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Trawl survey of oreos and orange roughy on the south Chatham Rise, October-November 1993 (TAN9309)

P. J. McMillan
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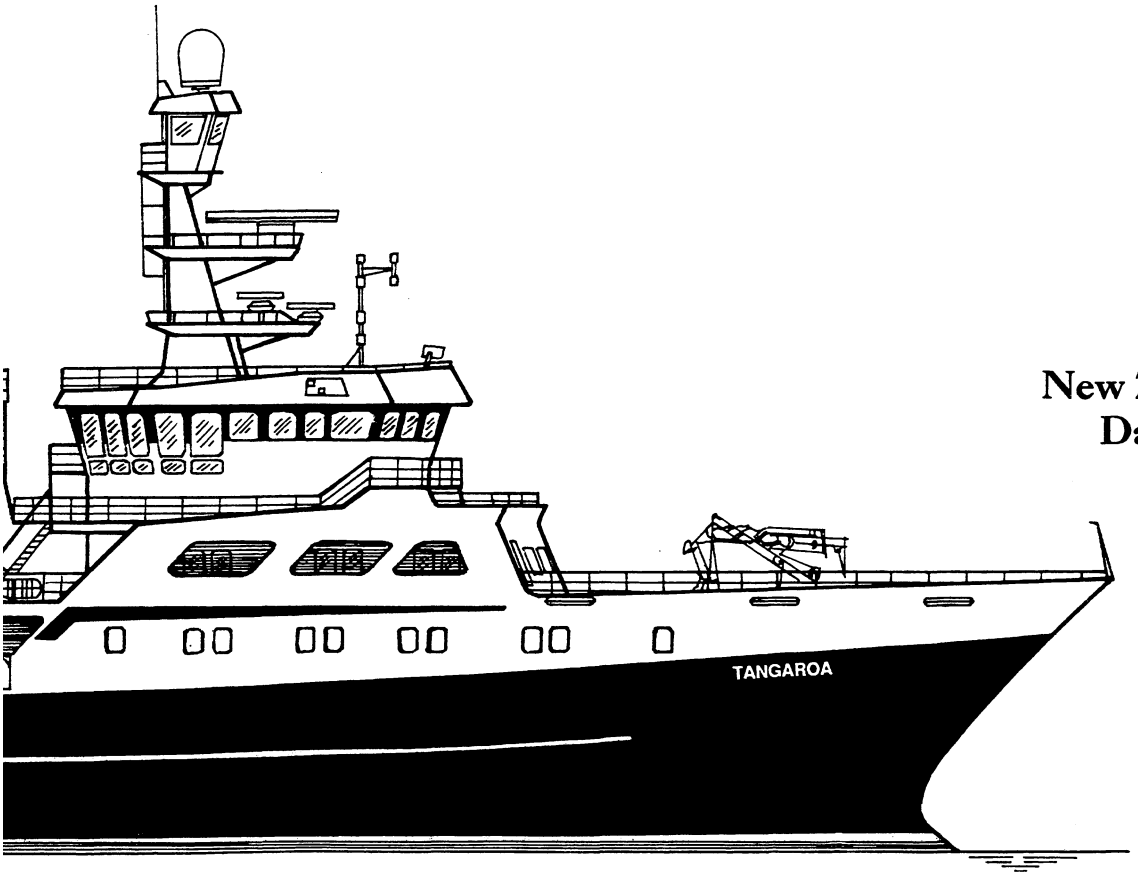

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Introduction

This report describes the third in a series of trawl surveys of deepwater fish on the south Chatham Rise carried out using GRV *Tangaroa* in October and November 1993. McMillan & Hart (1994a, 1994b) described the first (1991) and the second (1992) surveys. This and previous surveys were carried out in October-November because black oreo and smooth oreo are then at or near spawning and biological information associated with spawning can be collected, e.g., length at maturity.

The principal aim of this time series of trawl surveys is to estimate the relative biomass of black oreo (*Allocyttus niger*), smooth oreo (*Pseudocyttus maculatus*), and orange roughy (*Hoplostethus atlanticus*) on the south Chatham Rise. Relative biomass is required for stock assessment of these species from the area.

Three different surveys were carried out between 4 October and 10 November 1993. The "standard" survey, carried out in 1991 and 1992, was repeated and sampled flat and undulating ground. The second, termed the "hill" survey, covered the same set of six hills sampled in 1992 and was an attempt to estimate biomass on hills that are commercially fished. Hills are not sampled by the standard survey and it was thought that a considerable proportion of the biomass of oreos may therefore be missed. The hill survey attempted to sample biomass on a subset of hills only and could not sample all hills because of lack of time and knowledge of the location of hills that are fished by the commercial fleet. The third survey, termed the "high catch rate area" survey, sampled two strata at the western end of the Chatham Rise. Analysis of the oreo commercial catch and effort data showed that these areas (strata) had provided high catch rates in the past. Catches from the area on the standard survey were very low in 1991 and 1992 and only 24 stations were carried out there in 1992. The high catch rate area survey aimed to determine if there was a problem with the standard survey design by sampling areas of high commercial catch rate with an additional 20 stations.

The survey period was extended by 9 days in 1993. Four days were taken up steaming to and from Wellington for the crew change on 22 October. A survey of the high catch rate areas in subarea 1 was carried out during 2 days and the remaining 3 days were used to carry out additional stations on the hills.

Objectives of the survey

1. To estimate the relative biomass and determine the distribution of deepwater species, principally black oreo, smooth oreo, and orange roughy.
2. To determine the size structure of the populations of black oreo, smooth oreo, and orange roughy and other commercial or potentially commercial species.
3. To determine the spawning condition of the populations of black oreo, smooth oreo, and orange roughy.
4. To retain rare or unusual species of fish, molluscs, and crustaceans for the Museum of New Zealand Te Papa Tongarewa, Wellington.

Methods

Survey area and stratification

Standard survey. (Figure 1, Table 1). The 1993 survey area was the same as the 1992 survey area and totalled 60 503 km^2. It was divided into 7 subareas and 26 strata (1–26).

Hill survey. (Figure 1, Table 2). The six hills on the south Chatham Rise sampled in 1992 were sampled again in 1993. Each hill was defined as a stratum (strata 30–35).

High catch rate area. (Figure 2, Table 3). A catch per unit effort (CPUE) analysis for oreos carried out for subarea 1 identified three areas that had produced high catches from 1978 to 1992 (Ralph Coburn, NIWA, Wellington, pers. comm.). Two of these areas were defined as strata (100, 101) and were randomly sampled for the first time in 1993.

Survey design

All three surveys were designed to sample black oreo, smooth oreo, and orange roughy.

Standard survey. A two-phase stratified random bottom trawl survey design (*after* Francis 1981, 1984) was used with 105 stations planned for phase 1 and 45 for phase 2.

Hill survey. The survey was a two-phase random design. It was planned to carry out at least three stations on each of six hills (each hill was defined as a stratum).

High catch rate area. A single phase survey was carried out with 10 stations in each of the two strata.

Station allocation

Standard survey, phase 1. The number of stations planned (105) was the same as in the 1992 survey.

Standard survey, phase 2. The strata and numbers of stations required to reduce the variability of the recruited (to the fishery) biomass estimates were calculated. Emphasis was placed on reducing the coefficient of variation (*c.v.*) of the largest recruited biomass estimate (smooth oreo) to less than 30%.

Hill survey, phase 1. Three stations (the minimum required for biomass estimation) were allocated to each hill.

Hill survey, phase 2. Extra stations were attempted.

High catch rate area. Ten stations were allocated to each of the two strata (100 and 101).

Station position selection

Standard survey. Phase 1 random station positions were the same as those used in 1992. The rationale for using the same random stations for the first phase was discussed by MAF Fisheries staff when the survey series was planned. It was considered to be an advantage not to have to find new trawl ground for every station. This gave a considerable time saving because trawl ground is difficult to find in some parts of the survey area. Using the same positions would not compromise the analysis of the data (Chris Francis, NIWA, Wellington, pers. comm.). New random positions (random longitude and depth pairs) were generated on board for phase 2 stations.

Hill survey. Phase 1 station positions were new. The direction of tow for each station was randomly selected. The tow path was surveyed by echosounder to determine if it was trawlable. If it was not, then the next random direction was surveyed. The aim at each station was to tow from the top down the side of the hill. In practice we had to limit tow length when we judged that large amounts of fish might have entered the net.

High catch rate area. A set of vectors (random start point and direction) each 3 n. miles long were generated before the survey. Ten vectors for each stratum were selected at random.

Station execution

Phase 1 stations had the same start and finish positions as those in the 1992 survey. For phase 2, the station was carried out by towing through a randomly selected position. Where this was not possible because of foul ground, an area within 2 n. miles of the position was searched for trawl ground. If a station was still not possible, the position was abandoned and replaced with the next one on the list.

Phase 1 and phase 2 stations for the standard survey were intended to be 2 n. miles long, but ranged from 0.80 to 2.13 n. miles (n = 148, mean = 1.92 n. miles). Some tows were less than 2 n. miles either because of insufficient trawl ground or the gear being hauled early because of large quantities of fish in the net.

Hill survey stations were 0.1–0.96 n. miles long (n = 22, mean = 0.39 n.mile).

For the high catch rate area survey a bathymetry run along each vector was carried out to see if there were 2 n. miles of trawlable ground. If the ground was too rough to trawl on then the next vector on the list was selected. Stations were 0.76–2.15 n. miles long (n = 20, mean = 1.74 n. mile).

Survey timing

The survey was carried out from 4 to 21 October and 23 October to 10 November 1993.

Vessel and gear

Vessel specifications were given by McMillan & Hart (1994a). Trawl gear specifications that differ from the 1992 survey are given in Appendix 1.

Biomass estimation

Biomass estimation was carried out using the area-swept method described by Francis (1981). The formulas were summarised by Vignaux (1994).

The assumptions about the effective fishing width of the net are unchanged from the 1992 survey, i.e., the distance between the wings of the net (28 m, measured during gear trials in 1991) was assumed to be the effective fishing width. The mean distance between the doors for the standard survey was 118 m (*see* Appendix 1), and consequently vulnerability (V) was assigned a value of 0.237. The mean distance between the doors for the hill survey was 103 m (*see* Appendix 1) and V was estimated to be 0.272.

Biomass was calculated with the Trawlsurvey Analysis Program held at Greta Point. The combined biomass and length frequency analysis was used and biomass stations were selected from the required strata where gear performance was 1 or 2. Run parameters for the analysis included: recorded distance towed; constant doorspread of 118 m (standard and high catch rate area) or 103 m (hill); catch data weight as recorded in catch table; length-weight relationship calculated for each species from data collected during the 1993 survey; fish vulnerability, 0.237 (standard and high catch rate area) or 0.272 (hill); vertical availability, 1.0; areal availability, 1.0. Catch rates were expressed as $kg.km^{-1}$.

Biomass estimates for the three main species (black oreo, smooth oreo, and orange roughy) were made for fish of all lengths ("all fish") and also for fish that were considered to have recruited to the fishery ("recruited").

Separate biomass estimates were made for the standard, hill, and high catch rate area surveys.

Data recording and handling

All station data were recorded by hand on 030 forms and were then entered on to the on board computer. All the catch and biological data were entered directly on to computer in the wet lab using the digitisers. All weights, including catch, individual fish, and gonad weights, were measured and entered directly on to computer. Data were checked on board by scientific staff and were checked and edited at Greta Point by Alan Hart before being loaded on to the database.

Catch sampling

All catches were sorted by species and all bycatch species were weighed and recorded.

Small catches totalling less than about 2 t were weighed in full on the Seaway weighers and the data recorded.

For catches over about 2 t, the weight of the smooth oreo, black oreo, or orange roughy was back-calculated from the amount of fish processed on board. This required the conversion factor (from unprocessed to headed and gutted state), estimated for most of the large catches from about 200 kg of unprocessed fish (results of conversion factor tests are given in Appendix 2) and the weight of the processed fish from the Scanvaegt data capture system. The weight from the Scanvaegt system was accepted only after comparison with an estimate of processed weight calculated by multiplying the hand tallies of block counts by the mean block weight. The total catch of each species was then calculated from the product of the processed weight and the conversion factor. Small specimens of the three main species that could not be processed were sorted out of large catches, weighed, recorded, and discarded.

Rare or unusual fish, molluscs, and crustaceans were labelled with a station number and frozen for the Museum of New Zealand, Wellington.

Biological sampling

A sample of up to about 200 individuals each of black oreo, smooth oreo, orange roughy (and other quota species when they were caught) was taken at each station to determine the length frequency distribution in different areas and depths. Lengths and gonad stage were recorded for most of the smooth oreo and black oreo ("staged"). Length (to the nearest millimetre), weight (nearest 10 g), sex, gonad stage, gonad weight (nearest 1 g), and otoliths were collected for up to 20 individual specimens of the above three species at each station (termed "biologicals" below). These data were collected for studies of size and age structure (not described in this report), length-weight relationship, and reproductive state of the populations sampled. Reproductive state was assessed by macroscopic gonad staging using the definitions for black oreo, smooth oreo, and orange roughy given in appendix 3 in McMillan & Hart (1994a). About 600 otolith pairs for each species were collected. The stomachs of smooth oreo sometimes contained a large amount of water, probably taken in during capture, and consequently the stomach was removed before weighing. Black oreo and orange roughy were weighed intact.

Scaling length data

Length frequency data were scaled or adjusted to represent the population in the survey area using the Trawlsurvey Analysis Program. Options selected for running the program were: combined biomass and length frequency; scaled to percent sampled and distance towed; stations were selected from the required strata where gear performance was 1 or 2; length-weight parameters used were obtained from data collected during the 1993 survey (*see* Table 16). The calculations within the program were described by Vignaux (1994).

Water temperatures

The value of sea surface temperature data collected during the survey is uncertain because readings from the bridge weather station were 0.8–0.9 °C lower than samples measured by hand using the factory temperature probe. Data recorded are those from the weather station plus 0.8. Bottom temperatures were not available because the Kaijo-Denki net monitor had no temperature sensor.

Results

Trawl stations

All station data are summarised in Appendix 3.

Standard survey. The 148 stations (103 in phase 1 and 45 in phase 2) completed were used for biomass estimation (*see* Table 1).

Hill survey. Twenty-two stations were completed and used for biomass estimation (*see* Table 2).

High catch rate area. Twenty stations were completed and used for biomass estimation (*see* Table 3).

Catch and catch rates

A summary of the catch of the 10 most abundant species from all stations from the standard, hill, and high catch rate area surveys is given in Table 4. Catches of the three main species from all stations are listed in Appendix 4. The species caught during the survey are listed in Appendix 5.

Standard survey. Catch and catch rates of black oreo, smooth oreo, and orange roughy from each stratum and catch from each subarea are given in Table 5. Catch rates of the three main species are plotted by station in Figures 3–5.

Hill survey. Catch and catch rate data are given in Table 6.

