Almost all orange roughy sampled were in immature/resting or early stages of maturation (stages 1 and 2) as is expected several months after the spawning period (early–mid July).

Smooth oreo and black oreo were mainly in stages 1, 2, and 3. There were many small immature fish (< 30 cm) in Puysegur and Macquarie which contributed to high proportions of stages 1 and 2. The larger fish were generally at stage 3 (maturing), which is consistent with the known spawning period of October–November for both smooth oreo and black oreo.

### **Feeding**

A total of 1041 orange roughy stomachs was examined during the survey (Table 11). Of these, 569 (55%) were part-full or full and were analysed in more detail. The major prey groups (Table 12) were fish, shrimps and prawns, squids, and amphipods.

Smooth oreo stomachs were frequently everted (24%) or empty (50%) (*see* Table 11) and only 21% were part-full or full: salps and squids were the major prey (Table 13).

Most black oreo stomachs were everted (58%) or empty (24%) (*see* Table 11). The main prey identified were fish and salps (Table 14).

## Discussion

The design of this survey, the second in a planned time series, was based largely on that of TAN9208 with which it had to be comparable. Core strata on Puysegur Bank remained the same, but extra areas were included on the northern Macquarie Ridge (strata 803, 804) and near the Auckland Islands (1001, 1002, 1003), where the fishery has expanded in 1992 and 1994.

The survey design incorporates fishing on a number of hill features, which are treated as separate strata (*see* Clark & Tracey 1992, Clark 1994). During the survey there were no indications of rapid gear saturation, or of the net catching fish while approaching, or coming off, the bottom so the measurement of tow distance on the bottom should accurately describe catching distance, even on short tows. Short tows were made because of small and steep hills, not because of high catch rates. There were no indications of fish movement between strata.

There have been marked changes in the commercial fishery in recent years, and the quota has been reduced. Two surveys are not enough for reliable estimation of biomass and yields, but a number of major changes since the 1992 survey need to be highlighted.

1. There has been a marked decrease in the frequency of high catch rates of orange roughy on Puysegur Bank (including "Mt Duncan" and "Porirua").

In 1992, 14 out of 75 tows had catch rates of 500–9999 kg.km<sup>-1</sup> and 1 had over 10 000 kg. km<sup>-1</sup>. In 1994, only 2 out of 73 tows were in the 500–9999 kg.km<sup>-1</sup> range.

2. The distribution of catch rates has changed. In 1992 the highest mean catch rates were on the hills (particularly "Godiva" and "Goomzy"), but these hills were not important in 1994. The mean catch rates (kg. km<sup>-1</sup>) for each stratum were:

	1992	1994
0243 ("Alistairs")	605	115
0244 ("Godiva")	3 800	85
0245 ("Goomzy")	2 550	20
0501 ("Mt Duncan")	70	270
0502 ("Porirua")	115	2
0247 ("Malcolm's Monument")	800	130

3. The biomass index for orange roughy has declined substantially, from 6630 t in 1992 to 1160 t in 1994. For fish below 30 cm total length the decline is from 5850 t to 780 t.

4. Length frequency distributions have changed. In 1992 the overall orange roughy size distribution was slightly bimodal, with a strong modal peak at 35–36 cm and a secondary mode at 26–28 cm. In 1994 the pattern was reversed, with a strong mode at 27–28 cm and a secondary peak at 35–36 cm.

Figure 8 shows length frequency distributions from the eastern side, western side, and hills of the Puysegur Bank. Both slope areas in 1994 show a decrease in the 30–40 length mode since 1992, while the size structure on the hills remained similar to that in 1992. The change in overall size is a combination of fewer large fish on the slope areas and a dramatically lower biomass on the hills.

5. Catch rates and the biomass index of oreo species have decreased. The precision of results for oreos is much lower than for orange roughy because the survey focused on orange roughy. Nevertheless, there are strong indications of decline in stock size of oreos in the Puysegur Bank area.

The 1994 survey (September–October) was held later than in 1992 (August–September): it is not known what effect this might have on results. Commercial catch rate data for August–November 1992–94 show no obvious trends, which suggests that a decline in biomass with a possible post-spawning migration is unlikely between the different times of the surveys.

The survey results show that the stock size of fish resident on the Puysegur Bank has been considerably reduced. The fishery might, therefore, become based more on orange roughy moving into the area each winter to spawn. It is not clear how well the survey covers the likely range of dispersed fish as catch rates in deeper water and on adjacent slope and hill features were relatively low. A survey in 1995 would be unlikely to show sufficient contrast to the 1994 results, so the third survey is planned for 1996.

## Acknowledgments

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**Table 1: Reported catches (t) of orange roughy (ORH), smooth oreo (SSO), black oreo (BOE), and unspecified oreo (OEO) by area from 1990–91 to 1993–94 (from QMS data, ORH figures in brackets are corrected from estimated catch per tow records to total reported catch in ORH 3B from QMRs)**

Year	ORH		SSO	BOE	OEO	Total oreo
<b>Puysegur</b>						
1990-91	790	(850)	402	1 687	15	2 104
1991-92	6 592	(6900)	478	1 807	147	2 432
1992-93	4 720	(5450)	417	1 214	270	1 901
1993-94	2 381	(2675)	1 023	886	18	1 927
<b>Snares</b>						
1990-91	28		38	188	0	226
1991-92	9		99	273	0	372
1992-93	472		715	2 289	0	3 004
1993-94	37		656	1 680	9	2 345
<b>Auckland</b>						
1990-91	-					
1991-92	-					
1992-93	211		307	0	0	307
1993-94	190		163	0	27	300

**Table 2: Stratum areas, description, and number of stations surveyed in 1992 (TAN9208) and 1994 (TAN9409)\***

Stratum	Area (km <sup>2</sup> )	Description	1992	1994
0110	252.0	north Puysegur, 600–800 m	3	3
0120	111.5	north Puysegur, 800–1000 m	2	(1x)
0140	64.0	north Puysegur, 1000–1500 m	1	
0210	180.0	west Puysegur, 600–800 m	3	3
0220	71.0	west Puysegur, 800–900 m	4	3 (1x)
0230	62.0	west Puysegur, 900–1000 m	3	8
0241	102.0	west Puysegur, 1000–1200 m (west)	7	4
0242	257.0	west Puysegur, 1000–1200 m (east)	6	5
0243	10.0	west Puysegur, 1000–1200 m (“Alistairs”)	6	5
0244	7.0	west Puysegur hill (“Godiva”)	4 (3x)	4 (1x)
0245	17.0	west Puysegur hill (“Goomzy”)	8 (1x)	5
0246	28.0	west Puysegur hills (“Hydro” and “Labrador”)	4	5
0247	21.0	west Puysegur hill (“Malcolm’s Monument”)	6 (1x)	5
0250	461.0	west Puysegur, 1200–1500 m	3	5
0320	78.0	central Puysegur, 800–1200 m	4 (1x)	3
0410	79.0	east Puysegur, 600–800 m	3	3
0420	46.0	east Puysegur, 800–900 m	3	3
0430	79.0	east Puysegur, 900–1000 m	3 (1x)	5
0440	187.0	east Puysegur, 1000–1200 m	3	5
0450	193.0	east Puysegur, 1200–1500 m	3	3
0501	19.0	south Puysegur hill (“Mt Duncan”)	2 (2x)	6
0502	7.0	south Puysegur hill (“Porirua”)	2 (1x)	4 (2x)
0610	567.0	north Stewart, 600–800 m	3	
0620	604.0	north Stewart, 800–1000 m	3	
0640	723.0	north Stewart, 1000–1200 m	3	
0650	372.0	north Stewart, 1200–1500 m	3	
0710	212.0	south Stewart, 600–800 m	2	
0720	375.0	south Stewart, 800–1000 m	5	
0740	585.0	south Stewart, 1000–1200 m	4	
0750	408.0	south Stewart, 1200–1500 m	3	
0801	8.0	Macquarie hill (“Bob’s Gun” {north})	5	4 (1x)
0802	14.0	Macquarie hill (“Bob’s Gun” {south})	3(1x)	3
0803	10.0	Macquarie hill (“Fifino”)		2
0804	14.0	Macquarie hill (“True Confessions”)		2
0901	*1.0	Macquarie hill (“Searle City”)		
0902	*1.0	Macquarie hill (“Jackos”)		
1001	14.0	Auckland hill (“DSW”)		2
1002	8.0	Auckland hill (“Barbara Thomas”)		3
1003	5.0	Auckland hill (“Ruth Baby”)		1

\* Strata 901 and 902 were not fished.

x Denotes unsatisfactory, excluded tows.