High catch rate area. Catch and catch rate data are given in Table 7.

Biomass estimates

Biomass estimates for all quota species and commercially important non-quota species caught during the standard survey are given in Table 8. Catch and biomass estimates of hoki from the depth intervals 600–800, 800–1000, and 1000–1200 m for all catches made during daylight (0451–1813 hours NZST) are listed in Table 9. The survey covered only a fraction of the depth range of species such as hoki, hake, ling, ribaldo, and pale ghost shark and was not designed to measure the biomass of these species.

Biomass estimates for all strata, individual strata, and for recruited fish and fish of all lengths for each of the three main species are given for the standard survey (Table 10), the hill survey (Table 11), and the high catch rate area survey (Table 12).

Biomass estimates for the three main species for fish of all lengths from the standard and hill surveys are summarised by subarea in Table 13 and by depth for the standard survey only in Table 14.

Biological data

The numbers of length and other biological samples taken during the survey are given in Table 15.

The scaled length distributions of black oreo, smooth oreo, and orange roughy measured during the survey are given in Figure 6.

Scaled length data for black oreo, smooth oreo, and orange roughy from the depth intervals 600–800, 800–1000, and 1000–1200 m are given in Figure 7. Figure 8 presents scaled length data for the same species by three defined areas: 1, 172° 30′–176° E; 2, 176°–179° 30′ E; 3, 179° 30′ E–174° W. These areas are the same as those used by McMillan & Hart (1994b).

Length-weight relationships for the fish sampled are given in Table 16.

The results of macroscopic staging of gonads for the three species sampled throughout the survey are summarised in Table 17. A large proportion of samples of black oreo and smooth oreo were either immature or developing (stages 1–3). Most of the orange roughy were immature or resting (stages 1–2).

Tables 18 and 19 give the incidence (not scaled) of each gonad stage for the three main species by depth interval and subarea, respectively.

Water temperatures

Surface temperatures are not reported because the data may be inaccurate.

Discussion

Catch rates from the 1993 standard survey, for smooth oreo particularly, were relatively homogeneous and we are confident that the design for this survey is satisfactory. The standard survey covers much of the south Chatham Rise, and it continues to produce most of the biomass of smooth oreo (compared to the hill survey) because of high catch rates in a few strata and the large size of strata compared to hill strata. There is still concern about the reduced number of stations (24) in subareas 1 and 2 compared to the 1991 (44 stations) and earlier surveys.

In 1993 we sampled the same commercial fishing hills at the eastern end of the south Chatham Rise that were sampled in 1992. The hill survey was affected by interaction with commercial fishing on two of the hills (Possum and Cotopaxi) and catch rates on those hills may be lower than expected. In addition, gear problems (poor net monitor performance and difficulty in keeping the net on the bottom) prevented us from completing the planned number of hill stations. Time constraints did not allow us to address these problems to our satisfaction and consequently biomass results from the hill survey should be interpreted with caution.

Areas of historically high catch rates west of 176° E were stratified and randomly sampled for the first time in 1993 (the high catch rate area survey). Catches in these new strata (100 and 101) were low, similar to, or lower than catch rates in the standard strata. Some small oreo marks were seen near dropoffs in these strata, but were missed by the random trawls. A commercial trawler operating nearby was infrequently catching 2–3 t bags by targeting similar small marks. It appears that the low abundance or low availability of oreo in the area at the time of the survey could have been real and consequently that the standard survey is very probably measuring what is in the area. It may be worth continuing the high catch rate area survey to determine if catch rates change with time.

The next survey should continue to refine the biomass estimate of smooth oreo by repeating the standard survey which is comprehensive and fulfils statistical requirements for random trawl survey design and provides the longest series of comparable biomass estimates from the area. It would also be desirable to develop a hill/dropoff strategy to sample the western end of the survey area (173–176° E), plus hills and dropoffs just to the east of 176° E, in a future survey. *Tangaroa* was funded by the fishing industry to undertake a survey of hills and features in orange roughy depths on the Chatham Rise in 1994 (TAN9406), including some hills and dropoffs in this area. We intend to use the information from that survey to design our sampling strategy west of 176° E and also to improve the hill survey on the eastern end of the survey area (near Chatham Island).

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Table 1: Subareas, strata, and numbers of stations in the standard survey

Stratum	Depth (m)	Area (km^2)	No. of stations Phase 1	Phase 2	Total
Subarea 1					
1	600–800	3 630	3		3
2	800–1000	3 167	6		6
3	1000–1200	3 351	6		6
	Subtotal	10 148	15	0	15
Subarea 2					
4	600–800	4 180	3		3
5	800–1000	3 248	3		3
6	1000–1200	3 474	3		3
	Subtotal	10 902	9	0	9
Subarea 3					
7	600–1200	4 875	3	0	3
Subarea 4					
8	600–800	2 909	3		3
9	800–900	1 376	3		3
10	900–1000	1 361	7		7
11	1000–1100	1 580	4	16	20
12	1100–1200	2 242	6		6
	Subtotal	9 468	23	16	39
Subarea 5					
13	600–800	1 922	3		3
14	800–1000	2 366	3		3
15	1000–1200	2 380	3		3
16	1200–1500	3 990	3		3
	Subtotal	10 658	12	0	12
Subarea 6					
17	600–800	2 106	3		3
18	800–900	1 295	5		5
19	900–1000	1 039	7	19	26
20	1000–1100	1 159	6	3	9
21	1100–1200	1 094	6		6
22	1200–1500	4 085	2	7	9
	Subtotal	10 778	29	29	58
Subarea 7					
23	600–800	930	3		3
24	800–1000	547	3		3
25	1000–1200	846	3		3
26	1200–1500	1 351	3		3
	Subtotal	3 674	12	0	12
Total		60 503	103	45	148

Table 2: Hill strata and numbers of stations

Hill	Stratum	Area (km^2)	No. of stations Phase 1	Phase 2	Total
Trev's pinnacle	30	1	4		4
Condoms	31	3	3	1	4
Mangrove	32	1	3	1	4
Charlies	33	2	3		3
Possum	34	8	4		4
Cotopaxi	35	2	3		3
Total		17	20	2	22

Table 3: High catch rate area strata and numbers of stations

Stratum no.	Area (km^2)	No. of stations
100	316	10
101	498	10
Total		20

Table 4: Total catch, percentage catch composition by weight, and number of stations at which the species was caught for the 10 most abundant species from all valid stations combined (standard, hill, and high catch rate area stations)

	Total catch (kg)	Percentage composition	No. of stations
Smooth oreo	176 335	76.8	181
Black oreo	22 209	9.7	156
Orange roughy	11 092	4.8	103
Baxter's lantern dogfish	4 220	1.8	174
Shovelnosed dogfish	4 097	1.8	75
Hoki	1 926	0.8	97
Johnson's cod	1 302	0.6	125
Bigscaled brown slickhead	774	0.3	59
Smallscaled brown slickhead	727	0.3	104
Warty squid	677	0.3	128
All other species	6 208	2.7	–
All species	229 567		190

Table 5: Catch, percentage of total catch, and mean catch rate for black oreo (BOE), smooth oreo (SSO), and orange roughy (ORH) by stratum and subarea from the standard survey

	Catch (kg)				% of total catch			Mean catch rate (kg.km^{-1})		
Stratum	BOE	SSO	ORH	All species	BOE	SSO	ORH	BOE	SSO	ORH
Subarea 1										
1	160	5	0	507	31.6	1.0	0	60	2	0
2	423	4 572	0	5 340	7.9	85.6	0	113	1 328	0
3	70	31	0	363	19.3	8.5	0	32	7	0
Subtotal	653	4 608	0	6 210	10.5	74.2	0			
Subarea 2										
4	888	8	0	1 138	78.0	0.7	0	401	4	0
5	86	4	0	166	51.8	2.4	0	33	2	0
6	0	6	0	182	0	3.3	0	0	2	0
Subtotal	974	19	0	1 486	65.5	1.3	0			
Subarea 3										
7	146	23	4	638	22.9	3.6	0.6	55	9	2
Subtotal	146	23	4	638	22.9	3.6	0.6			
Subarea 4										
8	1 013	6	0	1 284	78.9	0.5	0	385	2	0
9	525	434	5	1 212	43.3	35.8	0.4	197	164	2
10	1 486	2 645	14	4 811	30.9	55.0	0.3	244	516	2
11	274	20 450	36	22 408	1.2	91.3	0.2	17	1 196	2
12	14	14	0	248	5.6	5.6	0	3	3	0
Subtotal	3 311	23 550	56	29 963	11.1	78.6	0.2			
Subarea 5										
13	558	28	0	1 020	54.7	2.7	0	213	11	0
14	57	238	6	501	11.4	47.5	1.2	23	90	3
15	5	24	5	289	1.7	8.3	1.7	2	9	2
16	0	9	0	132	0	6.8	0	0	3	0
Subtotal	620	299	11	1 942	31.9	15.4	0.6			
Subarea 6										
17	70	245	0	959	7.3	25.5	0	26	93	0
18	277	1 957	21	3 020	9.2	64.8	0.7	61	451	6
19	1 131	60 284	1 131	67 374	1.7	89.5	1.7	60	3 159	56
20	103	6 363	160	7 816	1.3	81.4	2.0	15	814	21
21	14	1 423	143	2 343	0.6	60.7	6.1	3	274	27
22	2	9 907	35	11 004	<0.1	90.0	0.3	<0.5	1 251	5
Subtotal	1 597	80 181	1 491	92 516	1.7	86.7	1.6			
Subarea 7										
23	0	5	6	522	0	1.0	1.1	0	2	2
24	3	9	41	548	0.5	1.6	7.5	1	4	20
25	5	134	137	836	0.6	16.0	16.4	2	51	50
26	6	10	39	300	2.0	3.3	13.0	2	4	15
Subtotal	14	157	223	2 207	0.6	7.1	10.1			
Total	7 314	108 837	1 784	134 961	5.4	80.6	1.3			

Table 6: Catch, percentage of total catch, and mean catch rate for black oreo (BOE), smooth oreo (SSO), and orange roughy (ORH) by hill stratum*

Hill	Stratum	Catch (kg)				% of total catch			Mean catch rate (kg.km^{-1})		
		BOE	SSO	ORH	All species	BOE	SSO	ORH	BOE	SSO	ORH
Trev's pinnacle	30	204	2 980	35	3 302	6.2	90.2	1.1	288	3 730	62
Condoms	31	468	11 185	4 787	16 574	2.8	67.5	28.9	704	16 900	15 853
Mangrove	32	1 654	33 341	1 432	37 206	4.4	89.6	3.8	2 307	50 587	1 962
Charlies	33	11 735	18 888	2 745	33 971	34.5	55.6	8.1	22 046	36 370	5 605
Possum	34	129	739	183	1 315	9.8	56.2	13.9	102	655	139
Cotopaxi	35	494	271	125	982	50.3	27.6	12.7	1 016	562	259
Total		14 684	67 404	9 307	93 350	15.7	72.2	10.0			

* Mean catch rate (kg.km^{-1}) was taken from the biomass mean catch rate calculation which is scaled by a fish vulnerability of 0.271.

Table 7: Catch, percentage of total catch, and mean catch rate for black oreo (BOE), smooth oreo (SSO), and orange roughy (ORH) by high catch rate area strata

Stratum	Catch (kg)				% of total catch			Mean catch rate (kg.km^{-1})		
	BOE	SSO	ORH	All species	BOE	SSO	ORH	BOE	SSO	ORH
0100	70	31	0	518	13.5	6.0	0	8	4	0
0101	142	63	0	739	19.2	8.5	0	27	10	0

Table 8: Biomass estimates (for fish of all lengths) for all quota species and commercially important non-quota species caught during the standard survey*

	Biomass (t)	*c.v.* (%)
Smooth oreo	151 514	27.0
Black oreo	43 921	16.7
Hoki	10 412	24.3
Shovelnosed dogfish	6 164	15.6
Pale ghost shark	4 248	19.8
Orange roughy	2 049	13.0
Hake	1 289	41.9
Ling	506	63.4
Ribaldo	269	33.2
Other	41 446	-
Total	261 818	17.5

* The total biomass was calculated using the "Biopc" program held on the main computer at Greta Point. The vulnerability value used in that calculation was restricted to two decimal points i.e., 0.24 was used rather than the 0.237 which was used for the rest of the biomass calculations.

Table 9: Catch and biomass of hoki (all lengths) from catches taken during the standard survey between 0451 and 1813 hours NZST

Depth (m)	Catch (kg)	Biomass (t)	*c.v.* (%)	No. of stations where caught
600–800	309.0	4 359	28.4	6
800–1000	403.8	1 009	21.5	30
1000–1200	48.0	110	52.4	28

Table 10 : Biomass estimates (t) for fish of all lengths (all fish) and for recruited fish for black oreo, smooth oreo, and orange roughy*

Stratum	Area (km²)	No. of stations	Black oreo				Smooth oreo				Orange roughy			
			All fish	*c.v.* (%)	Recruited	*c.v.* (%)	All fish	*c.v.* (%)	Recruited	*c.v.* (%)	All fish	*c.v.* (%)	Recruited	*c.v.* (%)
Subarea 1														
1	3 630	3	1 852	18	1 661	21	58	91	0		0		0	
2	3 167	6	3 021	77	2 499	75	35 635	99	3 862	100	0		0	
3	3 351	6	916	98	915	98	208	28	152	36	0		0	
Subarea 2														
4	4 180	3	14 189	37	10 968	44	142	56	98	58	0		0	
5	3 248	3	912	79	756	82	49	36	12	79	0		0	
6	3 474	3	0		0		70	36	41	46	0		0	
Subarea 3														
7	4 875	3	2 262	88	1 674	89	366	54	271	52	61	100	61	100
Subarea 4														
8	2 909	3	9 501	27	8 988	31	58	73	10	100	0		0	
9	1 376	3	2 302	45	2 260	45	1 915	56	815	85	21	39	0	
10	1 361	7	2 813	71	2 804	71	5 956	77	4 918	80	27	39	18	44
11	1 580	20	230	51	226	51	16 014	49	14 255	49	30	32	25	38
12	2 242	6	49	64	48	65	50	61	42	59	0		0	
Subarea 5														
13	1 922	3	3 474	47	3 056	57	175	96	20	100	0		0	
14	2 366	3	460	53	417	55	1 802	94	710	92	60	87	31	100
15	2 380	3	40	84	31	79	182	51	107	41	40	58	40	58
16	3 990	3	0		0		115	89	114	89	0		0	
Subarea 6														
17	2 106	3	476	98	181	98	1 662	97	0		0		0	
18	1 295	5	673	56	598	58	4 949	24	949	91	67	51	7	100
19	1 039	26	524	57	494	60	27 815	38	15 764	57	489	34	116	41
20	1 159	9	146	68	106	64	7 991	46	2 023	50	205	22	123	22
21	1 094	6	24	34	21	36	2 542	47	600	41	252	29	190	32
22	4 085	9	10	52	7	50	43 320	35	31 315	36	155	69	113	66
Subarea 7														
23	930	3	0		0		15	51	7	100	19	100	0	
24	547	3	6	29	3	100	16	66	2	100	94	53	28	87
25	846	3	13	56	10	55	364	92	24	42	362	25	143	26
26	1 351	3	28	53	28	53	45	38	45	38	169	46	63	43
Total	60 503	148	43 921		37 751		151 514		76 156		2 049		957	
Lower bound †			29 293		24 187		69 572		41 965		1 515		670	
Upper bound †			58 549		51 314		233 455		110 348		2 582		1 243	
c.v. (%)			16.7		18.0		27.0		22.5		13.0		15.0	

* Recruited size for black oreo is ≥ 27 cm TL, for smooth oreo ≥ 34 cm TL and for orange roughy ≥ 33 cm SL.

† ± 2 standard deviations.

Table 11: Biomass estimates from hill strata for black oreo, smooth oreo, and orange roughy*

Hill	Area (km^2)	No. of stations	Black oreo				Smooth oreo				Orange roughy			
			All fish	*c.v.* (%)	Recruited	*c.v.* (%)	All fish	*c.v.* (%)	Recruited	*c.v.* (%)	All fish	*c.v.* (%)	Recruited	*c.v.* (%)
Trev's pinnacle	1	4	3	70	2	72	36	98	23	98	1	58	1	58
Condoms	3	4	21	44	19	43	492	51	464	51	461	86	350	85
Mangrove	1	4	22	58	22	59	491	36	472	38	19	49	18	48
Charlies	2	3	428	74	410	75	706	23	688	24	109	39	97	40
Possum	8	4	8	47	6	42	51	82	46	84	11	55	8	55
Cotopaxi	2	3	20	36	19	37	11	12	11	11	5	39	4	41
Total	17	22	501		478		1 786		1 705		606		477	
Lower bound			0		0		1 078		1 015		0		0	
Upper bound			1 134		1 090		2 494		2 394		1 402		1 079	
c.v. (%)			63.3		64.0		19.8		20.2		65.8		63.1	

* Recruited size for black oreo is ≥ 27 cm TL, for smooth oreo ≥ 34 cm TL, and for orange roughy ≥ 33 cm SL.

Table 12: Biomass estimates from high catch area strata for black oreo, smooth oreo, and orange roughy*

Stratum	Area (km^2)	No. of stations	Black oreo				Smooth oreo				Orange roughy			
			All fish	*c.v.* (%)	Recruited	*c.v.* (%)	All fish	*c.v.* (%)	Recruited	*c.v.* (%)	All fish	*c.v.* (%)	Recruited	*c.v.* (%)
101	316	10	22	25	20	24	10	24	6	31	0		0	
102	498	10	114	46	109	48	40	33	27	34	0		0	
Total	814	20	136		129		50		33					
Lower bound			30		25		23		14					
Upper bound			243		233		76		53					
c.v. (%)			39.0		40.4		26.4		28.4					

* Recruited size for black oreo is ≥ 27 cm TL, for smooth oreo ≥ 34 cm TL, and for orange roughy ≥ 33 cm SL.

Table 13: Biomass estimates for fish of all lengths by subarea for black oreo (BOE), smooth oreo (SSO), and orange roughy for the standard survey subareas and hill survey

Subarea	Area (km²)	% of area	Biomass (t) BOE	SSO	ORH	% of biomass BOE	SSO	ORH
1	10 148	16.8	5 789	35 901	0	13.2	23.7	0.0
2	10 902	18.0	15 100	261	0	34.4	0.2	0.0
3	4 875	8.1	2 262	366	61	5.2	0.2	3.0
4	9 468	15.6	14 894	23 993	78	33.9	15.8	3.8
5	10 658	17.6	3 974	2 273	100	9.1	1.5	4.9
6	10 778	17.8	1 853	88 279	1168	4.2	58.3	57.0
7	3 674	6.1	46	440	643	0.1	0.3	31.4
Hills	17	< 0.1	501	1786	606			
Total	60 503		43 921	151 514	2 049			

NB: totals exclude hill survey data.

Table 14: Biomass estimates for fish of all lengths by depth for black oreo (BOE), smooth oreo (SSO), and orange roughy for the standard survey only*

Depth interval (m)	Area (km²)	Biomass (t) BOE	SSO	ORH	% of biomass BOE	SSO	ORH
600–800	15 677	29 492	2 110	19	70.8	1.4	1.0
800–1000	14 399	10 711	78 136	758	25.7	51.8	38.1
1000–1200	16 126	1 419	27 421	888	3.4	18.1	44.6
1200–1500	9 426	38	43 480	324	0.1	28.8	16.3
All depths	55 628	41 660	151 147	1 989			

* excluding subarea 3 (600–1200 m).

Table 15: Number of length and sex and "biological" samples taken during voyage TAN9309

	Length & sex	Staged	"Biological"	Otoliths
Black oreo	9 610	4 541	1 673	yes
Smooth oreo	16 344	11 375	1 876	yes
Orange roughy	4 235	840	840	yes
Hoki	1 153			no
Spiky oreo	235	164	† 90	no
Hake	24			no
Lookdown dory	19			no
Ling	15			no
Alfonsino	10			no
Warty oreo	11			no
Spiny dogfish	8			no
Sea perch	6			no
Cardinalfish	2			no
White warehou	1			no

† Samples taken for a genetic stock difference study

Table 16: Length-weight relationships for oreos and orange roughy

	Weight range (g)	Length range (cm)	*a*	*b*	r^2	*n*
Black oreo	210–2 030	21.7–45.3	0.010	3.20	93.9	1 673
Smooth oreo	75–4 110	16.0–56.6	0.032	2.87	98.1	1 876
Orange roughy	120–2 465	14.8–44.2	0.063	2.80	97.9	840

* $W = a.L^b$. Lengths are total length for oreos and standard length for orange roughy. *n* = number of observations

Table 17: Relative proportions of gonad stages sampled during TAN9309

	Black oreo				Smooth oreo				Orange roughy			
Gonad stage	Male	%	Female	%	Male	%	Female	%	Male	%	Female	%
1	1 151	48.9	811	37.1	1 183	20.2	1 948	35.9	152	42.5	88	18.3
2	534	22.7	663	30.6	928	15.8	2 277	42.0	206	57.5	372	77.2
3	568	24.1	567	26.1	2 556	43.6	404	7.5			13	2.7
4	41	1.7	75	3.5	1 133	19.3	447	8.2				
5	62	2.6	12	0.6	69	1.2	217	4.0				
6			36	1.7			94	1.7			2	0.4
7			5	0.2			34	0.6			7	1.5
All	2 356	100.0	2169	100.0	5 869	100.0	5 421	100.0	358	100.0	482	100.0

Table 18: Percentage of gonads at stage by species by depth range from the standard survey only *

Black oreo

	Males						Females						
Depth range (m)	1	2	3	4	5	*n*	1	2	3	4	5	6	*n*
600–800	60.8	28.2	11.1			380	53.6	32.0	11.6	2.5		0.3	362
800–1000	49.9	27.1	21.8	0.2	1.0	623	35.3	40.1	19.2	3.8	1.3	0.3	604
1000–1200	33.0	33.5	15.7	4.2	13.6	191	22.7	34.0	30.4	10.8	1.5	0.5	194
1200–1500	66.7	33.3				3			100				3
Total number	607	341	208	9	32	1 197	451	424	220	53	11	4	1 163

Smooth oreo

	Males						Females						
Depth range (m)	1	2	3	4	5	*n*	1	2	3	4	5	6	*n*
600–800	86.1	11.1	2.8			36	85.7	7.1	7.1				42
800–1000	39.7	19.9	30.4	9.2	0.8	2098	50.9	34.2	6.1	4.9	2.4	1.4	2025
1000–1200	15.7	19.3	47.5	16.9	0.5	1340	30.4	49.0	7.8	6.8	3.0	2.9	1258
1200–1500	6.2	17.6	37.7	34.3	4.2	551	33.8	45.1	6.3	6.7	5.2	2.9	521
Total number	108	777	1484	609	47	4 025	1626	1547	257	221	113	82	3 846

Orange roughy

	Males			Females				
Depth range (m)	1	2	*n*	1	2	3	7	*n*
600–800			0					0
800–1000	70.9	29.1	110	49.3	50.7			150
1000–1200	40.2	59.8	92	4.8	89.5	3.8	1.9	105
1200–1500	38.1	61.9	21	5.3	84.2	5.3	5.3	19
Total number	123	100	223	80	186	5	3	274

* Excluding subarea 3.

Appendix 2: Conversion factor (C.F.) and block weight measurements used to back-calculate large catches*.

Station	Green weight (kg)	Headed and gutted (kg)	C.F.
Black oreo			
94	214.6	89.6	2.39
94	245.8	105.2	2.34
127	185.2	69.4	2.67
135	158.7	68.0	2.33
Smooth oreo			
22	175.6	81.8	2.15
52	221.1	100.1	2.21
79	179.2	84.0	2.13
89	219.7	102.7	2.14
94	197.0	93.5	2.11
94	186.5	92.7	2.01
95	141.7	67.0	2.12
101	131.2	58.3	2.25
107	169.1	75.3	2.25
119	104.4	46.2	2.26
121	235.2	90.6	2.60
127	192.8	74.1	2.60
135	213.9	98.8	2.16
162	276.2	121.1	2.28
188	115.6	46.4	2.49
192	149.4	66.5	2.25
Orange roughy			
94	151.6	76.4	1.98
95	206.3	103.4	1.99
121	200.3	97.7	2.05
127	222.4	111.7	1.99
135	230.5	115.1	2.00

* All weights were measured on a "Seaway" weigher. Green weight is the weight before processing; Headed and gutted is the weight after processing; and C.F. is the conversion factor calculated by dividing the green weight by the headed and gutted weight.

Appendix 3: Summary of station data

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
1	100	5 Oct	44 49.55	174 12.70 E	44 49.71	174 15.49 E	860	883	1.99	1 700
2	100	5 Oct	44 52.29	174 16.72 E	44 53.72	174 14.79 E	930	1 034	1.98	1 940
3	100	5 Oct	44 58.00	174 15.58 E	44 58.82	174 17.33 E	987	1 019	1.48	1 810
4	100	5 Oct	44 57.54	174 12.68 E	44 56.88	174 15.32 E	974	1 044	1.98	1 900
5	100	5 Oct	44 55.98	174 11.25 E	44 55.47	174 14.02 E	962	1 003	2.03	1 840
6	100	6 Oct	44 55.56	174 10.44 E	44 53.95	174 12.12 E	836	904	2.00	1 540
7	100	6 Oct	44 54.50	174 04.50 E	44 54.81	174 06.94 E	1 005	1 011	2.05	1 820
8	100	6 Oct	44 51.45	174 17.14 E	44 52.53	174 19.53 E	947	1 018	2.01	1 780
9	100	6 Oct	44 54.99	174 14.07 E	44 55.97	174 13.73 E	993	1 032	1.01	1 800
10	100	6 Oct	44 51.76	174 10.02 E	44 53.03	174 12.27 E	915	956	2.04	1 710
11	101	6 Oct	44 42.74	173 27.17 E	44 43.03	173 29.01 E	905	948	1.34	1 670
12	101	6 Oct	44 42.13	173 24.18 E	44 44.11	173 23.61 E	937	985	2.02	1 700
13	101	7 Oct	44 43.86	173 21.07 E	44 44.61	173 18.49 E	918	990	1.98	1 810
14	101	7 Oct	44 43.73	173 17.14 E	44 43.75	173 14.95 E	912	917	1.56	1 660
15	101	7 Oct	44 49.02	173 24.29 E	44 48.42	173 21.38 E	968	983	2.15	1 800
16	101	7 Oct	44 48.26	173 09.73 E	44 46.24	173 10.04 E	1 027	1 088	2.03	1 890
17	101	7 Oct	44 47.36	173 09.21 E	44 46.85	173 07.47 E	1 045	1 090	1.34	1 970
18	101	7 Oct	44 43.01	173 15.75 E	44 42.25	173 15.83 E	903	918	0.76	1 650
19	101	7 Oct	44 49.04	173 06.03 E	44 49.82	173 04.87 E	1 072	1 076	1.13	1 940
20	101	8 Oct	44 51.69	173 12.81 E	44 51.35	173 10.06 E	1 041	1 065	1.98	1 970
21	3	8 Oct	44 44.40	173 14.97 E	44 44.11	173 16.02 E	1 002	1 022	0.80	1 820
22	2	8 Oct	44 41.59	173 36.22 E	44 40.38	173 35.56 E	849	887	1.30	1 550
23	1	8 Oct	44 23.56	173 35.86 E	44 22.44	173 38.13 E	657	665	1.97	1 160
24	2	8 Oct	44 37.46	173 50.53 E	44 36.16	173 52.69 E	842	868	2.01	1 620
25	2	8 Oct	44 32.94	173 54.20 E	44 31.78	173 56.47 E	808	818	1.99	1 440
26	1	8 Oct	44 23.98	174 21.09 E	44 22.63	174 23.18 E	685	694	2.00	1 250
27	1	8 Oct	44 29.66	174 16.74 E	44 31.66	174 15.94 E	745	773	2.08	1 390
28	2	8 Oct	44 35.21	174 00.71 E	44 35.71	173 58.01 E	875	889	1.99	1 600
29	3	9 Oct	44 49.79	173 49.97 E	44 51.40	173 48.30 E	988	1 050	2.00	1 860
30	3	9 Oct	44 54.33	173 47.79 E	44 55.98	173 49.41 E	1 146	1 166	2.01	2 000
31	3	9 Oct	44 55.90	174 06.81 E	44 55.70	174 04.00 E	1 025	1 084	2.00	2 000
32	3	9 Oct	44 57.06	174 09.77 E	44 59.01	174 09.02 E	1 002	1 117	2.02	2 020
33	2	9 Oct	44 50.25	174 18.81 E	44 51.30	174 19.02 E	944	1 006	1.06	1 740