**Table 3: Total catch and percentage composition by weight of the 12 most abundant species caught in the survey**

	Catch (kg)	% of total
Smooth oreo	40 558	41.2
Black oreo	22 077	22.4
Orange roughy	13 099	13.3
Smallscaled brown slickhead	6 736	6.8
Baxter's dogfish	5 057	5.1
Hoki	2 259	2.3
Leafscaled gulper shark	1 093	1.1
Longnosed velvet dogfish	915	0.9
Hake	810	0.8
Owston's spiny dogfish	694	0.7
Plunket shark	555	0.6
Ling	520	0.5
All species	98 397	

**Table 4: Total catches (kg) of the three main commercial species by area**

	Puysegur	Macquarie	Auckland
Orange roughy	8 289.6	118.7	4 690.6
Smooth oreo	4 999.9	3 160.2	32 398.2
Black oreo	4 693.1	17 378.5	5.8

**Table 5: Catch rates (all fish) and biomass of orange roughy by stratum**

Stratum	Mean catch rate (kg.km <sup>-1</sup> )	s.d.	Biomass		
			All fish	1–29 cm fish	30 + cm fish
Puysegur					
0110	0.3	0.5	2.7	0.1	2.6
0210	2.3	1.1	15.8	0.8	15.0
0220	15.6	23.9	42.6	1.0	41.6
0230	62.6	102.6	149.2	78.4	70.8
0241	5.9	7.9	23.3	1.9	21.4
0242	12.6	16.4	125.0	65.9	59.1
0243	113.7	150.5	43.7	0.3	43.4
0244	85.6	156.8	23.1	0.5	22.6
0245	21.3	25.1	14.0	1.5	12.5
0246	116.9	225.6	125.9	32.5	93.4
0247	128.0	106.0	103.4	22.7	80.7
0250	4.6	5.7	80.8	36.5	44.3
0320	7.0	4.4	21.1	5.9	15.2
0410	0	0	0	0	0
0420	0.7	0.7	1.2	1.2	0
0430	37.7	49.7	114.6	71.5	43.1
0440	10.7	19.8	76.7	53.4	23.3
0450	0.1	0.1	0.5	0.5	0
0501	270.4	640.4	197.6	3.2	194.4
0502	2.4	4.8	0.7	0.	0.7
Macquarie					
0801	0.2	0.4	0.1	0	0.1
0802	3.2	2.5	1.7	0.1	1.6
0803	0	0	0	0	0
0804	83.5	57.6	44.9	0	44.9
Auckland					
1001	155.5	86.9	83.7	3.2	80.5
1002	1 089.8	1 648.4	335.3	1.5	333.8
Total			1 627.6	382.2	1 244.8



**Table 6: Catch rates (all fish) and biomass of orange roughy by stratum**

Stratum	Mean catch rate (kg <sup>-1</sup> )	s.d.	Biomass (t)		
			All fish	1–29 cm fish	30 + cm fish
Puysegur					
0110	0	0	0	0	0
0210	1.3	1.8	9.2	0	9.2
0220	0	0	0	0	0
0230	0.6	1.2	1.5	0.3	1.2
0241	0.6	0.7	2.2	0.3	1.9
0242	0.5	0.8	4.5	1.0	3.5
0243	19.7	27.7	7.6	0.1	7.5
0244	20.0	37.4	5.4	0.4	5.0
0245	1.4	2.0	0.9	0.7	0.2
0246	79.0	172.1	85.1	9.8	75.3
0247	4.3	5.3	3.5	0.2	3.3
0250	0.4	0.5	6.8	0.8	6.0
0320	4.5	4.6	13.5	0.4	13.1
0410	0.3	0.5	0.9	0	0.9
0420	10.2	17.7	18.0	0.1	17.9
0430	0.2	0.2	0.5	0.5	0
0440	0.1	0.1	0.2	0.2	0
0450	0	0	0	0	0
0501	623.7	856.4	455.8	110.2	345.6
0502	425.0	836.7	114.4	0.8	113.6
Macquarie					
0801	292.1	436.7	89.9	6.7	83.2
0802	130.4	159.9	70.2	11.6	58.6
0803	676.6	739.4	260.2	14.5	245.7
0804	15.9	22.5	8.6	0.2	8.4
Auckland					
1001	416.1	54.3	224.1	0.5	223.6
1002	7 832.51	2 910.4	2 241.0	0	2 410.0
Total			3 793.1	159.4	1 244.8

**Table 7: Catch rates (all fish) and biomass of orange roughy by stratum**

Stratum	Mean catch rate (kg.km <sup>-1</sup> )	s.d.	Biomass (t)		
			(All fish)	1-29 cm fish	30 + cm fish
Puysegur					
0110	0	0	0	0	0
0210	0	0	0	0	0
0220	0	0	0	0	0
0230	0.1	0.2	0.2	0.2	0
0241	1.0	1.2	3.8	0.6	3.2
0242	0	0	0	0	0
0243	15.6	32.6	6.0	0	6.0
0244	231.5	462.8	62.3	6.2	56.1
0245	1.3	1.9	0.9	0.2	0.7
0246	16.0	34.2	17.2	3.3	13.9
0247	0.1	0.2	0.1	0	0.1
0250	0.1	0.1	0.5	0.5	0
0320	0	0	0	0	0
0410	0	0	0	0	0
0420	0	0	0	0	0
0430	0.9	1.9	2.7	0.7	2.0
0440	0	0	0	0	0
0450	0	0	0	0	0
0501	477.7	829.1	349.1	162.3	186.8
0502	874.5	727.2	235.4	32.2	203.2
Macquarie					
0801	3 299.0	5 822.1	1 015.1	14.1	1 001.0
0802	1 074.7	1 556.7	578.7	1.0	577.7
0803	1 017.3	1 348.6	391.2	75.3	315.9
0804	31.5	42.3	16.9	9.3	7.6
Auckland					
1001	0.5	0.7	0.3	0.1	0.2
1002	1.3	1.1	0.4	0	0.4
Total			2 680.9	305.9	2 375.0

**Table 8: Biomass indices (t) for orange roughy, smooth oreo, and black oreo (to nearest 10 t) for the Puysegur Bank strata in 1994 and 1992 surveys**

	1994			1992		
	Biomass	95 % range	c. v. (%)	Biomass	95 % range	c. v. (%)
Orange roughy						
All fish	1 160	610–1 710	23.7	6 630	2 950–10 320	27.7
1–29 cm	380	180–570	25.8	770	150–1 400	40.6
30–50 cm	780	330–1 230	28.7	5 860	2 670–9 040	27.2
Smooth oreo						
All fish	730	150–1 310	40.0	1 890	1 060–2 720	21.9
1–29 cm	130	10–240	44.7	90	50–120	17.6
30–60 cm	600	90–1 110	42.2	1 800	980–2 610	22.7
Black oreo						
All fish	680	0–1 370	50.7	2 950	1 490–4 440	24.6
1–29 cm	210	0–460	62.4	200	50–340	34.6
30–60 cm	470	0–960	51.5	2 750	1 350–4 150	25.4

**Table 9: Length-weight regression equations for orange roughy, smooth oreo, and black oreo by sex for the survey area\***

	Sex	LW regression	<i>n</i>	<i>r</i> <sup>2</sup>
Orange roughy	Both	$W = 6.06 \times 10^{-2} L^{2.83}$	1 042	0.96
	M	$W = 7.02 \times 10^{-2} L^{2.78}$	509	0.96
	F	$W = 6.36 \times 10^{-2} L^{2.82}$	533	0.97
Smooth oreo	Both	$W = 2.01 \times 10^{-2} L^{3.02}$	740	0.95
	M	$W = 2.60 \times 10^{-2} L^{2.94}$	332	0.97
	F	$W = 2.17 \times 10^{-2} L^{3.00}$	408	0.96
Black oreo	Both	$W = 5.83 \times 10^{-3} L^{3.36}$	482	0.94
	M	$W = 8.97 \times 10^{-3} L^{3.23}$	255	0.93
	F	$W = 4.78 \times 10^{-3} L^{3.42}$	227	0.94

\* *L*, length (cm); *W*, weight (g); *n*, samples size; *r*<sup>2</sup>, correlation coefficient.

**Table 10: Gonad stage percent frequency of orange roughy, smooth oreo, and black oreo from the main survey areas**

Stage	<u>Puysegur</u>		<u>Macquarie</u>		<u>Auckland</u>	
	% male	% female	% male	% female	% male	% female
<b>Orange roughy</b>						
1	68.2	22.0	75.0	0.0	63.6	2.5
2	30.6	77.2	25.0	91.3	36.4	95.1
3	0.0	0.5	0.0	8.7	0.0	2.5
4	0.0	0.0	0.0	0.0	0.0	0.0
5	1.2	0.2	0.0	0.0	0.0	0.0
6	0.0	0.2	0.0	0.0	0.0	0.0
<i>n</i>	579	601	20	23	33	81
<b>Smooth oreo</b>						
1	58.2	44.3	53.1	44.0	11.9	20.4
2	15.5	15.7	9.9	8.5	21.5	25.0
3	22.3	37.3	35.2	47.5	65.0	54.6
4	4.1	2.4	1.9	0.0	1.7	0.0
5	0.0	0.3	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0
<i>n</i>	220	287	324	366	303	280
<b>Black oreo</b>						
1	64.3	53.2	47.8	33.1		
2	20.0	20.2	12.4	19.5		
3	14.9	26.1	39.8	47.5		
4	0.0	0.5	0.0	0.0		
5	0.0	0.0	0.0	0.0		
6	0.0	0.0	0.0	0.0		
<i>n</i>	235	188	113	118		

Gonad stages follow Pankhurst *et al.* (1987).

Stage	Female	Male
1	Immature/resting	Immature/resting
2	Early maturation	Early maturation
3	Maturation	Maturation
4	Ripe	Ripe/running ripe
5	Running/ripe	Spent
6	Spent	—

**Table 11: Stomach states of orange roughy, smooth oreo, and black oreo examined during the survey**

State	Orange roughy		Smooth oreo		Black oreo	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Empty	392	37.7	364	49.6	114	24.0
Trace	80	7.7	35	4.8	10	2.1
Part-full	435	41.8	138	18.8	63	13.2
Full	134	12.9	18	2.5	11	2.3
Everted	0	0	179	24.4	278	58.4
<i>n</i>	1 041		734		476	

**Table 12: Major prey groups of orange roughy from the survey area\***

Prey group	Frequency		Volume		IV index	
	<i>n</i>	%	<i>v</i>	%	IV	IV%
Crustacea						
Amphipoda	110	19.3	5 705	10.0	13.9	12.1
Decapoda Natantia	133	23.4	9 750	17.1	20.0	17.3
Euphausiacea	31	5.4	1 635	2.9	4.0	3.4
Mysidacea	18	3.2	1 280	2.2	2.7	2.3
Crustacean remains	44	7.7	2 885	5.1	6.3	5.4
Mollusca						
Cephalopoda Decapoda	129	22.7	8 720	15.3	18.6	16.2
Pisces						
Macrouridae	2	0.4	200	0.4	0.4	0.3
Mesopelagic group <sup>1</sup>	55	9.7	4 705	8.3	8.9	7.7
Other groups <sup>2</sup>	13	2.3	1 015	1.8	2.0	1.7
Fish remains	238	41.8	19 410	34.1	37.8	32.7
Thaliacea						
Salpidae	3	0.5	250	0.4	0.5	0.4
Unidentified	2	0.4	200	0.4	0.4	0.3

\* *n*, number of fish with prey group; *v*, volume (sum of percentages); number of stomachs full or part full, 569.

<sup>1</sup> Includes families Paralepididae, Melamphidae, Idiacanthidae, Myctophidae, Photichthyidae, Malacosteidae, Melanonidae, Melanostomiidae, Sternoptychidae, Astronesthidae, Stomiidae, Chauliodontidae.

<sup>2</sup> Includes families Bathylagidae, Moridae, Apogonidae, Platytroutidae, Alepocephalidae.

**Table 13: Major prey groups of smooth oreo from the survey area\***

Prey group	Frequency		Volume		IV index	
	<i>n</i>	%	<i>v</i>	%	<i>IV</i>	<i>IV%</i>
<b>Crustacea</b>						
Decapoda Natantia	2	1.3	70	0.4	0.8	0.8
Euphausiacea	1	0.6	25	0.2	0.3	0.3
Crustacean remains	1	0.6	100	0.6	0.6	0.7
<b>Mollusca</b>						
Cephalopoda Decapoda	24	15.4	1 752	11.2	13.1	13.5
<b>Pisces</b>						
Mesopelagic group <sup>1</sup>	2	1.3	190	1.2	1.2	1.3
Fish remains	4	2.6	350	2.2	2.4	2.5
<b>Thaliacea</b>						
Salpidae	125	80.1	11 933	76.5	78.3	80.3
<b>Unidentified</b>	1	0.6	100	0.6	0.6	0.7

\* *n*, number of fish with prey group; *v*, volume (sum of percentages); number of stomachs full or part full, 156.

<sup>1</sup> Includes families Malacosteidae, Gonostomatidae, Stomiidae.

**Table 14: Major prey groups of black oreo from the survey area\***

Prey group	Frequency		Volume		IV index	
	<i>n</i>	%	<i>v</i>	%	<i>IV</i>	<i>IV%</i>
Crustacea						
Amphipoda	3	4.1	12	0.2	0.8	0.7
Decapoda Natantia	4	5.4	150	2.0	3.3	3.0
Euphausiacea	2	2.7	26	0.4	1.0	0.9
Crustacean remains	6	8.1	310	4.2	5.8	5.2
Mollusca						
Cephalopoda Decapoda	7	9.5	310	4.2	6.3	5.6
Pisces						
Mesopelagic group <sup>1</sup>	3	4.1	300	4.1	4.1	3.6
Nemichthyidae	1	1.4	100	1.4	1.4	1.2
Fish remains	49	66.2	4 384	59.2	56.2	56.2
Thaliacea						
Salpidae	21	28.4	1 608	21.7	24.8	22.3
Unidentified	1	1.4	100	1.4	1.4	1.2

\* *n*, number of fish with prey group; *v*, volume (sum of percentages); number of stomachs full or part full, 74.

<sup>1</sup> Includes families Malacosteidae, Astronesthidae, Stomiidae.

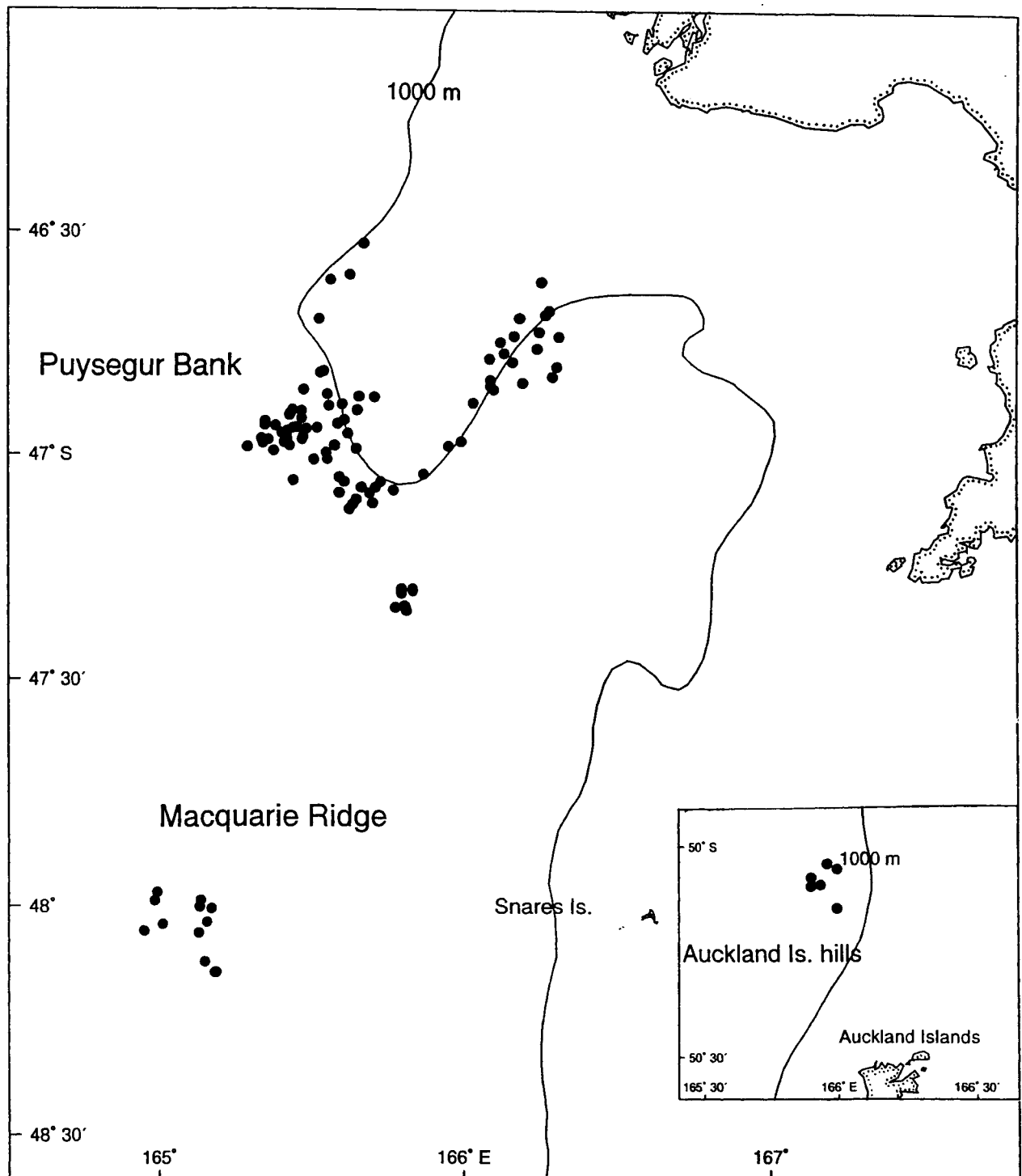


Figure 1: Survey area showing station positions (position of vessel at start of tow).