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
34	2	9 Oct	44 56.72	174 26.16 E	44 58.37	174 25.70 E	940	989	1.68	1 750
35	3	9 Oct	45 09.72	174 28.87 E	45 07.93	174 27.58 E	1 088	1 090	2.01	1 960
36	6	9 Oct	45 15.16	174 48.58 E	45 13.79	174 50.59 E	1 068	1 084	1.97	1 935
37	6	9 Oct	45 19.03	174 52.03 E	45 18.81	174 49.18 E	1 084	1 104	2.02	2 000
38	6	10 Oct	45 13.53	174 45.31 E	45 11.45	174 44.68 E	1 053	1 054	2.13	1 870
39	5	10 Oct	44 54.72	175 03.74 E	44 54.05	175 05.08 E	926	967	1.16	1 660
40	5	10 Oct	44 51.96	174 52.91 E	44 51.97	174 55.73 E	878	885	2.00	1 580
41	4	10 Oct	44 41.03	174 56.63 E	44 39.61	174 56.38 E	782	804	1.43	1 440
42	4	10 Oct	44 31.04	175 09.65 E	44 32.79	175 09.27 E	699	712	1.77	1 380
43	5	10 Oct	44 38.47	175 26.64 E	44 40.47	175 26.64 E	802	826	2.00	1 480
44	4	10 Oct	44 22.43	175 38.89 E	44 23.66	175 41.03 E	688	731	1.96	1 320
45	7	11 Oct	44 37.23	176 08.22 E	44 40.64	176 12.29 E	949	1 094	2.00	1 970
46	7	11 Oct	44 38.34	176 14.98 E	44 37.69	176 17.66 E	1 069	1 083	2.01	1 935
47	7	11 Oct	44 14.59	176 23.31 E	44 15.64	176 20.88 E	615	685	2.03	1 200
48	9	11 Oct	44 11.13	177 11.20 E	44 13.03	177 10.32 E	837	881	2.00	1 580
49	12	11 Oct	44 18.74	177 08.54 E	44 18.82	177 11.32 E	1 087	1 114	2.00	1 990
50	12	11 Oct	44 20.31	177 10.25 E	44 20.50	177 13.01 E	1 132	1 143	1.98	2 030
51	11	12 Oct	44 13.60	177 23.05 E	44 13.31	177 25.37 E	1 007	1 041	1.69	1 800
52	10	12 Oct	44 10.90	177 29.34 E	44 12.39	177 30.02 E	947	964	1.57	1 700
53	9	12 Oct	44 07.29	177 35.79 E	44 08.88	177 37.47 E	883	924	2.00	1 640
54	12	12 Oct	44 18.26	177 39.80 E	44 18.86	177 42.42 E	1 100	1 103	1.97	1 990
55	12	12 Oct	44 21.79	177 52.88 E	44 21.96	177 55.80 E	1 138	1 144	2.09	2 050
56	10	12 Oct	44 04.41	177 51.38 E	44 04.83	177 54.11 E	909	976	2.01	1 750
57	8	12 Oct	43 55.37	178 16.43 E	43 55.79	178 19.15 E	642	659	2.00	1 180
58	8	12 Oct	43 58.99	178 33.24 E	43 58.96	178 36.00 E	678	689	1.99	1 220
59	8	13 Oct	44 02.73	178 39.27 E	44 02.49	178 42.03 E	782	796	2.00	1 450
60	10	13 Oct	44 06.27	178 34.35 E	44 06.73	178 36.98 E	924	982	1.94	1 700
61	10	13 Oct	44 07.42	178 32.19 E	44 07.32	178 29.34 E	935	942	2.05	1 700
62	10	13 Oct	44 07.03	178 26.19 E	44 07.73	178 23.53 E	945	1 004	2.03	1 785
63	11	13 Oct	44 06.43	178 12.85 E	44 07.60	178 10.60 E	1 016	1 068	1.99	1 870
64	12	13 Oct	44 13.81	178 22.78 E	44 14.02	178 19.97 E	1 112	1 116	2.02	1 980
65	12	13 Oct	44 16.78	178 27.48 E	44 18.06	178 29.62 E	1 155	1 166	2.00	2 030
66	11	14 Oct	44 12.56	178 51.50 E	44 12.98	178 54.22 E	1 002	1 008	1.99	1 750
67	10	14 Oct	44 12.54	179 06.58 E	44 13.94	179 08.61 E	930	959	2.02	1 630

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
68	9	14 Oct	44 09.34	179 15.31 E	44 09.34	179 12.48 E	820	836	2.03	1 520
69	10	14 Oct	44 16.56	178 18.75 E	44 17.65	178 21.05 E	982	995	1.97	1 780
70	11	14 Oct	44 17.77	179 20.87 E	44 18.96	179 18.61 E	990	1 036	2.01	1 860
71	16	14 Oct	44 29.35	179 47.32 E	44 30.23	179 49.85 E	1 210	1 213	2.01	2 150
72	14	14 Oct	44 18.30	179 55.64 E	44 19.66	179 57.74 E	917	940	2.03	1 700
73	13	14 Oct	44 14.57	179 57.41 E	44 16.22	179 58.90 E	770	800	1.97	1 420
74	14	14 Oct	44 19.82	179 42.56 W	44 19.81	179 39.74 W	816	833	2.02	1 490
75	14	15 Oct	44 23.28	179 40.37 W	44 24.78	179 40.60 W	907	1 000	1.51	1 700
76	13	15 Oct	44 17.12	179 37.09 W	44 17.52	179 39.84 W	707	747	2.01	1 300
77	30	15 Oct	44 26.26	179 16.10 W	44 26.08	179 16.07 W	910	940	0.18	1 730
78*	30	15 Oct	44 26.89	179 15.28 W	44 26.85	179 14.80 W	890	980	0.35	1 700
79	30	15 Oct	44 26.82	179 15.41 W	44 26.81	179 14.85 W	880	931	0.40	1 700
80	30	15 Oct	44 26.38	179 15.90 W	44 26.10	179 15.68 W	893	924	0.32	1 700
81	30	15 Oct	44 26.23	179 15.98 E	44 26.01	179 15.84 E	768	960	0.24	1 500
82	16	15 Oct	44 46.23	179 31.34 W	44 45.89	179 28.05 W	1 312	1 369	2.00	2 370
83	15	15 Oct	44 29.13	179 07.86 W	44 27.22	179 08.81 W	1 027	1 071	2.03	1 900
84	15	16 Oct	44 31.59	179 02.62 W	44 31.64	178 59.80 W	1 120	1 131	2.01	1 980
85	16	16 Oct	44 41.32	178 27.69 W	44 41.34	178 24.87 W	1 273	1 279	2.01	2 250
86	17	16 Oct	44 34.62	175 58.29 W	44 33.70	175 55.79 W	765	776	2.00	1 420
87	18	16 Oct	44 33.75	175 52.28 W	44 33.73	175 49.46 W	802	858	2.01	1 550
88*	31	17 Oct	44 36.61	175 43.89 W	44 36.71	175 43.46 W	900	1 140	0.32	2 050
89*	31	17 Oct	44 36.69	175 44.42 W	44 36.75	175 44.21 W	860	869	0.16	1 690
90	31	17 Oct	44 36.92	175 44.38 W	44 37.14	175 43.97 W	867	1 080	0.37	1 550
91	17	17 Oct	44 29.62	175 44.63 W	44 29.36	175 43.01 W	600	632	1.18	1 100
92	23	18 Oct	44 22.31	175 03.95 W	44 20.57	175 02.55 W	770	798	2.01	1 420
93*	33	18 Oct	44 40.48	175 18.99 W	44 40.45	175 18.48 W	1 079	1 198	0.36	2 160
94	33	18 Oct	44 40.08	175 21.22 W	44 40.43	175 21.29 W	930	950	0.35	1 860
95	31	18 Oct	44 36.79	175 46.37 W	44 36.82	175 46.51 W	861	885	0.10	1 735
96	22	19 Oct	44 54.09	177 08.17 W	44 55.21	177 06.38 W	1 461	1 500	1.69	2 600
97	17	19 Oct	44 26.03	177 20.65 W	44 24.60	177 22.61 W	637	671	2.00	1 230
98	13	19 Oct	44 07.06	179 55.23 E	44 06.75	179 52.45 E	609	618	2.02	1 100
99	15	19 Oct	44 23.42	179 35.78 E	44 22.75	179 33.11 E	1 134	1 152	2.02	2 040
100	19	24 Oct	44 26.24	178 14.52 W	44 26.24	178 11.72 W	956	970	2.00	1 750
101	19	24 Oct	44 26.67	178 06.49 W	44 26.67	178 03.70 W	921	932	1.49	1 800

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
102	20	24 Oct	44 30.97	178 07.72 W	44 33.17	178 06.98 W	1 016	1 043	2.00	1 850
103	20	25 Oct	44 32.58	178 07.05 W	44 32.85	178 04.27 W	1 043	1 049	2.00	1 830
104	21	25 Oct	44 36.53	178 02.19 W	44 36.56	177 59.86 W	1 100	1 132	1.66	2 000
105	19	25 Oct	44 31.20	177 52.41 W	44 32.94	177 51.04 W	906	908	2.00	1 700
106	18	25 Oct	44 29.81	177 40.65 W	44 29.70	177 37.84 W	809	815	2.01	1 420
107	19	25 Oct	44 37.30	177 31.20 W	44 37.59	177 29.81 W	934	944	1.03	1 700
108	18	25 Oct	44 35.51	177 27.15 W	44 35.97	177 30.07 W	852	874	2.13	1 550
109	21	15 Oct	44 40.08	177 33.76 W	44 40.65	177 31.19 W	1 110	1 141	1.91	2 090
110	20	25 Oct	44 40.25	177 24.77 W	44 41.11	177 22.26 W	1 048	1 067	1.98	1 920
111	21	25 Oct	44 41.93	177 23.93 W	44 42.10	177 21.09 W	1 117	1 146	2.03	2 070
112	18	25 Oct	44 32.79	177 12.99 W	44 34.69	177 12.25 W	802	826	1.97	1 360
113	21	26 Oct	44 45.16	176 55.63 W	44 46.32	176 57.95 W	1 103	1 180	2.01	2 150
114	18	26 Oct	44 37.95	176 55.11 W	44 38.11	176 56.52 W	845	870	1.02	1 530
115	21	26 Oct	44 42.39	176 08.52 W	44 44.26	176 09.56 W	1 100	1 200	2.01	2 122
116	20	26 Oct	44 38.92	176 02.01 W	44 40.23	176 04.11 W	996	1 030	2.00	1 800
117*	31	26 Oct	44 36.82	175 46.37 W	44 37.00	175 46.82 W	860	1 000	0.37	1 520
118*	31	26 Oct	44 36.79	175 46.19 W	44 36.92	175 46.58 W	860	1 040	0.31	1 450
119	20	26 Oct	44 35.74	175 49.82 W	44 35.81	175 47.08 W	1 000	1 042	1.95	1 900
120*	31	27 Oct	44 36.81	175 46.46 W	44 36.90	175 46.76 W	860	970	0.23	1 500
121	31	27 Oct	44 36.72	175 46.14 W	44 36.93	175 46.88 W	865	1 030	0.57	1 770
122*	32	27 Oct	44 41.63	175 29.48 W	44 41.57	175 29.78 W	980	1 050	0.22	1 660
123	32	27 Oct	44 41.67	175 29.25 W	44 41.45	175 29.85 W	990	1 240	0.48	2 000
124	19	27 Oct	44 35.38	175 51.15 W	44 35.63	175 48.38 W	924	1 000	2.00	1 800
125	22	27 Oct	44 40.14	175 47.47 W	44 39.45	175 44.79 W	1 339	1 367	2.03	2 350
126*	32	27 Oct	44 41.76	175 29.39 W	44 41.70	175 29.91 W	990	1 159	0.37	1 650
127	32	28 Oct	44 41.09	175 28.30 W	44 40.76	175 28.38 W	1 036	1 170	0.33	–
128	32	28 Oct	44 41.78	175 29.54 W	44 41.71	175 29.97 W	1 028	1 190	0.31	1 950
129	20	28 Oct	44 33.73	175 23.47 W	44 34.44	175 26.07 W	1 042	1 057	1.98	1 850
130	19	28 Oct	44 32.66	175 24.05 W	44 32.50	175 21.23 W	975	978	2.02	1 735
131*	33	28 Oct	44 40.44	175 19.16 W	44 40.35	175 18.72 W	937	1 102	0.33	1 700
132*	33	28 Oct	44 39.96	175 20.29 W	44 39.49	175 20.25 W	1 100	1 160	0.47	1 675
133	19	28 Oct	44 31.96	175 28.38 W	44 32.65	175 31.05 W	911	942	2.00	1 800
134	33	29 Oct	44 40.33	175 21.40 W	44 40.26	175 21.56 W	925	1 020	0.13	1 720
135	33	29 Oct	44 41.56	175 20.56 W	44 41.99	175 20.59 W	924	1 130	0.43	1 750

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
136	21	29 Oct	44 35.22	175 23.39 W	44 35.53	175 20.62 W	1 084	1 127	2.00	1 980
137	25	29 Oct	44 31.95	175 13.37 W	44 31.96	175 10.57 W	1 071	1 159	2.00	2 090
138	25	29 Oct	44 29.36	174 56.78 W	44 29.44	174 53.99 W	1 102	1 200	1.99	2 000
139	24	29 Oct	44 25.74	175 01.51 W	44 24.34	175 03.49 W	863	935	1.99	1 600
140	24	29 Oct	44 23.81	175 02.70 W	44 21.90	175 01.72 W	812	853	2.03	1 600
141	26	30 Oct	44 23.95	174 37.21 W	44 22.18	174 36.34 W	1 420	1 463	1.88	2 550
142*	34	30 Oct	44 12.68	174 28.27 W	44 12.49	174 28.19 W	780	800	0.20	1 520
143*	34	30 Oct	44 12.83	174 28.45 W	44 12.83	174 28.45 W	740	740	–	–
144	34	30 Oct	44 13.64	174 27.79 W	44 13.92	174 27.30 W	830	1 134	0.45	1 650
145	34	30 Oct	44 13.47	174 27.85 W	44 13.62	174 26.95 W	820	1 110	0.66	1 320
146	34	30 Oct	44 12.34	174 29.37 W	44 11.42	174 29.76 W	870	1 187	0.96	2 180
147	34	30 Oct	44 12.41	174 28.97 W	44 11.86	174 28.99 W	800	1 090	0.55	1 300
148	26	30 Oct	44 04.84	174 24.55 W	44 04.48	174 21.82 W	1 202	1 238	1.99	2 200
149*	35	31 Oct	44 09.00	174 26.44 W	44 09.00	174 26.44 W	1 113	1 120	–	–
150	35	31 Oct	44 10.53	174 27.78 W	44 10.77	174 28.10 W	985	1 206	0.33	1 960
151	35	31 Oct	44 10.85	174 26.40 W	44 11.14	174 26.18 W	1 023	1 225	0.33	2 000
152	35	31 Oct	44 10.52	174 25.74 W	44 10.66	174 25.37 W	1 008	1 216	0.30	2 050
153	26	31 Oct	44 06.45	174 27.83 W	44 06.54	174 25.05 W	1 200	1 229	2.00	2 150
154	25	31 Oct	44 04.38	174 39.26 W	44 03.88	174 36.38 W	1 017	1 095	2.13	1 800
155	23	31 Oct	44 05.73	174 52.26 W	44 03.73	174 52.37 W	783	799	2.00	1 400
156	23	31 Oct	44 04.95	175 01.06 W	44 02.95	175 01.06 W	751	766	2.00	1 400
157	24	31 Oct	44 09.81	174 48.27 W	44 10.13	174 46.55 W	933	1 012	1.27	1 800
158*	33	1 Nov	44 40.57	175 21.77 W	44 40.61	175 22.01 W	997	1 064	0.18	1 650
159*	33	1 Nov	44 40.38	175 19.53 W	44 40.39	175 19.59 W	939	940	0.04	–
160	20	1 Nov	44 31.04	175 12.62 W	44 31.00	175 14.93 W	1 036	1 100	1.65	1 990
161	19	1 Nov	44 32.85	175 26.53 W	44 32.41	175 23.79 W	971	979	2.00	1 710
162	32	2 Nov	44 42.54	175 28.98 W	44 42.75	175 29.29 W	986	1 150	0.30	1 700
163*	33	2 Nov	44 40.67	175 21.70 W	44 40.64	175 22.08 W	960	1 060	0.27	1 950
164	19	2 Nov	44 31.88	175 36.35 W	44 32.48	175 39.04 W	951	981	2.01	1 750
165	19	2 Nov	44 33.61	175 45.16 W	44 33.62	175 47.97 W	908	975	2.00	1 700
166	19	2 Nov	44 35.02	175 50.79 W	44 35.35	175 53.54 W	923	963	1.99	1 750
167	19	2 Nov	44 37.26	176 00.07 W	44 38.13	176 02.25 W	935	956	1.78	–
168	22	3 Nov	44 43.05	176 02.50 W	44 42.58	176 05.31 W	1 248	1 325	2.05	2 300