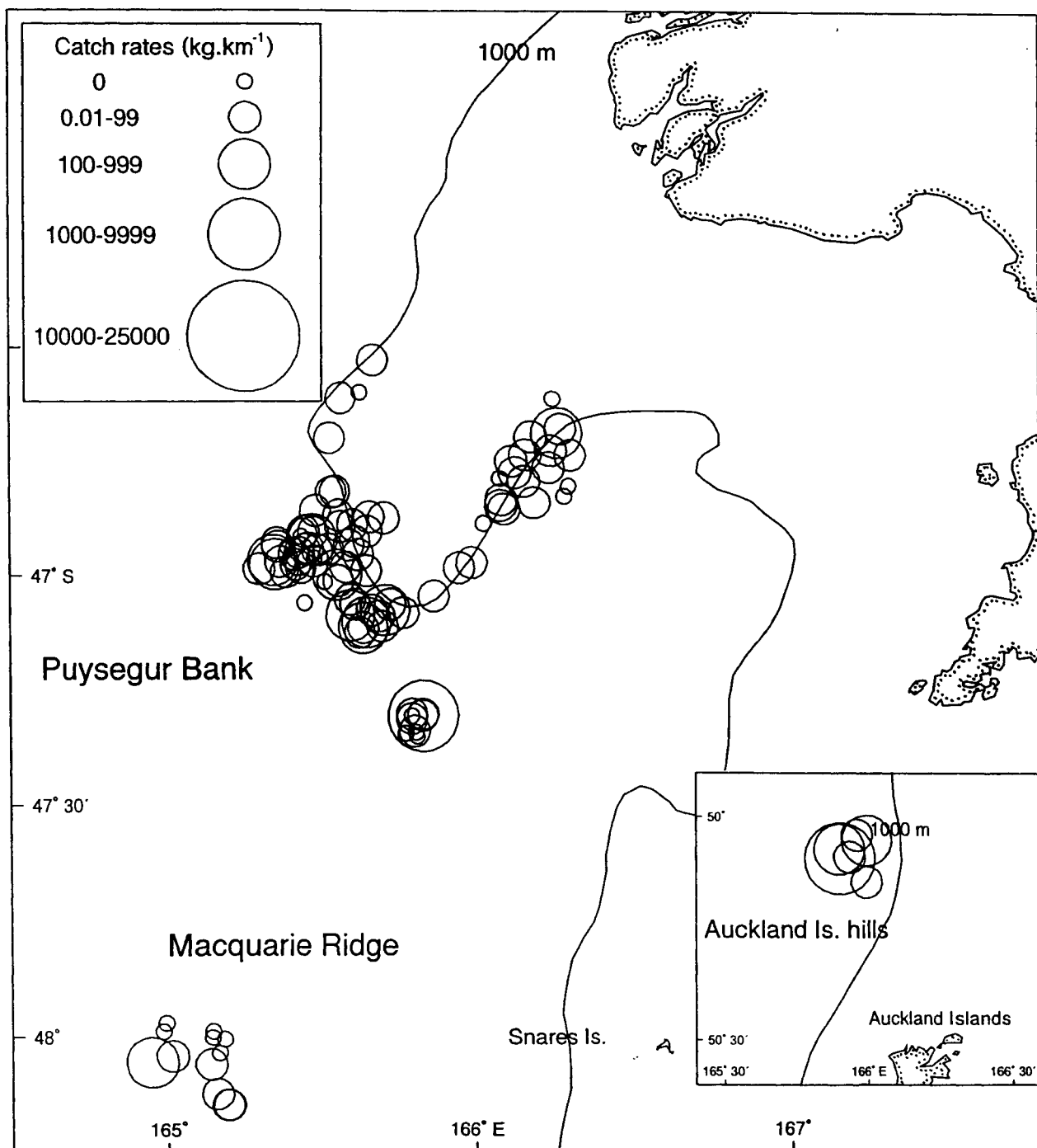


Figure 2: Catch rates of orange roughy.

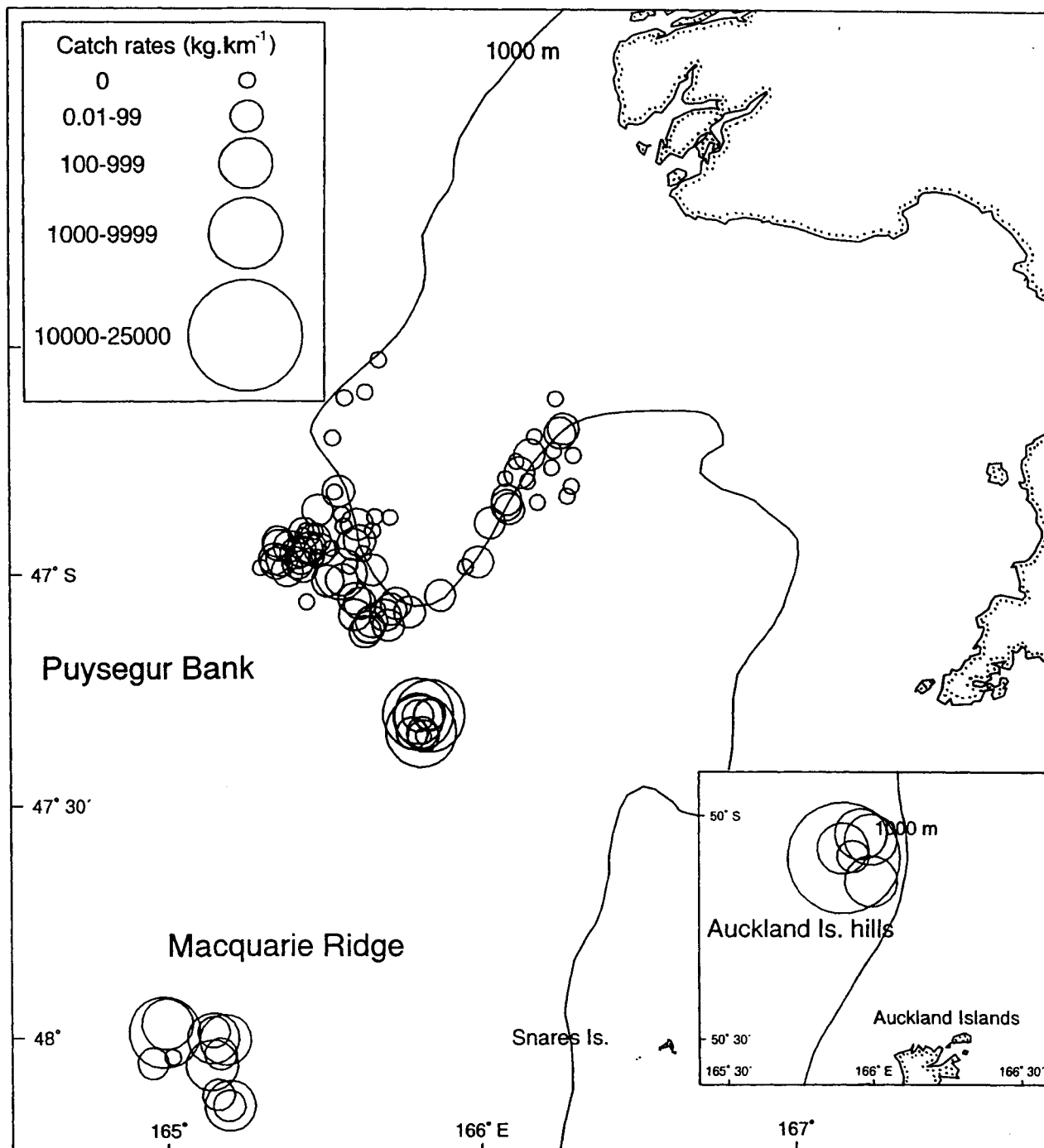


Figure 3: Catch rates of smooth oreo.

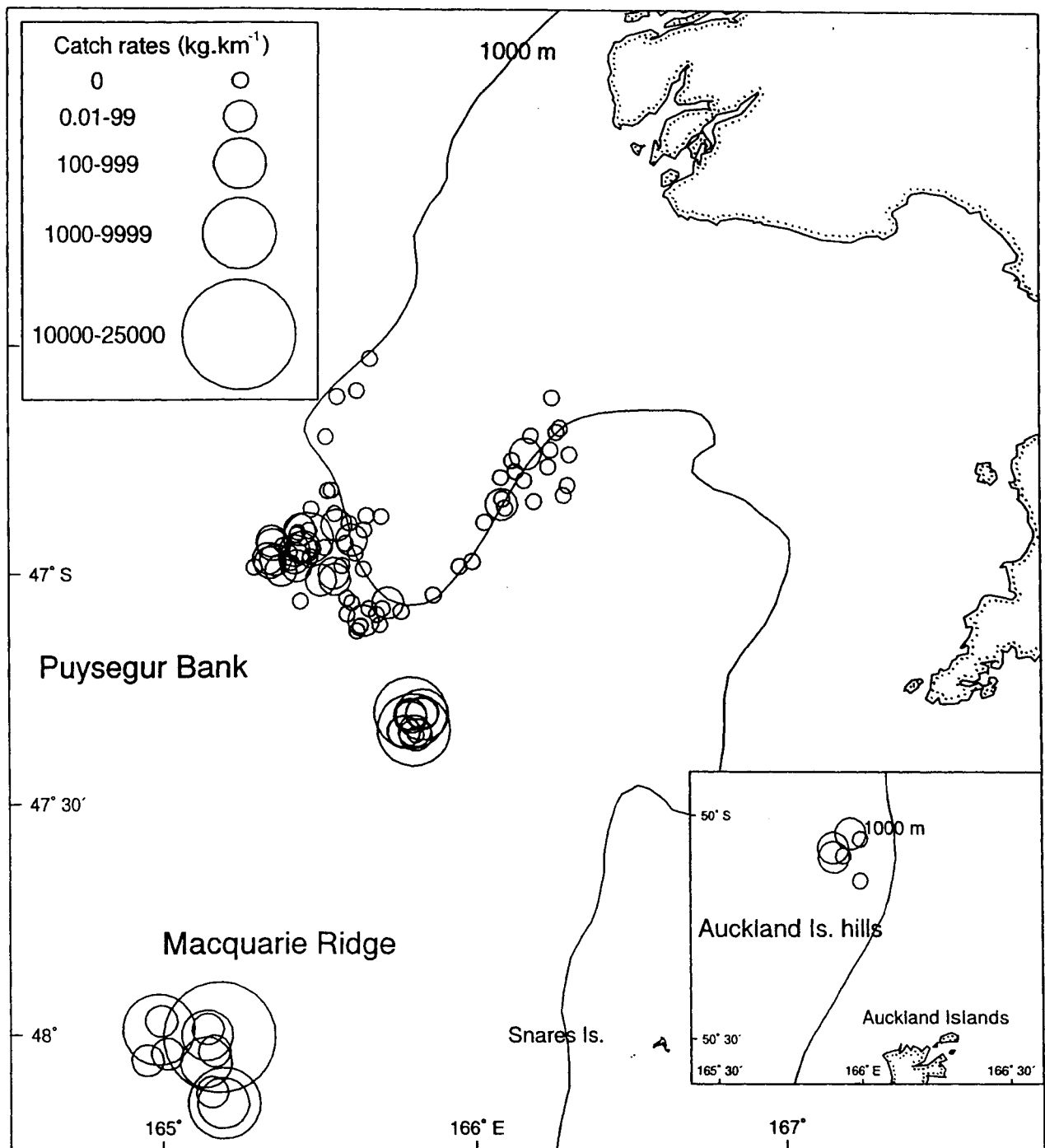


Figure 4: Catch rates of black oreo.

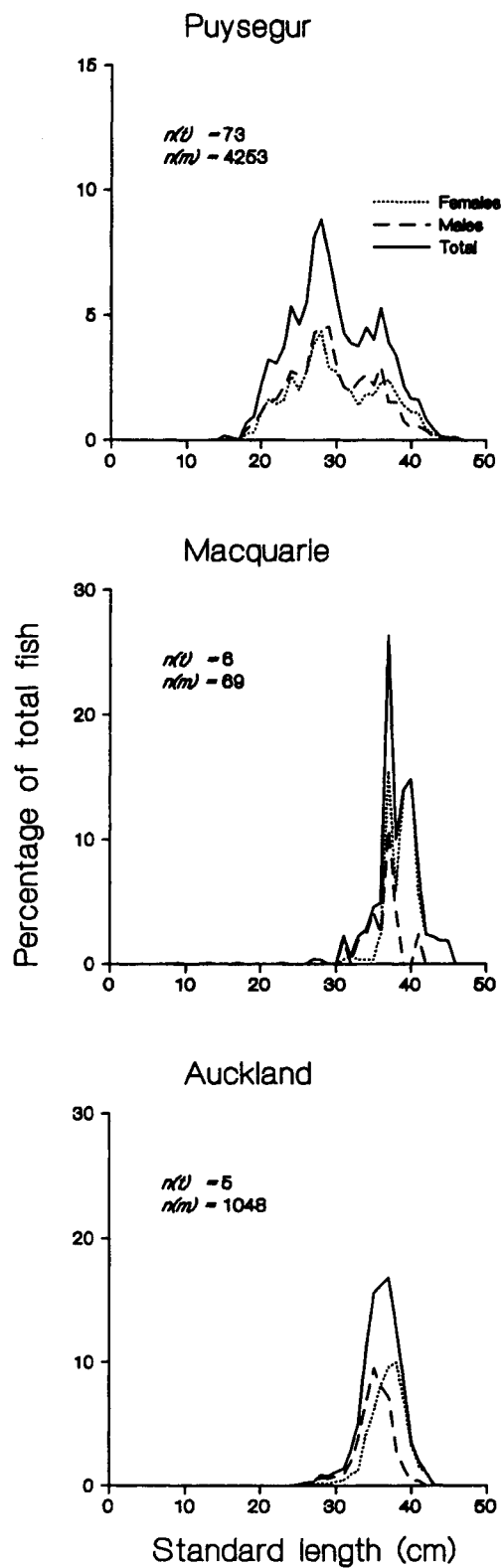


Figure 5: Length frequency distribution of orange roughy by area (scaled to represent the total population:  $n(t)$ , number of trawls with samples;  $n(m)$ , number of fish actually measured).

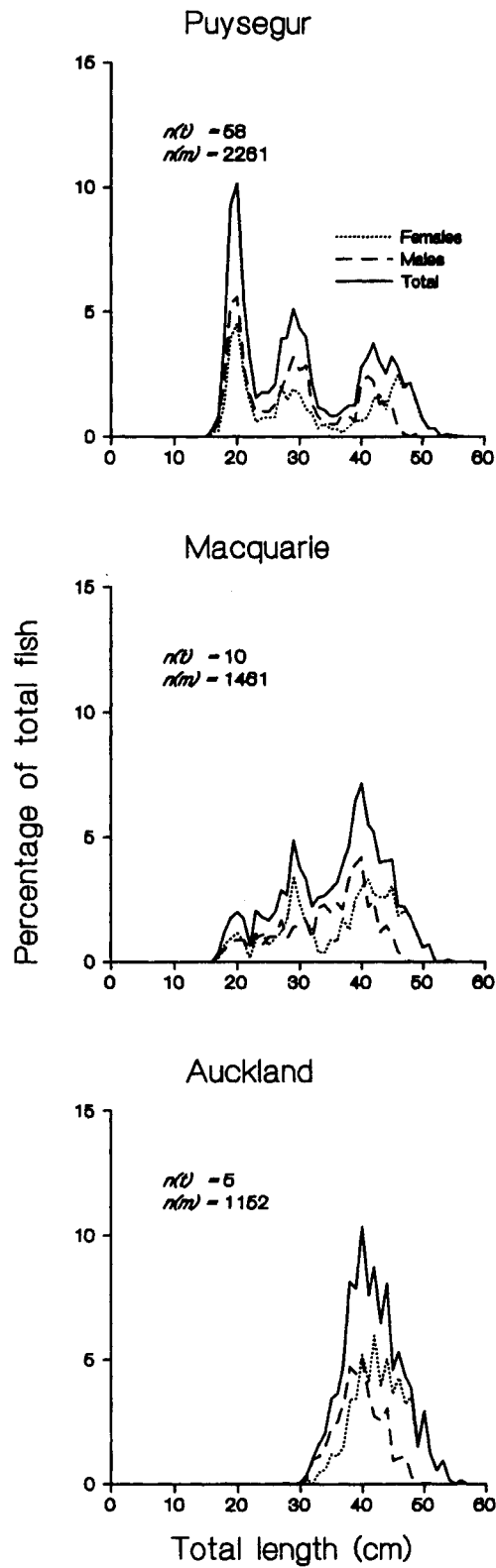


Figure 6: Length frequency distribution of smooth oreo by area (scaled to represent the total population:  $n(t)$ , number of trawls with samples;  $n(m)$ , number of fish actually measured).

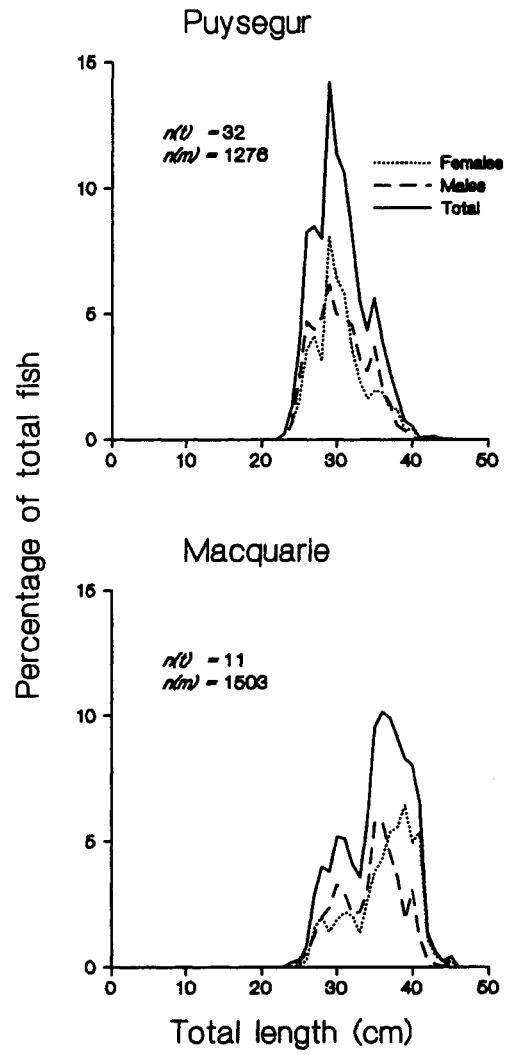


Figure 7: Length frequency distribution of black oreo by area (scaled to represent the total population:  $n(t)$ , number of trawls with samples;  $n(m)$ , number of fish actually measured).