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
169	22	3 Nov	44 45.19	176 09.74 W	44 45.04	176 12.57 W	1 272	1 361	2.02	2 300
170	19	3 Nov	44 41.56	176 22.61 W	44 41.68	176 25.43 W	972	1 000	2.01	1 700
171	19	3 Nov	44 42.59	176 41.29 W	44 43.23	176 39.01 W	976	991	1.74	1 700
172	19	3 Nov	44 40.54	176 50.73 W	44 41.18	176 48.10 W	941	986	1.98	1 700
173	19	3 Nov	44 38.22	176 03.83 W	44 38.44	176 05.93 W	913	945	1.51	1 650
174*	31	4 Nov	44 37.16	175 45.70 W	44 37.27	175 45.70 W	898	920	0.11	–
175	31	4 Nov	44 35.64	175 45.44 W	44 35.14	175 45.50 W	872	1 120	0.50	1 850
176	22	4 Nov	44 39.61	175 54.15 W	44 38.90	175 51.55 W	1 198	1 205	1.98	2 100
177	19	4 Nov	44 38.56	177 08.97 W	44 38.30	177 06.21 W	919	969	1.98	1 650
178	19	4 Nov	44 39.70	177 08.04 W	44 39.59	177 05.25 W	935	976	1.99	–
179	20	5 Nov	44 42.92	177 08.83 W	44 42.96	177 06.02 W	1 044	1 084	2.00	1 900
180	22	5 Nov	44 44.31	177 19.80 W	44 44.36	177 17.01 W	1 213	1 229	1.98	2 150
181	19	5 Nov	44 37.15	177 23.41 W	44 37.85	177 26.07 W	877	904	2.02	1 620
182	22	5 Nov	44 43.29	177 43.10 W	44 43.68	177 45.88 W	1 253	1 260	2.01	2 250
183	19	5 Nov	44 33.26	177 42.92 W	44 33.65	177 40.16 W	942	953	2.00	–
184	19	5 Nov	44 32.42	177 44.33 W	44 32.33	177 47.16 W	888	923	2.02	–
185	19	5 Nov	44 32.82	177 50.72 W	44 33.01	177 53.57 W	908	926	2.04	1 620
186	22	6 Nov	44 46.02	178 09.44 W	44 46.93	178 06.95 W	1 377	1 382	1.99	2 400
187	22	6 Nov	44 46.98	178 02.32 W	44 47.18	177 59.50 W	1 365	1 367	2.01	2 400
188	19	6 Nov	44 31.31	177 58.03 W	44 30.38	178 00.56 W	949	954	2.03	1 700
189	20	6 Nov	44 33.46	177 59.18 W	44 34.82	177 57.11 W	1 001	1 003	2.01	1 800
190	19	6 Nov	44 26.60	178 21.37 W	44 26.18	178 18.64 W	951	993	2.00	1 710
191	19	6 Nov	44 26.69	178 13.76 W	44 26.48	178 10.72 W	973	992	2.00	1 710
192	19	7 Nov	44 29.91	178 07.00 W	44 29.19	178 09.63 W	997	999	2.00	1 710
193	11	7 Nov	44 19.97	179 21.87 E	44 20.59	179 24.56 E	1 065	1 098	2.02	1 900
194	11	7 Nov	44 14.31	179 01.49 E	44 15.16	179 04.01 E	1 037	1 099	1.99	1 900
195	11	7 Nov	44 14.38	178 54.45 E	44 14.31	178 57.23 E	1 036	1 044	1.99	1 875
196	11	7 Nov	44 14.20	178 51.66 E	44 14.14	178 48.85 E	1 039	1 052	2.01	1 875
197	11	8 Nov	44 13.47	178 41.87 E	44 14.05	178 44.62 E	1 065	1 072	2.05	1 900
198	11	8 Nov	44 12.86	178 34.20 E	44 12.29	178 31.50 E	1 072	1 076	2.02	1 900
199	11	8 Nov	44 14.32	178 36.06 E	44 14.67	178 38.81 E	1 098	1 099	2.00	1 980
200	11	8 Nov	44 06.16	178 11.03 E	44 05.89	178 08.36 E	1 000	1 007	1.94	1 800
201	11	8 Nov	44 06.32	178 04.31 E	44 07.33	178 06.70 E	1 036	1 037	1.99	1 850

Station	Stratum	Date 1993	Start Latitude ° 'S	Start Longitude ° 'E/W	Finish Latitude ° 'S	Finish Longitude ° 'E/W	Depth (m) Min.	Depth (m) Max.	Distance towed (n. mile)	Warp length (m)
202	11	8 Nov	44 09.53	178 04.17 E	44 09.55	178 01.35 E	1 083	1 090	2.02	2 000
203	11	8 Nov	44 13.60	177 38.87 E	44 14.63	177 36.30 E	1 038	1 041	2.00	1 890
204	11	8 Nov	44 12.69	177 36.65 E	44 13.58	177 34.12 E	999	1 014	2.02	1 800
205	11	8 Nov	44 18.08	177 31.64 E	44 17.02	177 29.25 E	1 093	1 100	2.01	1 950
206	11	8 Nov	44 14.63	177 29.85 E	44 14.69	177 27.65 E	1 012	1 017	1.57	1 810
207	11	9 Nov	44 16.44	177 21.43 E	44 15.95	177 18.72 E	1 059	1 086	2.00	1 890
208	11	9 Nov	44 17.58	177 08.64 E	44 17.99	177 05.92 E	1 027	1 065	1.90	1 860

* Gear performance 3 (unsatisfactory)
– No data

Appendix 4: Catch (kg) of black oreo, smooth oreo, and orange roughy at each station

Station	Black oreo	Smooth oreo	Orange roughy
1	19.6	1.3	0
2	5.5	2.3	0
3	2.4	1.2	0
4	0.4	4.5	0
5	2.5	3.0	0
6	3.4	5.6	0
7	13.0	9.3	0
8	11.6	1.6	0
9	2.9	1.7	0
10	8.7	0.6	0
11	17.9	0.5	0
12	8.1	1.6	0
13	14.0	9.4	0
14	32.2	9.5	0
15	7.6	0.2	0
16	9.1	5.5	0
17	0.3	1.0	0
18	44.3	2.7	0
19	7.9	14.5	0
20	0.5	18.5	0
21	66.8	5.1	0
22	309.0	4 496.9	0
23	40.5	4.6	0
24	30.7	72.2	0
25	56.5	1.6	0
26	72.2	0	0
27	47.0	0.3	0
28	22.8	1.2	0
29	1.4	5.3	0
30	0	9.0	0
31	1.0	7.7	0
32	0.5	0	0
33	3.3	0	0
34	0.8	0.3	0
35	0	3.8	0
36	0	2.4	0
37	0	3.2	0
38	0	0.7	0
39	1.4	0.4	0
40	10.1	1.4	0
41	243.9	5.3	0
42	515.9	1.7	0
43	74.7	2.6	0
44	128.2	1.2	0
45	10.2	14.5	0
46	1.6	8.9	3.9
47	134.4	0	0
48	73.0	296.6	0.6
49	7.8	0	0
50	0	9.1	0
51	0	84.0	0
52	147.8	1 965.0	0
53	120.0	21.1	2.7
54	5.8	1.2	0
55	0	0.9	0
56	7.5	4.8	0
57	154.3	0	0

Station	Black oreo	Smooth oreo	Orange roughy
58	443.2	1.2	0
59	415.2	5.0	0
60	51.5	8.9	0.9
61	1 137.0	54.9	2.7
62	100.9	602.4	6.2
63	50.2	581.2	3.6
64	0	0.8	0
65	0	1.7	0
66	2.6	218.1	4.0
67	29.6	6.9	1.9
68	331.7	116.5	1.4
69	11.8	2.3	2.6
70	1.4	4 368.4	2.5
71	0	8.3	0
72	2.9	230.8	0.7
73	349.5	27.0	0
74	40.1	1.7	0
75	13.5	5.7	5.4
76	56.7	0.8	0
77	21.3	5.7	11.7
78	5.2	2.4	1.6
79	176.4	2 959.4	23.7
80	5.6	2.0	0
81	0.7	12.6	0
82	0	0	0
83	0.6	15.9	1.7
84	0	6.3	3.5
85	0	0.7	0
86	0.8	240.8	0
87	0.8	338.7	3.6
88	0.9	17.3	4.4
89	205.6	2 609.7	471.8
90	0.3	240.6	15.3
91	0	0	0
92	0	3.0	0
93	4.3	0	1.7
94	9 565.0	7 555.1	1 750.0
95	62.9	1 686.7	2 834.0
96	0	28.5	1.6
97	69.4	4.5	0
98	152.0	0	0
99	4.7	1.9	0
100	0	1156.7	6.0
101	2.5	4 047.7	5.5
102	1.6	2 641.6	15.1
103	0.5	10.5	4.4
104	0	92.5	3.6
105	45.1	1 451.2	35.5
106	103.8	448.7	0
107	253.3	11 047.6	140.4
108	158.4	770.9	10.1
109	0.8	113.6	6.7
110	1.0	42.9	6.3
111	3.2	45.3	45.7
112	11.1	326.9	0
113	1.7	16.6	21.6
114	2.6	71.4	6.9
115	2.8	723.2	42.4

Station	Black oreo	Smooth oreo	Orange roughy
116	13.2	59.5	16.8
117	10.3	43.7	46.0
118	0	0	0
119	8.7	2 067.1	12.3
120	0	0	0
121	107.1	8 570.0	1 747.0
122	228.3	67.8	508.0
123	447.9	5 947.7	466.5
124	3.6	1 341.4	13.9
125	0	512.1	6.7
126	0	1 187.8	0
127	1 026.0	4 506.0	766.0
128	92.0	7 236.8	189.5
129	7.3	864.6	18.9
130	24.2	921.8	21.5
131	38.1	6.9	8.9
132	19.3	750.0	20.0
133	1.3	92.3	43.0
134	152.4	1 270.7	209.7
135	2 017.0	10 062.2	785.4
136	5.3	433.1	23.3
137	1.7	126.8	26.1
138	3	5.1	42.5
139	0.5	7.1	18.6
140	1.6	1.0	1.1
141	0	5.5	1.2
142	8.3	10.8	0
143	2.2	0.6	0
144	7.2	19.3	12.8
145	75.7	81.7	122.4
146	11.9	14.8	28.3
147	34.1	623.5	19.8
148	3.8	1.4	16.7
149	5.8	0	4.0
150	93.1	73.1	73.5
151	288.3	110.7	15.2
152	112.3	86.8	36.4
153	2.6	3.1	20.8
154	0	1.9	68.3
155	0	1.8	6.4
156	0	0.1	0
157	1.0	0.7	21.2
158	18.8	10.7	43.0
159	726.0	2 021.9	13.3
160	68.6	21.1	22.5
161	20.1	429.0	10.6
162	88.1	15 650.2	10.4
163	3.5	37.4	0
164	50.7	459.0	9.3
165	10.5	2 139.1	8.7
166	10.5	1 124.1	7.2
167	6.7	189.7	6.5
168	0	1 670.1	1.6
169	0	2 538.3	0
170	5.2	2 132.9	47.3
171	2.0	763.9	34.9
172	8.0	1 276.8	105.3
173	1.6	1 035.5	7.2

Station	Black oreo	Smooth oreo	Orange roughy
174	2.2	10.4	6.2
175	297.6	687.9	190.5
176	0.9	2 434.8	24.7
177	3.7	237.9	37.4
178	21.5	255.9	37.6
179	1.0	308.1	45.5
180	0.8	2 420.3	0.4
181	9.4	174.1	13.8
182	0.5	294.9	0
183	0	1 448.5	19.7
184	4.1	495.2	76.4
185	644.1	19 731.9	368.8
186	0	7.9	0
187	0	0.2	0
188	0.3	3 653.6	12.1
189	1.1	347.6	17.9
190	0.6	1 051.8	22.9
191	1.2	1 700.8	38.4
192	0.4	1 925.4	2.0
193	0	9 020.5	1.5
194	0.5	25.4	4.0
195	1.1	3 626.4	3.1
196	1.1	35.6	3.1
197	0.4	0.7	0
198	0	2.3	0
199	0	0.3	0
200	1.0	1.4	0
201	0.5	0.5	1.0
202	0	0.7	0
203	0	71.8	0
204	82.5	108.4	1.0
205	9.2	7.1	0
206	102.3	2 271.2	9.0
207	18.9	21.5	0
208	1.9	4.8	0

Appendix 5: Species caught.