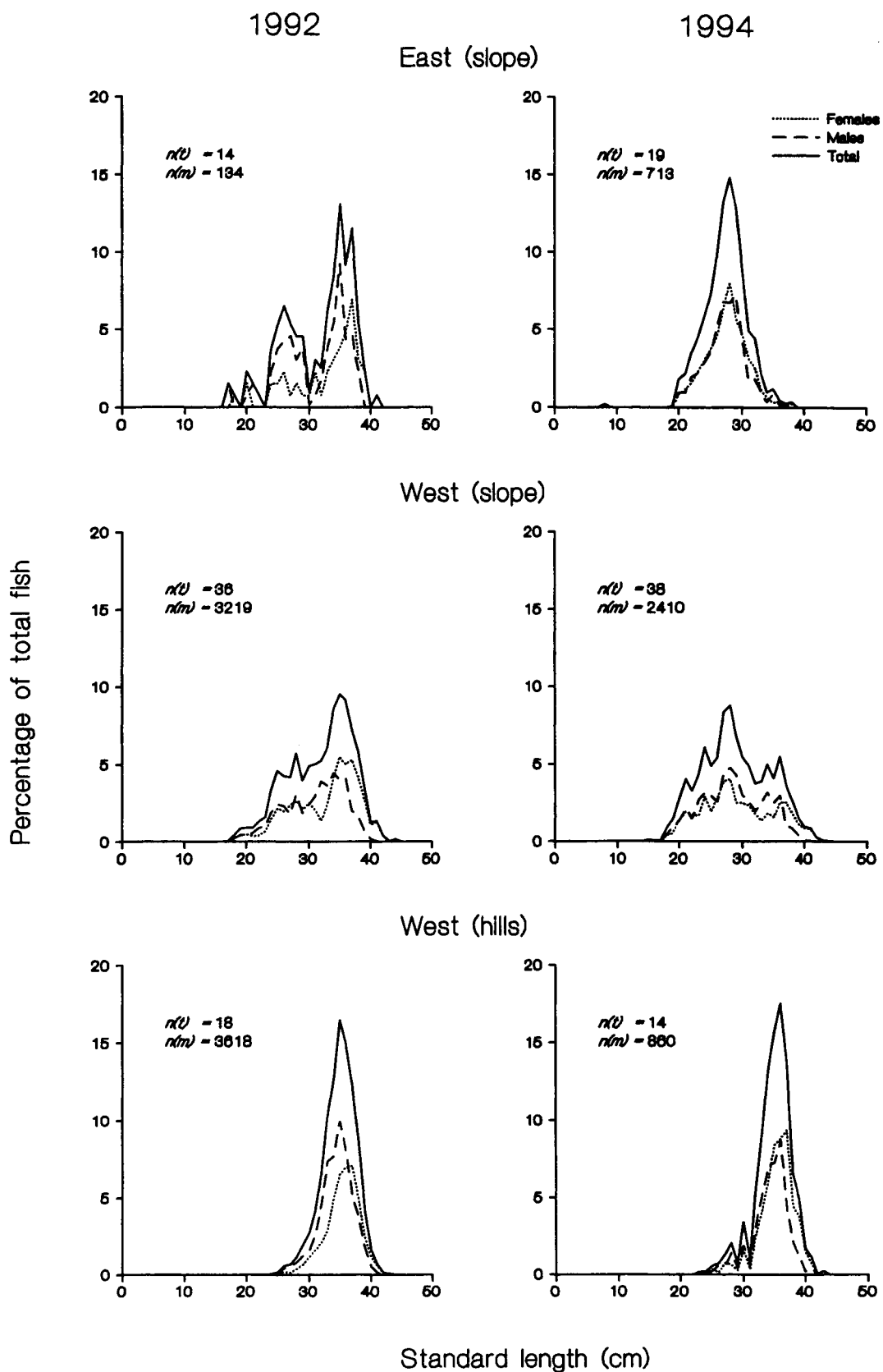
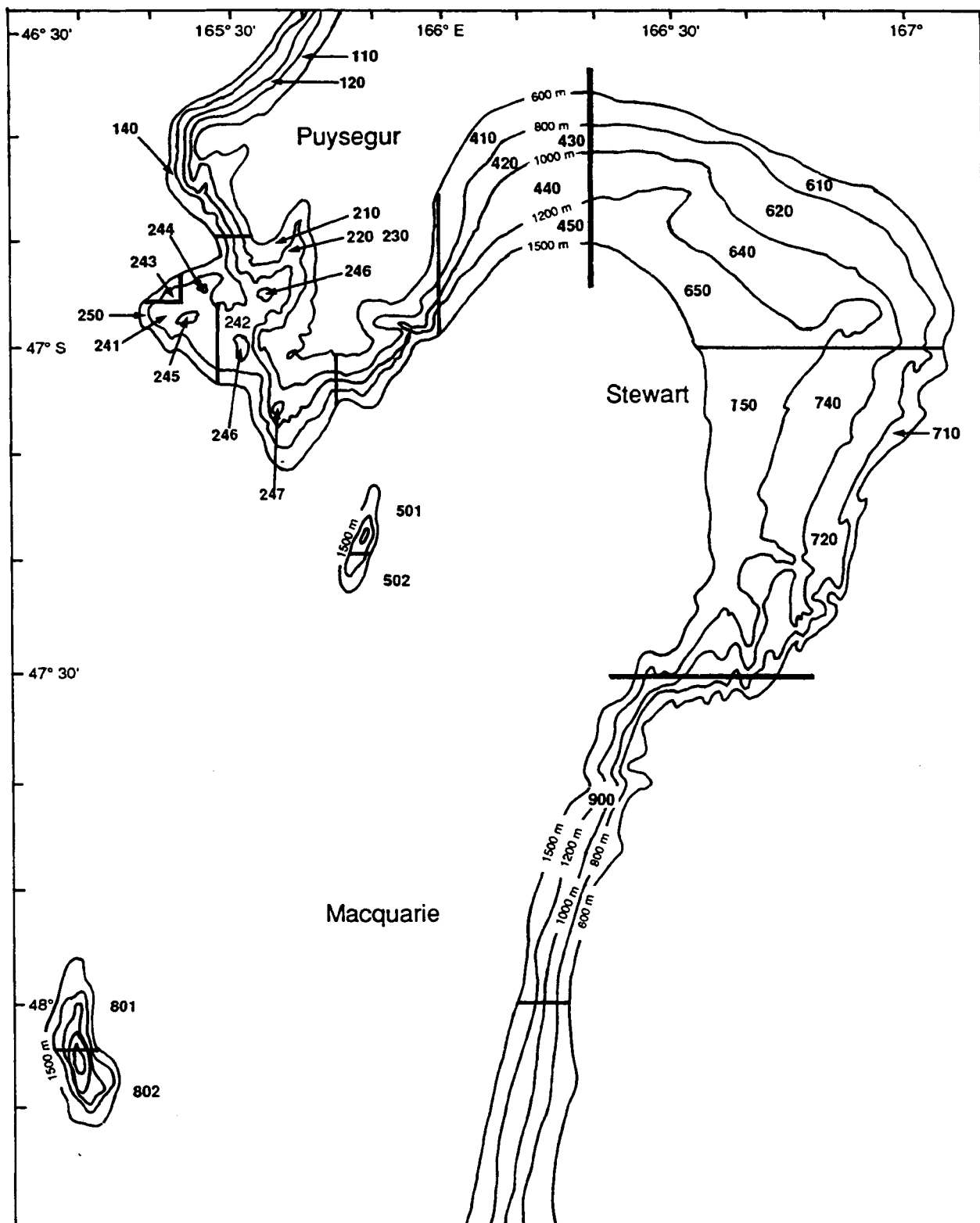


Figure 8: Comparison of length frequency distributions of orange roughy from subareas of the Puysegur Bank in 1992 and 1994.

Appendix 1: Survey area showing stratum boundaries.





**Appendix 2: Individual station and catch data for orange roughy (ORH), smooth oreo (SSO), and black oreo (BOE).**

Station	Stratum	Date	Start of tow		Depth (m)		Distance towed (n.mile)	Direction of tow (°T)	Start time	Total catch (kg)	Species catch (kg)		
			Lat ° ' S	Long ° ' E	Min.	Max.					ORH	SSO	BOE
1	0410	24 Sep 94	46 36.84	166 14.94	787	795	1.50	239	2028	154.2	0.0	0.0	0.0
2	0420	24 Sep 94	46 41.80	166 10.80	873	875	1.49	216	2218	356.8	4.3	0.0	0.0
3	0430	25 Sep 94	46 46.54	166 07.82	930	956	1.51	037	0034	153.6	6.3	0.2	0.0
4	0440	25 Sep 94	46 47.70	166 09.50	1 000	1 090	1.53	167	0225	248.0	16.4	0.0	0.0
5	0410	25 Sep 94	46 53.24	166 01.85	645	700	1.42	030	0451	183.8	0.0	2.3	0.0
6	0230	25 Sep 94	47 03.77	165 43.50	922	949	1.50	216	0754	259.1	15.2	1.5	0.2
7	0247	25 Sep 94	47 07.51	165 37.54	820	1 100	2.00	170	0959	271.3	6.4	1.2	0.0
8	0245	25 Sep 94	46 57.01	165 25.41	946	1 017	1.48	021	1509	43.5	1.7	0.6	0.5
9	0241	25 Sep 94	46 56.48	165 27.24	1 008	1 154	1.42	096	1847	126.3	5.3	1.6	2.2
10	0244	25 Sep 94	46 54.22	165 26.40	960	1 138	1.24	319	2042	183.6	47.2	0.0	0.7
11	0243	25 Sep 94	46 55.73	165 21.02	1 025	1 190	1.09	274	2255	72.7	4.5	14.4	3.6
12	0243	26 Sep 94	46 58.56	165 20.56	1 080	1 167	0.56	201	0101	206.3	150.6	1.3	0.8
13	0250	26 Sep 94	46 59.15	165 17.58	1 315	1 384	0.75	050	0510	40.2	5.8	0.0	0.0
14	0250	26 Sep 94	46 59.60	165 22.76	1 208	1 251	1.50	100	0813	2 532.3	9.9	2.2	0.4
15	0241	26 Sep 94	46 58.95	165 25.76	1 065	1 156	1.50	254	1018	164.9	10.2	0.5	0.9
16	0245	26 Sep 94	46 57.23	165 24.35	950	1 080	2.22	293	1246	367.6	254.6	19.4	0.0
17	0242	26 Sep 94	46 56.69	165 29.02	1 096	1 190	1.51	021	1525	88.1	1.5	0.7	0.0
18	0242	26 Sep 94	46 56.58	165 31.24	1 160	1 195	1.49	055	1742	50.0	4.8	0.0	0.0
19	0244	26 Sep 94	46 54.91	165 25.80	965	1 064	0.91	267	1943	88.9	0.0	0.0	0.0
20	0243	26 Sep 94	46 56.31	165 23.09	1 035	1 154	1.62	275	2144	88.7	0.0	0.3	0.0
21	0245	26 Sep 94	46 57.96	165 25.29	972	1 124	2.00	188	2356	356.1	96.5	7.1	15.9
22	0801	27 Sep 94	48 02.18	165 09.77	713	769	0.32	090	1041	12.0	0.0	8.5	3.5
23	0430	09 Oct 94	46 40.80	166 16.45	973	979	1.50	240	1254	462.2	214.6	0.2	0.0
24	0440	09 Oct 94	46 43.69	166 14.57	1 036	1 040	1.50	242	1514	164.6	127.4	0.0	0.0
25	0420	09 Oct 94	46 45.07	166 07.16	826	864	1.51	200	1746	168.2	0.5	0.0	0.0
26	0410	09 Oct 94	46 47.32	166 04.95	667	760	1.41	201	1952	150.5	0.0	0.0	0.0
27	0320	09 Oct 94	46 58.39	165 59.49	830	1 180	1.13	130	2225	93.1	16.9	19.1	0.0
28	0320	10 Oct 94	46 59.01	165 57.04	799	1 170	0.61	078	0328	190.3	2.5	0.0	0.0
29	0230	10 Oct 94	47 04.57	165 42.48	913	978	1.48	218	0643	1 299.4	838.7	2.2	0.0