Species code	Scientific name	Common name
Crustacea		
APE	*Acanthephyra pelagica*	
LHO	*Lipkius holthuisi*	omega prawn
NEB	*Neolithodes brodiei*	southern stone crab
PZE	*Paralomis zelandica*	
PBA	*Pasiphaea barnardi*	
PAS	*Pasiphaea* spp.	
NAU	*Notostomus auriculatus*	
GNA	*Gnathophausia* sp.	
Cephalopods		
VSQ	*Histioteuthis* spp.	violet squid
MIQ	*Moroteuthis ingens*	warty squid
MRQ	*M. robsoni*	warty squid
DWO	*Octopus* sp.	deepwater octopus
RSQ	*Ommastrephes bartrami*	red squid
CHQ	Cranchiidae	cranchiid squid
OPI	*Opisthoteuthis* sp.	
OSQ	Octopoteuthiidae	
AMP	*Amphitretus* spp.	deepwater octopus
Chondrichthyes		
Squalidae		
CSQ	*Centrophorus squamosus*	leafscaled gulper shark
CYP	*Centroscymnus crepidater*	longnosed velvet dogfish
CYO	*C. owstoni*	smooth skinned dogfish
CYL	*C. coelolepis*	Portuguese dogfish
SND	*Deania calcea*	shovelnosed spiny dogfish
ETB	*Etmopterus baxteri*	Baxter's lantern dogfish
ETL	*E. lucifer*	Lucifer dogfish
ETM	*Etmopterus* sp.	
PLS	*Scymnodon plunketi*	Plunket's shark
BSH	*Scymnorhinus licha*	seal shark
SPD	*Squalus acanthias*	spiny dogfish
Scyliorhinidae		
APR	*Apristurus* spp.	catshark
Rajidae		
PSK	*Bathyraja shuntovi*	longnosed deepsea skate
BTH	*Pavoraja* spp.	bluntnosed skate
SSK	*Raja innominata*	smooth skate
Rhinochimaeridae		
LCH	*Harriotta raleighana*	longnosed chimaera
RCH	*Rhinochimaera pacifica*	widenosed chimera
Chimaeridae		
CHG	*Chimaera* sp. B	giant chimaera
CHP	*Chimaera* sp. C	purple chimaera
HYB	*Hydrolagus* sp. A	black hydrolagus
GSP	*Hydrolagus* sp. B	pale hydrolagus
HYP	*Hydrolagus* sp. C	longnosed blue hydrolagus

Teleosts

Notacanthiformes		
Halosauridae		
HPE	*Halosaurus pectoralis*	common halosaur
Notocanthidae		
SBK	*Notacanthus sexspinis*	spineback eel
Anguilliformes		
Nemichthyidae		
NEM	*Nemichthys scolapaceus*	slender snipe eel
Synaphobranchidae		
BEE	*Diastobranchus capensis*	basketwork eel
Serrivomeridae		
SAW	*Serrivomer* sp.	sawtooth eel
Salmoniformes		
Platytroctidae		
PER	*Persparsia kopua*	tubeshoulder
HOL	*Holtbyrnia* sp.	tubeshoulder
Bathylagidae		
DSS	*Bathylagus* sp.	deepsea smelt
Alepocephalidae		
SSM	*Alepocephalus australis*	smallscaled brown slickhead
SBI	*Alepocephalus* sp.	bigscaled brown slickhead
BSL	*Xenodermichthys copei*	black slickhead
Stomiiformes		
Photichthyidae		
PHO	*Photichthys argenteus*	lighthouse fish
Chauliodontidae		
CHA	*Chauliodus sloani*	viperfish
Melanostomiidae		
MST	Melanostomiidae (family)	scaleless dragonfishes
OMI	*Opostomias micripnus*	scaleless black dragonfish
Malacosteidae		
MAL	Malacosteidae (family)	loosejaws
Idiacanthidae		
IDI	*Idiacanthus* spp.	black dragonfishes
Aulopiformes		
Scopelarchidae		
SCP	*Scopelarchus* sp.	pearleye
Notosudidae		
SPL	*Scopelosaurus* sp.	waryfish
Myctophiformes		
Myctophidae		
LAN	Myctophidae (family)	lanternfish
GYM	*Gymnoscopelus* spp.	
LPA	*Lampanyctus* spp.	

Gadiformes		
Moridae		
VCO	*Antimora rostrata*	violet cod
HJO	*Halargyreus johnsonii*	Johnson's cod
SMC	*Lepidion microcephalus*	smallheaded cod
LPS	*L. schmidti*	giant lepidion
RIB	*Mora moro*	ribaldo
Melanonidae		
MEL	*Melanonus gracilis*	pelagic cod
Merlucciidae		
LYC	*Lyconus* sp.	blackmouth hake
HOK	*Macruronus novaezelandiae*	hoki
HAK	*Merluccius australis*	hake
Macrouridae		
OMU	*Odontomacrurus murrayi*	largefang rattail
CKX	*Caelorinchus acanthiger*	spottyfaced rattail
CBO	*C. bollonsi*	Bollon's rattail
CFA	*C. fasciatus*	banded rattail
CIN	*C. innotabilis*	notable rattail
CKA	*C. kaiyomaru*	Kaiyomaru rattail
CMA	*C. matamua*	Mahia rattail
COL	*C. oliverianus*	Oliver's rattail
CMX	*Coryphaenoides mcmillani*	
CMU	*C. murrayi*	abyssal rattail
CSE	*C. serrulatus*	serrulate rattail
CSU	*C. subserrulatus*	fourrayed rattail
CSL	*Coryphaenoides* sp. A	slender rattail
CBA	*Coryphaenoides* sp. B	long barbelled rattail
NPU	*Kuronezumia leonis*	
JAV	*Lepidorhynchus denticulatus*	javelinfish
MCA	*Macrourus carinatus*	ridgescaled rattail
BJA	*Mesobius antipodum*	black javelinfish
NNA	*Nezumia namatahi*	squashedfaced rattail
WHR	*Trachyrincus longirostris*	white rattail
WHX	*Trachyrincus* sp.	unicorn rattail
VNI	*Ventrifossa nigromaculata*	blackspot rattail
Ophidiiformes		
Ophidiidae		
BCR	*Brotulotaenia crassa*	blue cusk eel
LIN	*Genypterus blacodes*	ling
Carapidae		
ECR	*Echiodon cryomargarites*	messmate fish
Lophiiformes		
Ceratiidae		
SDE	*Cryptopsaras couesi*	seadevil
Lampriformes		
Trachipteridae		
DEA	*Trachipterus trachypterus*	dealfish
Regalecidae		
AGR	*Agrostichthys parkeri*	ribbonfish

Beryciformes		
Trachichthyidae		
ORH	*Hoplostethus atlanticus*	orange roughy
Diretmidae		
DIS	*Diretmus argenteus*	discfish
Anoplogastridae		
ANO	*Anoplogaster cornuta*	fangtooth roughy
Berycidae		
BYS	*Beryx splendens*	alfonsino
Melamphaidae		
MPH	*Melamphaes* sp.	bigscale fish
Rondeletiidae		
RMW	*Rondeletia loricata*	red-mouth whalefish
Zeiformes		
Zeidae		
LDO	*Cyttus traversi*	lookdown dory
Oreosomatidae		
BOE	*Allocyttus niger*	black oreo
WOE	*A. verrucosus*	warty oreo
SOR	*Neocyttus rhomboidalis*	spiky oreo
SSO	*Pseudocyttus maculatus*	smooth oreo
Syngnathiformes		
Macrorhamphosidae		
BBE	*Centriscops humerosus*	redbanded bellowsfish
NOF	*Notopogon fernandezianus*	orange bellowsfish
Scorpaeniformes		
Scorpaenidae		
TRS	*Trachyscorpia capensis*	cape scorpionfish
Psychrolutidae		
COT	*Cottunculus nudus*	bony skull toadfish
PSY	*Psychrolutes* sp.	blobfish
TOP	*Neophrynichthys angustus*	pale toadfish
Perciformes		
Apogonidae		
EPL	*Epigonus lenimen*	bigeyed cardinalfish
EPR	*E. robustus*	robust cardinalfish
EPT	*E. telescopus*	black cardinalfish
ROS	*Rosenblattia robusta*	
Bramidae		
RBM	*Brama*	Ray's bream
BSP	*Taratichthys longipinnis*	bigscale pomfret
Serranidae		
SPE	*Helicolenus* sp.	sea perch
Chiasmodontidae		
CNI	*Chiasmodon niger*	black swallower

Centrolophidae		
TUB	*Tubbia tasmanica*	
WWA	*Seriolella caerulea*	white warehou
Trichiuridae		
BEN	*Benthodesmus* sp. ?	scabbard fish
BNT	*Benthodesmus tenius*	scabbard fish
Caristiidae		
PLA	*Platyberyx* sp.	
Pleuronectiformes		
Bothidae		
MAN	*Neoachiropsetta milfordi*	finless flounder

Others

AST	
SCC	sea cucumbers
ONG	sponges
COU	red coral
COB	black coral
COZ	bryozoan
ECH	echinodermata
ANT	anemones
ASR	starfish
GAS	gastropoda
OPH	brittle star
SAL	salp
JFI	jellyfish
SCY	jellyfish
SUR	sea urchin

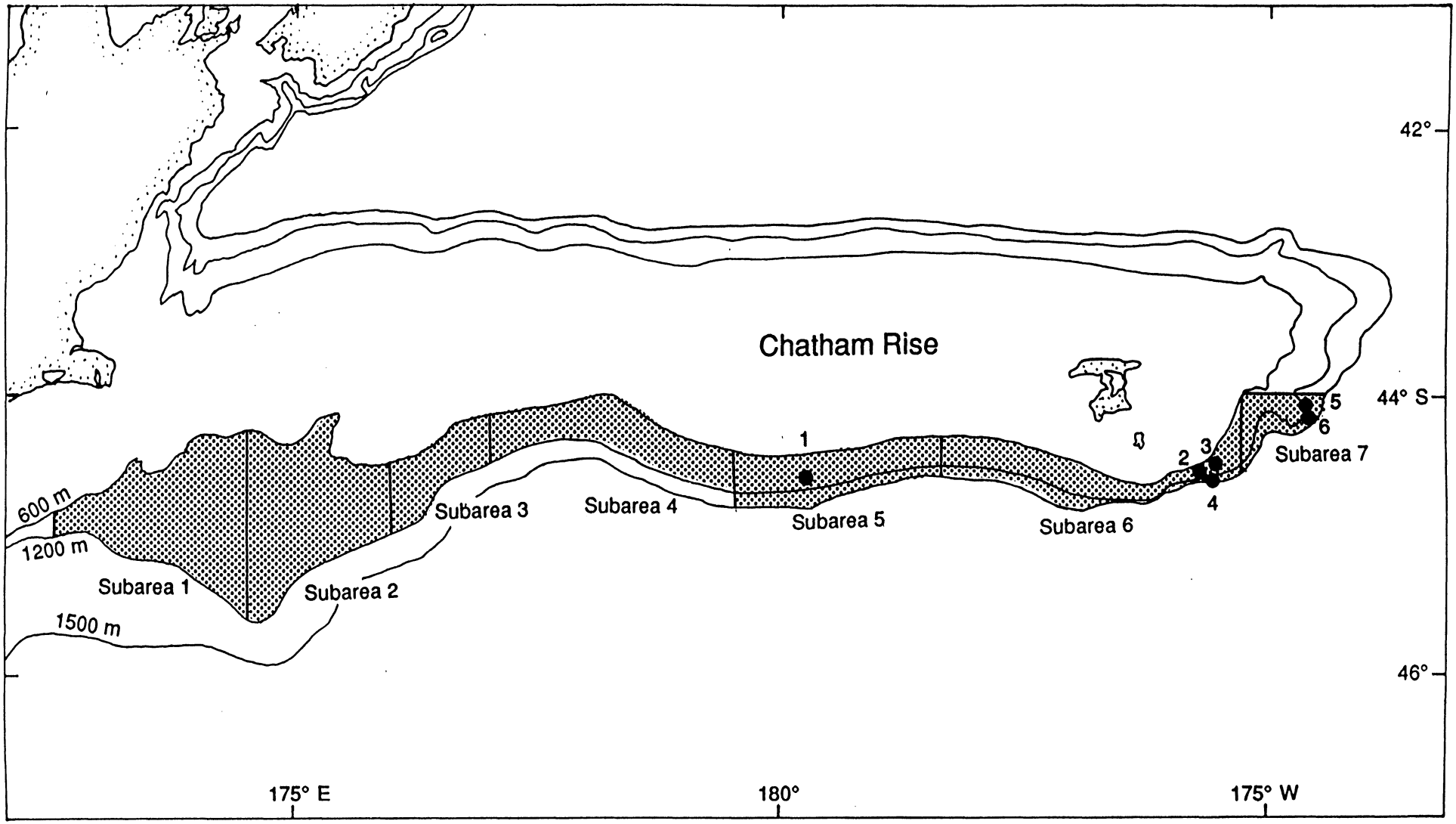


Figure 1: Survey area showing subareas and locations of hills sampled: 1. Trev's pinnacle, 2. Condoms, 3. Mangrove, 4. Charlies, 5. Possum, 6. Cotopaxi.

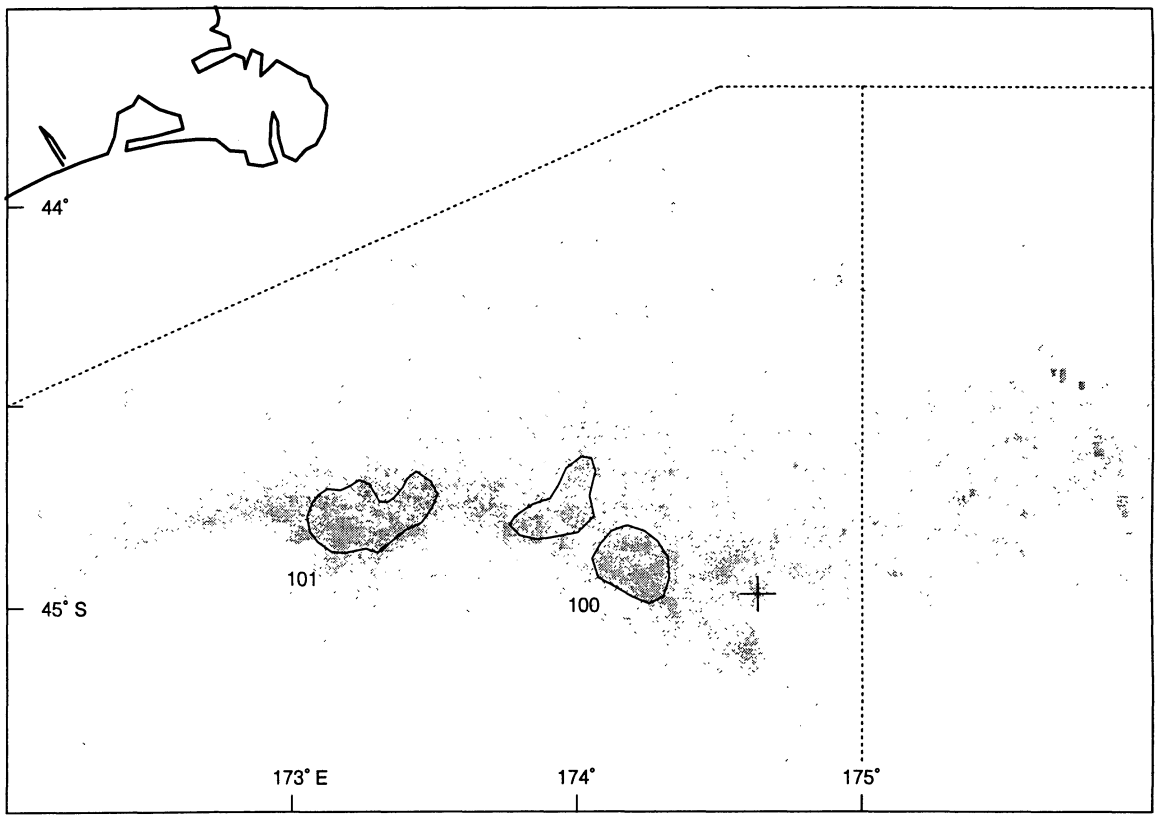
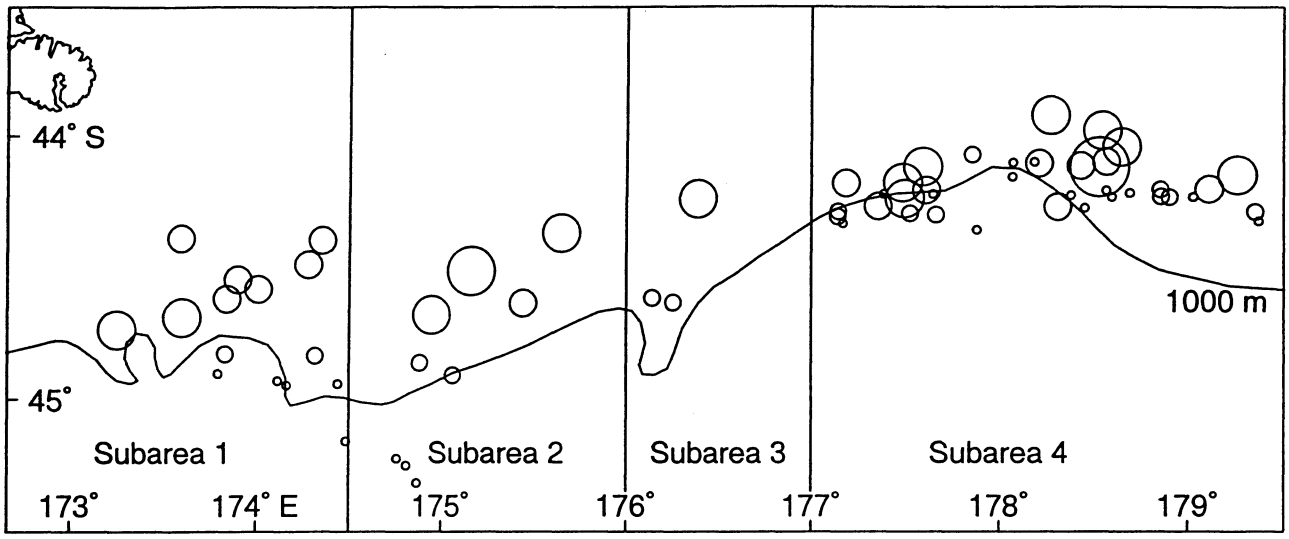
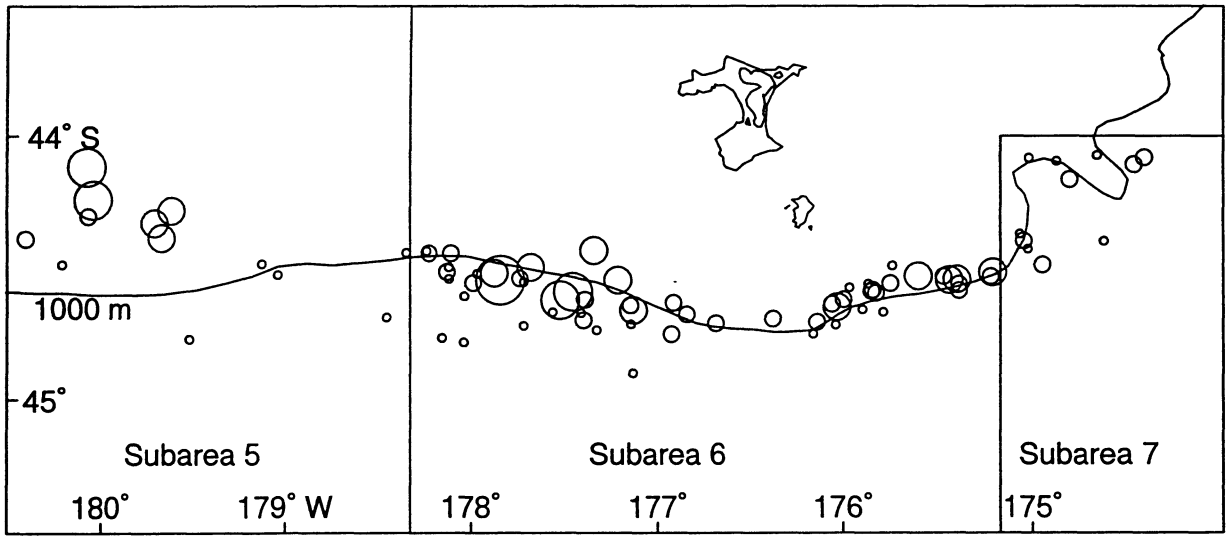


Figure 2: The high catch rate survey area. The central stratum was not used in the analysis.





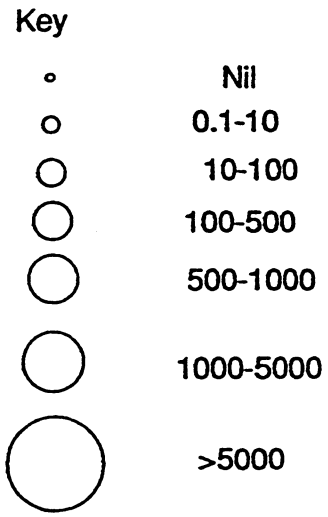


Figure 3: Catch rates (kg.km^{-1}) of black oreo.

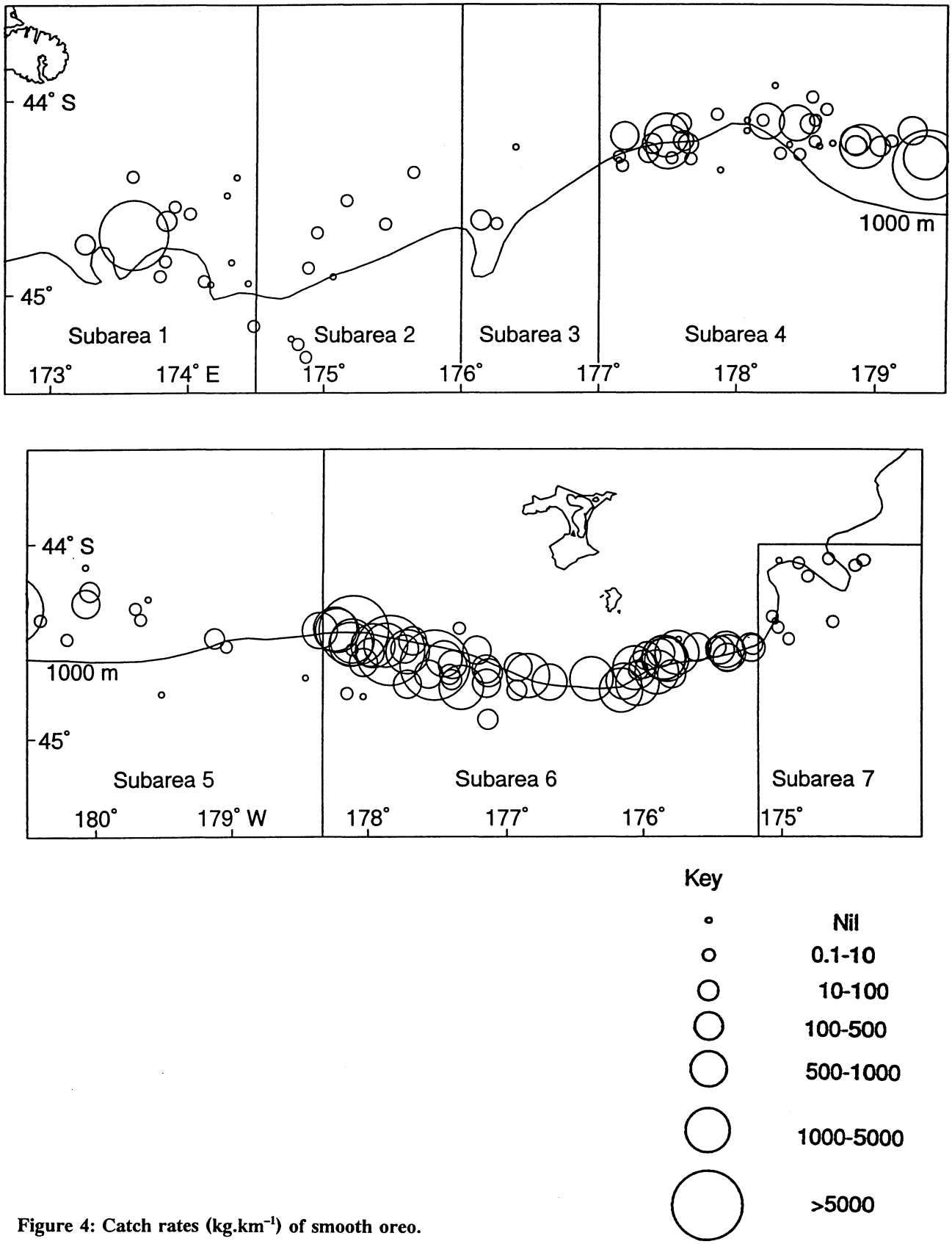


Figure 4: Catch rates (kg.km^{-1}) of smooth oreo.

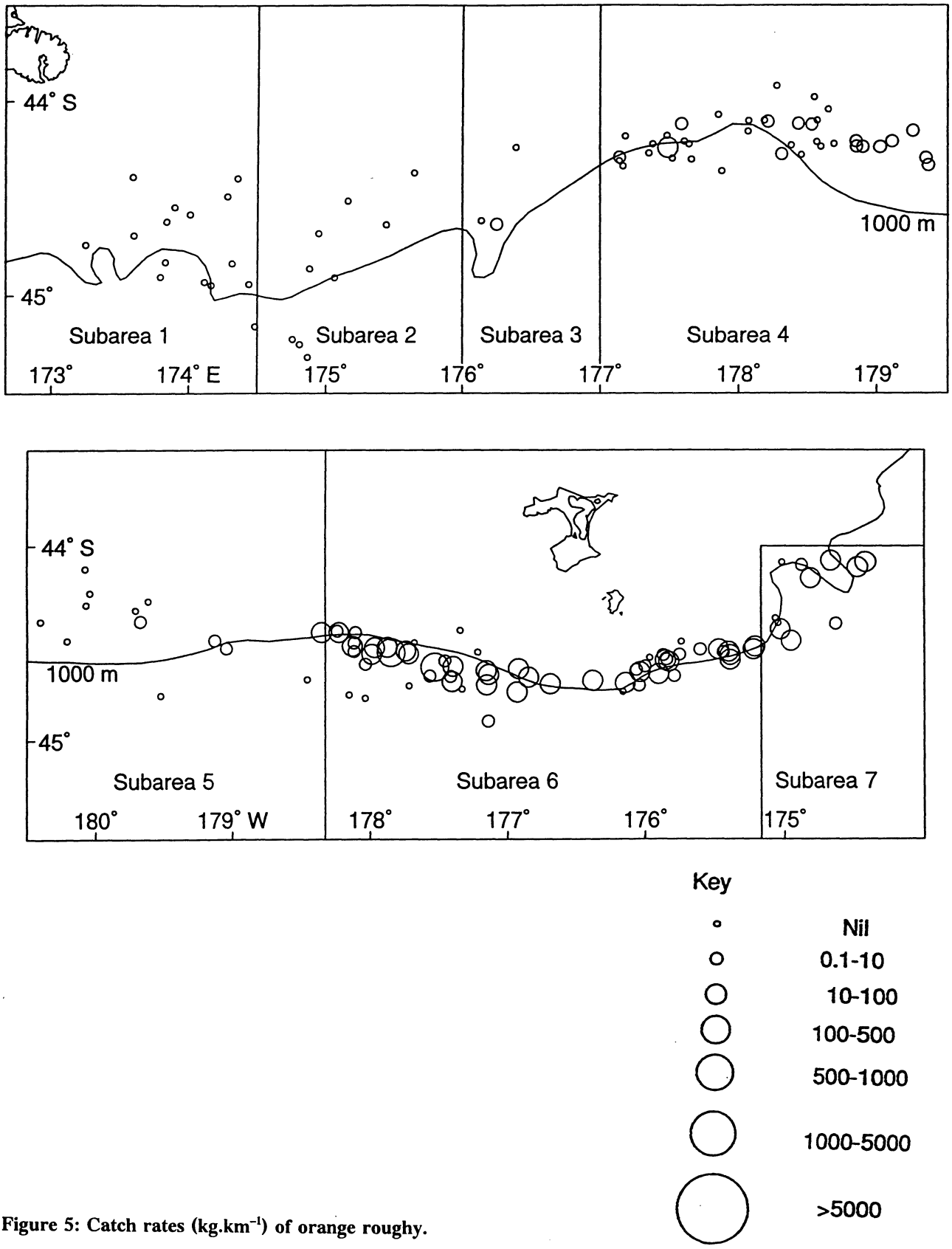


Figure 5: Catch rates (kg.km^{-1}) of orange roughy.