Station	Stratum	Date	Start of tow		Depth (m)		Distance towed (n.mile)	Direction of tow (°T)	Start time	Total catch (kg)	Species catch (kg)		
			Lat ° ' S	Long ° ' E	Min.	Max.					ORH	SSO	BOE
30	0247	10 Oct 94	47 05.27	165 35.61	820	1 045	0.80	316	0842	310.2	225.3	19.2	0.0
31	0242	10 Oct 94	47 03.19	165 35.60	1 000	1 135	1.19	312	1037	139.0	2.8	0.2	0.0
32	0246	10 Oct 94	46 59.92	165 32.99	856	1 024	0.98	081	1251	1 921.1	943.3	702.0	140.2
33	0220	10 Oct 94	46 58.93	165 34.68	818	881	1.51	018	1454	357.8	120.9	0.0	0.0
34	0210	10 Oct 94	46 59.37	165 38.83	601	640	1.50	040	1707	168.8	2.7	1.6	0.0
35	0230	10 Oct 94	46 57.30	165 37.24	940	986	1.50	346	1855	251.7	39.1	0.0	0.0
36	0242	10 Oct 94	46 54.21	165 39.01	1 054	1 056	1.48	195	2047	596.7	100.1	0.0	0.0
37	0246	10 Oct 94	46 56.01	165 35.31	876	1 082	1.53	189	2255	327.8	43.9	0.5	0.0
38	0246	11 Oct 94	47 00.82	165 30.56	930	1 085	0.70	261	0053	70.1	0.0	0.3	0.4
39	0245	11 Oct 94	46 56.56	165 26.56	960	1 004	0.73	070	0257	131.7	22.7	0.2	3.1
40	0244	11 Oct 94	46 54.35	165 28.19	1 000	1 055	0.42	059	0446	21.9	15.2	0.0	0.0
41	0244	11 Oct 94	46 55.29	165 28.14	960	1 035	0.29	119	0824	724.7	172.1	40.9	497.2
42	0250	11 Oct 94	46 51.51	165 28.59	1 279	1 310	1.37	182	1045	131.7	36.4	0.3	0.0
43	0220	11 Oct 94	46 52.12	165 33.22	816	855	0.91	176	1455	65.9	1.9	0.0	0.0
44	0210	11 Oct 94	46 48.99	165 32.58	650	725	1.50	349	1639	184.1	8.7	9.5	0.0
45	0110	11 Oct 94	46 42.01	165 31.51	605	670	1.50	359	1837	185.7	2.2	0.0	0.0
46	0110	11 Oct 94	46 35.92	165 37.56	713	719	1.50	034	2033	98.0	0.0	0.0	0.0
47	0110	11 Oct 94	46 31.70	165 40.16	605	689	1.37	205	2224	650.6	0.1	0.0	0.0
48	0120	12 Oct 94	46 36.69	165 33.72	874	880	1.00	230	0032	82.3	2.7	0.0	0.0
49	0220	12 Oct 94	46 49.14	165 31.84	800	803	0.20	174	1112	74.1	1.9	0.0	0.0
50	0230	12 Oct 94	46 52.39	165 39.40	900	960	0.76	191	1256	193.3	32.6	0.0	0.0
51	0210	12 Oct 94	46 52.47	165 42.28	717	750	1.51	167	1454	189.3	7.7	0.0	0.0
52	0244	12 Oct 94	46 54.62	165 25.98	963	1 091	1.12	292	1815	102.9	3.3	8.4	0.0
53	0243	12 Oct 94	46 56.19	165 21.05	1 053	1 156	1.39	243	2038	447.0	153.2	60.7	3.8
54	0243	12 Oct 94	46 58.01	165 20.26	1 064	1 138	0.51	256	2243	626.3	341.4	62.6	69.9
55	0241	13 Oct 94	46 58.19	165 21.64	1 066	1 171	1.29	213	0021	425.7	42.2	3.6	6.5
56	0245	13 Oct 94	46 58.54	165 24.74	1 013	1 102	1.01	211	0254	91.5	2.6	0.3	0.0
57	0241	13 Oct 94	46 57.78	165 28.44	1 085	1 100	0.20	208	0503	9.6	0.0	0.0	0.0
58	0241	13 Oct 94	46 58.11	165 28.24	1 071	1 100	1.50	204	0651	82.8	1.1	0.0	0.0
59	0250	13 Oct 94	47 03.62	165 26.49	1 387	1 412	0.46	145	0924	15.5	0.0	0.0	0.0
60	0246	14 Oct 94	47 00.73	165 33.24	870	1 015	0.84	095	0716	134.4	58.5	6.0	3.4

Station	Stratum	Date	Start of tow		Depth (m)		Distance towed (n.mile)	Direction of tow (°T)	Start time	Total catch (kg)	Species catch (kg)		
			Lat ° ' S	Long ° ' E	Min.	Max.					ORH	SSO	BOE
61	0220	14 Oct 94	47 04.57	165 39.92	800	864	1.52	220	0913	155.6	6.7	0.0	0.0
62	0247	14 Oct 94	47 06.17	165 38.81	805	1 070	2.40	102	1108	2 238.8	1 016.2	25.3	2.3
63	0247	14 Oct 94	47 06.86	165 38.24	802	1 070	2.08	138	1406	733.5	128.0	3.9	0.0
64	0501	14 Oct 94	47 18.42	165 49.95	860	1 000	0.47	073	1810	6 195.3	1 373.1	1 748.1	670.1
65	0501	14 Oct 94	47 18.43	165 47.71	865	1 120	0.55	292	1953	81.3	0.0	3.6	4.2
66	0502	14 Oct 94	47 20.67	165 46.46	922	1 178	0.37	295	2203	17.0	0.0	4.4	0.5
67	0502	14 Oct 94	47 20.42	165 48.28	940	1 048	0.32	039	2346	3 153.8	5.7	995.7	2 053.7
68	0430	15 Oct 94	46 50.90	166 05.17	905	957	1.06	209	0621	226.5	4.1	0.3	8.3
69	0420	15 Oct 94	46 50.16	166 05.20	865	896	1.23	017	0822	337.9	0.8	69.7	0.0
70	0450	15 Oct 94	46 50.53	166 11.39	1 200	1 255	1.51	201	1051	85.2	0.5	0.0	0.0
71	0450	15 Oct 94	46 49.69	166 17.14	1 275	1 325	1.53	260	1342	44.3	0.0	0.0	0.0
72	0450	15 Oct 94	46 48.35	166 17.93	1 257	1 264	1.50	056	1605	26.4	0.0	0.0	0.0
73	0440	15 Oct 94	46 44.28	166 18.31	1 112	1 119	1.53	233	1904	44.1	0.5	0.0	0.0
74	0320	16 Oct 94	47 02.73	165 52.10	785	1 140	0.81	117	0327	335.5	16.3	6.6	0.0
75	0250	16 Oct 94	47 04.90	165 46.10	1 240	1 260	1.01	043	0720	100.5	1.3	1.9	0.0
76	0501	16 Oct 94	47 18.80	165 47.75	865	1 110	0.56	253	1049	488.2	0.4	363.5	14.1
77	0502	16 Oct 94	47 21.03	165 48.71	925	1 156	0.34	092	1237	44.2	0.0	6.9	17.2
78	0501	16 Oct 94	47 18.17	165 49.97	896	1 038	0.67	040	1420	54.6	2.6	7.4	2.0
79	0801	17 Oct 94	47 59.32	165 08.51	905	1 160	0.45	287	1308	202.0	0.0	4.8	62.3
80	0801	17 Oct 94	48 00.38	165 10.74	869	975	0.28	113	1448	7 303.4	0.0	489.0	6 229.9
81	0801	17 Oct 94	48 03.59	165 08.15	610	1 190	2.50	301	1642	1 581.0	3.4	513.9	849.3
82	0803	17 Oct 94	47 58.25	164 59.67	948	1 196	0.92	335	2046	405.1	0.0	262.0	108.5
83	0803	17 Oct 94	47 59.32	164 59.15	948	1 125	0.38	242	2242	2 257.0	0.0	844.1	1 387.0
84	0804	18 Oct 94	48 02.49	165 00.85	1 010	1 170	0.25	088	0136	41.4	19.8	0.0	0.7
85	0804	18 Oct 94	48 03.33	164 57.06	1 014	1 187	0.32	221	1107	148.7	73.6	18.9	36.4
86	0802	18 Oct 94	48 07.42	165 09.38	634	1 142	1.12	217	1330	295.7	6.7	135.4	37.4
87	0802	18 Oct 94	48 08.89	165 11.58	896	1 191	1.24	142	1522	7 568.5	13.1	717.7	6 573.5
88	1001	19 Oct 94	50 03.16	165 59.68	845	965	0.72	096	0524	1 015.8	289.3	503.7	0.0
89	1001	19 Oct 94	50 02.44	165 57.57	840	1 050	0.68	323	0741	1 320.5	118.4	572.4	1.2
90	1002	19 Oct 94	50 05.43	165 56.02	993	1 191	1.13	123	1122	119.1	1.7	31.3	0.0
91	1002	19 Oct 94	50 04.40	165 53.89	991	1 375	0.56	330	1339	1 146.8	292.9	776.2	2.0

Station	Stratum	Date	Start of tow		Depth (m)		Distance towed (n.mile)	Direction of tow (°T)	Start time	Total catch (kg)	Species catch (kg)		
			Lat ° ' S	Long ° ' E	Min.	Max.					ORH	SSO	BOE
92	1002	19 Oct 94	50 05.66	165 53.98	990	1 100	0.72	215	1553	34 407.9	3 982.1	30 314.6	2.6
93	1003	20 Oct 94	50 08.81	165 59.72	882	1 050	0.50	219	0533	331.0	6.2	200.0	0.0
94	0802	21 Oct 94	48 08.86	165 11.42	940	1 170	1.59	186	1530	1 190.5	2.1	39.3	1 011.9
95	0801	21 Oct 94	48 00.11	165 08.37	955	1 064	0.63	272	1832	1 350.8	0.0	126.6	1 078.1
96	0502	21 Oct 94	47 20.57	165 48.53	929	1 090	0.37	062	2323	87.2	0.0	13.0	62.6
97	0502	22 Oct 94	47 20.66	165 46.55	926	1 200	0.54	312	0222	10.9	0.0	2.5	4.8
98	0502	22 Oct 94	47 21.08	165 48.69	930	950	0.20	093	0350	0.0	0.0	0.0	0.0
99	0501	22 Oct 94	47 18.18	165 47.73	890	1 005	0.28	300	0652	2 161.2	12.9	704.3	1 054.4
100	0501	22 Oct 94	47 18.36	165 49.93	893	1 005	0.58	077	0829	246.4	19.0	16.9	47.0
101	0242	22 Oct 94	47 06.66	165 41.98	1 055	1 163	1.17	220	1436	177.2	50.2	4.2	0.0
102	0247	22 Oct 94	47 06.88	165 38.17	800	1 020	1.76	149	1659	943.4	731.7	5.0	0.0
103	0230	22 Oct 94	47 05.31	165 41.41	933	976	1.50	049	1903	487.0	260.9	9.6	0.0
104	0246	22 Oct 94	46 55.54	165 36.56	878	1 042	1.84	109	2147	485.0	40.4	13.6	0.7
105	0230	23 Oct 94	46 53.65	165 33.58	965	1 008	0.82	123	0022	126.3	56.5	0.0	0.8
106	0230	23 Oct 94	46 53.42	165 36.06	910	1 000	0.94	099	0203	174.8	35.6	0.3	0.0
107	0230	23 Oct 94	47 03.80	165 36.56	900	980	1.15	206	0512	69.4	0.5	0.3	0.0
108	0440	23 Oct 94	46 51.38	166 05.74	1 005	1 075	1.48	040	0820	212.1	0.4	0.3	0.0
109	0430	23 Oct 94	46 44.22	166 09.77	925	952	1.49	034	1006	261.7	5.6	1.3	0.7
110	0440	23 Oct 94	46 45.92	166 14.18	1 102	1 120	1.49	062	1222	64.6	3.8	0.0	0.0
111	0430	23 Oct 94	46 41.33	166 15.77	980	980	1.49	053	1417	453.7	289.5	0.2	0.0

### Appendix 3: Species caught

#### Echinodermata

- Asteroidea (starfish)
- Araeosoma* sp. (tam-o-shanter urchin)

#### Crustacea

- Lipkius holthuisi* (omega prawn)
- AcanthePHYra pelagica*
- AcanthePHYra* spp.
- Pasiphaea* spp.
- Plesiopenaeus edwardsianus* (scarlet prawn)
- Gnathophausia* sp.
- Lithodes murrayi* (southern stone crab)
- Neolithodes brodiei* (southern stone crab)
- Sergestes* spp.

#### Cephalopoda

- Cranchiidae (cranchiid squid)
- Nototodarus sloanii* (arrow squid)
- Ommastrephes bartrami* (red squid)
- Octopoteuthiidae
- Histioteuthis* spp. (violet squid)
- Moroteuthis* spp. (warty squid)
- M. ingens* (warty squid)
- Enoploteuthis* spp.
- Graneledone* sp. (deepwater octopus)

#### Chondrichthyes

##### Selachiformes

- Apristurus* spp. (catsharks)
- Scymnorhinus licha* (seal shark)
- Centroscymnus* spp. (deepsea sharks)
- C. owstoni* (Owston's spiny dogfish)
- C. crepidater* (longnosed velvet dogfish)
- Centrophorus squamosus* (leafscaled gulper shark)
- Etmopterus baxteri* (Baxter's dogfish)
- E. lucifer* (Lucifer dogfish)
- Scymnodon plunketi* (Plunket's shark)
- Deania calcea* (shovelnosed spiny dogfish)
- Mustelus lenticulatus* (rig)
- Somniosus rostratus* (little sleeper shark)

##### Rajiformes

- Pavoraja asperula*
- P. spinifera*
- Raja (Amblyraja)* sp. (deepwater spiny skate)
- Bathyraja* sp. (bluntnosed skate)

##### Chimaeriformes

- Chimaera* sp. (purple chimaera)
- Chimaera phantasma* (giant chimaera)
- Hydrolagus* sp. (black hydrolagus)
- Hydrolagus* sp. B (pale ghost shark)
- Hydrolagus* sp. C (purple finned hydrolagus)
- H. novaezealandiae* (ghost shark)
- Harriotta raleighana* (longnosed chimaera)
- Rhinochimaera pacifica* (widenosed chimaera)

## Osteichthyes

### Anguilliformes

- Avocettina* sp. (black snipe eel)
- Diastobranchus capensis* (basketwork eel)
- Bassanago bulbiceps* (swollenhead conger)
- B. hirsutus* (hairy conger)

### Salmoniformes

- Alepocephalus* sp. (bigscaled brown slickhead)
- A. australis* (smallscaled brown slickhead)
- Bathylagus* spp. (deepsea smelt)

### Stomiiformes

- Malacosteidae (loosejaw)
- Astronesthidae* spp. (snaggleteeths)
- Chauliodus sloani* (viper fish)
- Idiacanthus* spp. (starry dragonfish)
- Stomias* spp. (scaly dragonfish)
- Gonostoma elongatum* (elongate lightfish)
- Opostomias micripnus* (giant black dragonfish)

### Aulopiformes

- Magnisudis prionosa* (barracudina)

### Myctophiformes

- Myctophidae (lantern fish)

### Gadiformes

- Caelorinchus bollonsi* (Bollons's rattail)
- C. fasciatus* (banded rattail)
- C. innotabilis* (notable rattail)
- C. kaiyomaru* (Kaiyomaru rattail)
- C. acanthiger* (spottyfaced rattail)
- C. matamua* (Mahia rattail)
- C. oliverianus* (Oliver's rattail)
- Coryphaenoides* sp. A (slender rattail)
- Coryphaenoides* sp. B (long barbelled rattail)
- C. mcmillani*
- C. murrayi* (abyssal rattail)
- C. serrulatus* (serrulate rattail)
- C. subserrulatus* (fourrayed rattail)
- Macrourus carinatus* (ridgescaled rattail)
- Trachonurus* sp. B (velvet rattail)
- Trachyrincus longirostris* (white rattail)
- Trachyrincus* sp. (unicorn rattail)
- Nezumia namatahi* (squashedface rattail)
- N. bubonis* (bulbous rattail)
- Lepidorhynchus denticulatus* (javelinfish)
- Mesobius antipodum* (black javelinfish)
- Mora moro* (ribaldo)
- Halargreus johnsonii* (Johnson's cod)
- Antimora rostrata* (violet cod)
- Laemonema* spp.
- Lepidion schmidtii* & *L. inosimae* (giant lepidion)
- L. microcephalus* (small-headed cod)
- Macruronus novaezelandiae* (hoki)
- Merluccius australis* (hake)

### Ophidiiformes

- Genypterus blacodes* (ling)

Beryciformes

*Melamphaidae* (bigscaled fish)

*Hoplostethus atlanticus* (orange roughy)

Lophiiformes

*Linophryne arborifer* (black anglerfish)

Zeiformes

*Allocyttus niger* (black oreo)

*Neocyttus rhomboidalis* (spiky oreo)

*Pseudocyttus maculatus* (smooth oreo)

*Cyttus traversi* (lookdown dory)

Scorpaeniformes

*Helicolenus* sp. (sea perch)

*Trachyscorpia capensis* (cape scorpionfish)

Perciformes

*Caristius* sp. (manefish)

*Epigonus lenimen* (bigeyed cardinalfish)

*E. robustus* (robust cardinalfish)

*E. telescopus* (black cardinalfish)

*Melanostigma gelatinosum* (limp eel pout)

*Brama brama* (Ray's bream)

*Schedophilus* sp.

*Seriolella punctata* (silver warehou)

*Tubbia tasmanica*

Pleuronectiformes

*Neoachirosetta milfordi* (finless flounder)

Lampriformes

*Trachipterus trachipterus* (dealfish)

Notacanthiformes

*Notocanthus sexspinis* (spineback)

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