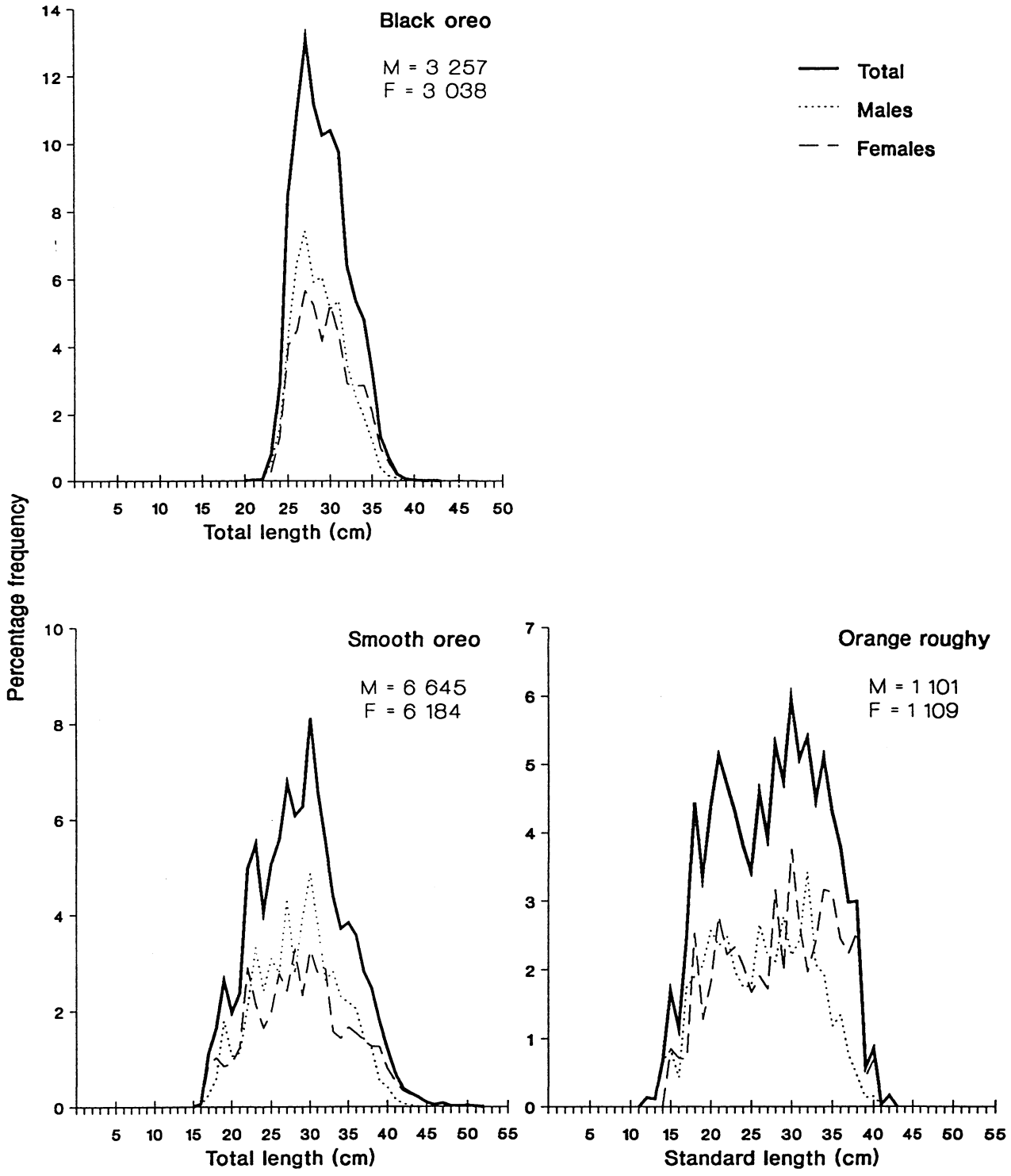


Figure 6: Scaled distribution of black oreo, smooth oreo, and orange roughy length samples for the entire survey area.

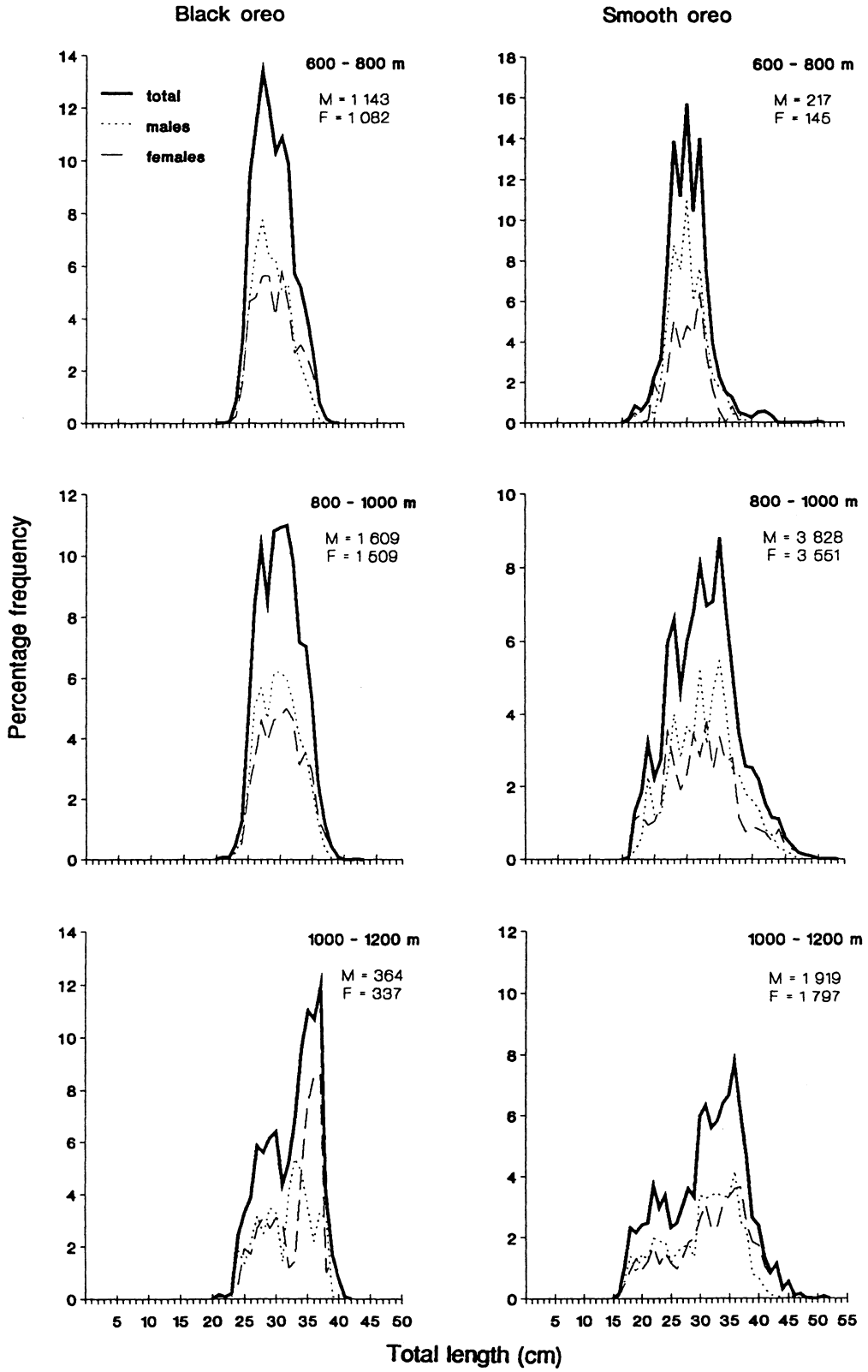


Figure 7: Scaled distribution of length data for black oreo, smooth oreo, and orange roughy by depth interval.

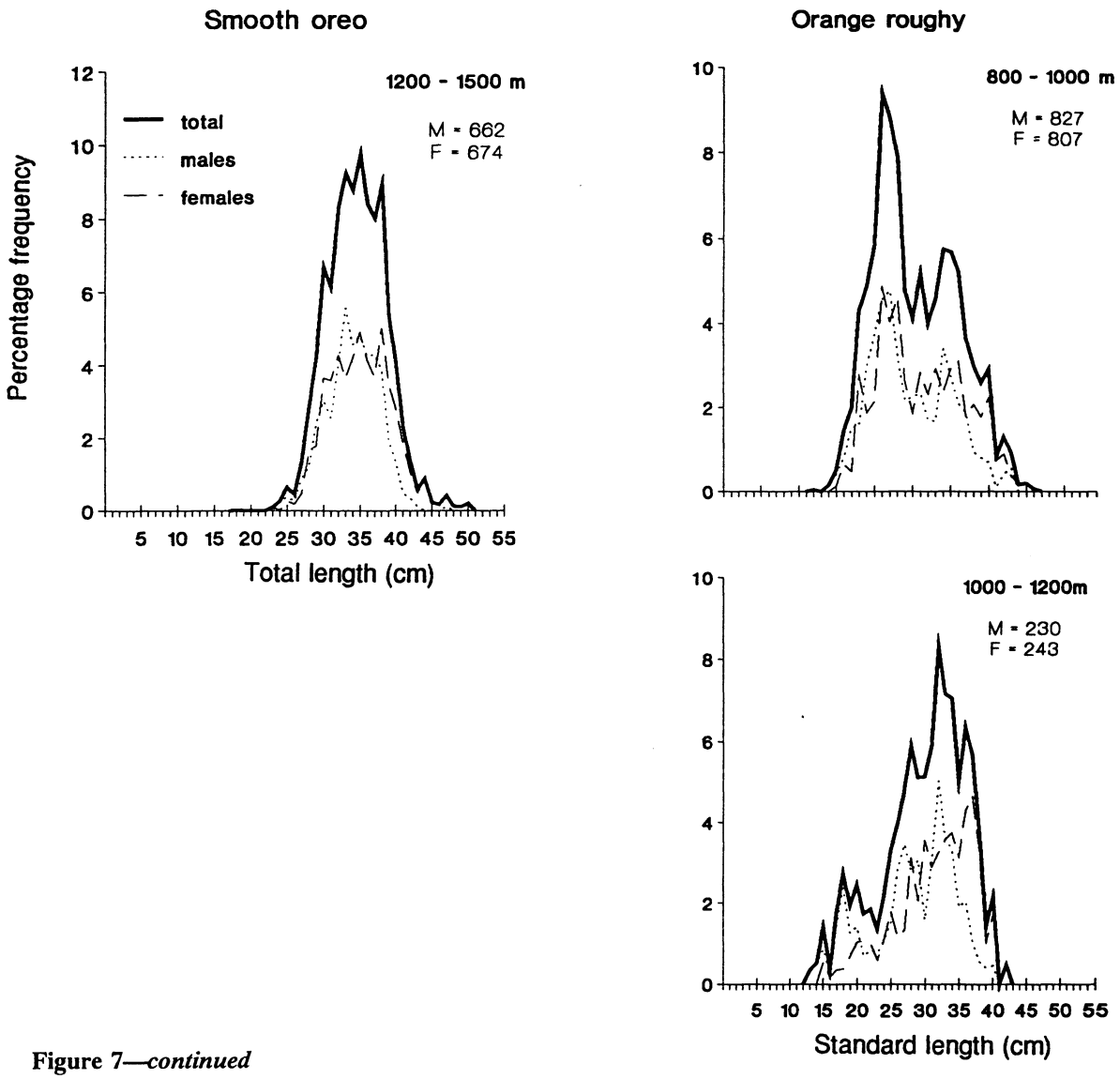


Figure 7—*continued*

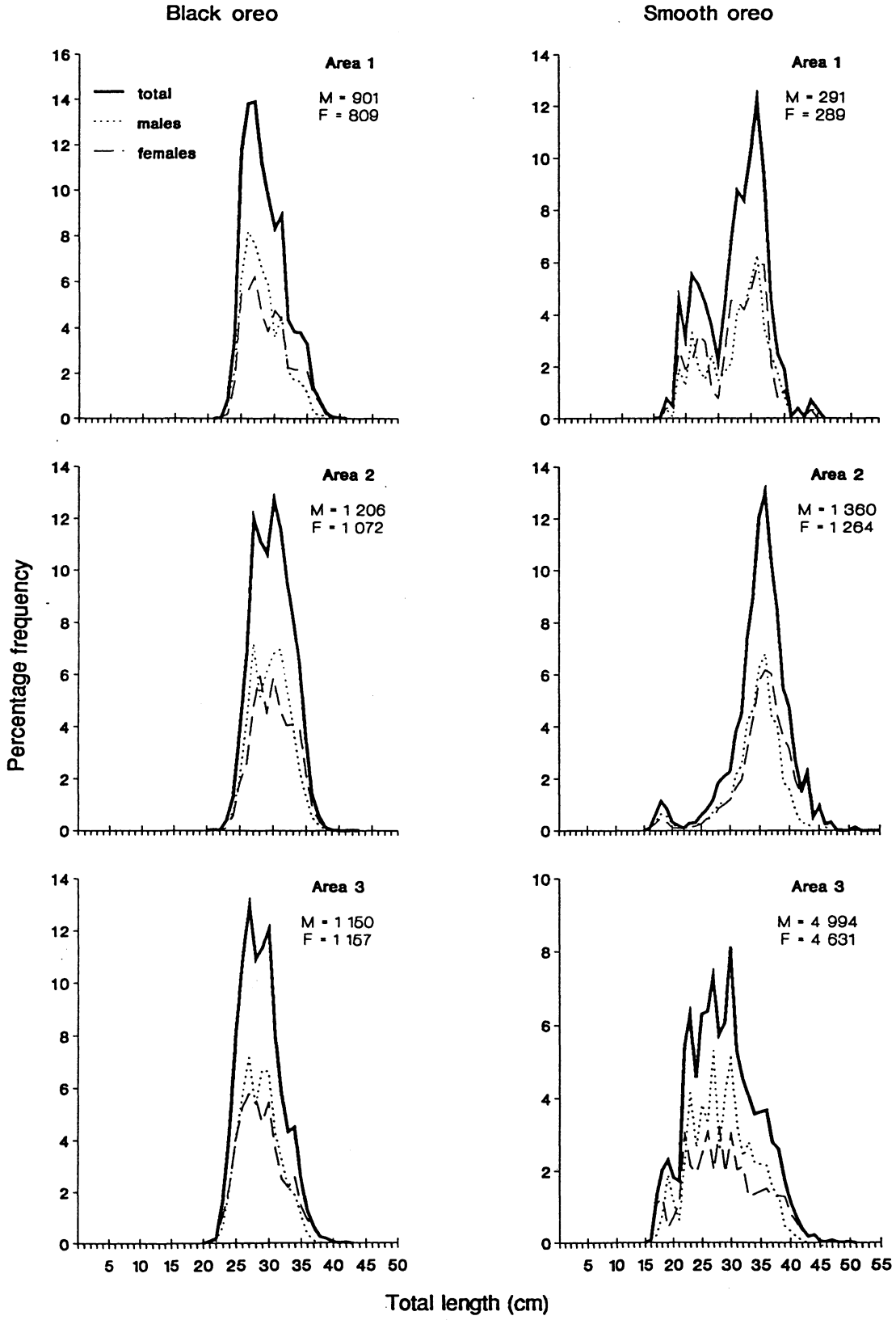


Figure 8: Scaled distribution of length data for black oreo, smooth oreo and orange roughy by area. Area 1 = 172° 30'–176° E, area 2 = 176°–179° 30' E and area 3 = 179° 30' E–174°W.

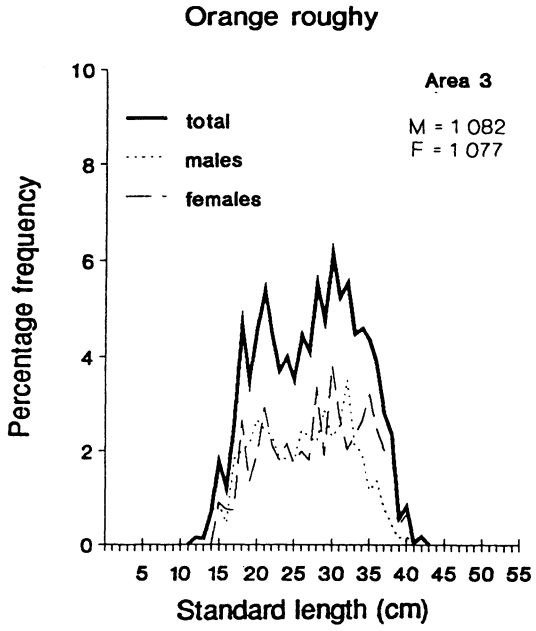


Figure 8—*continued*

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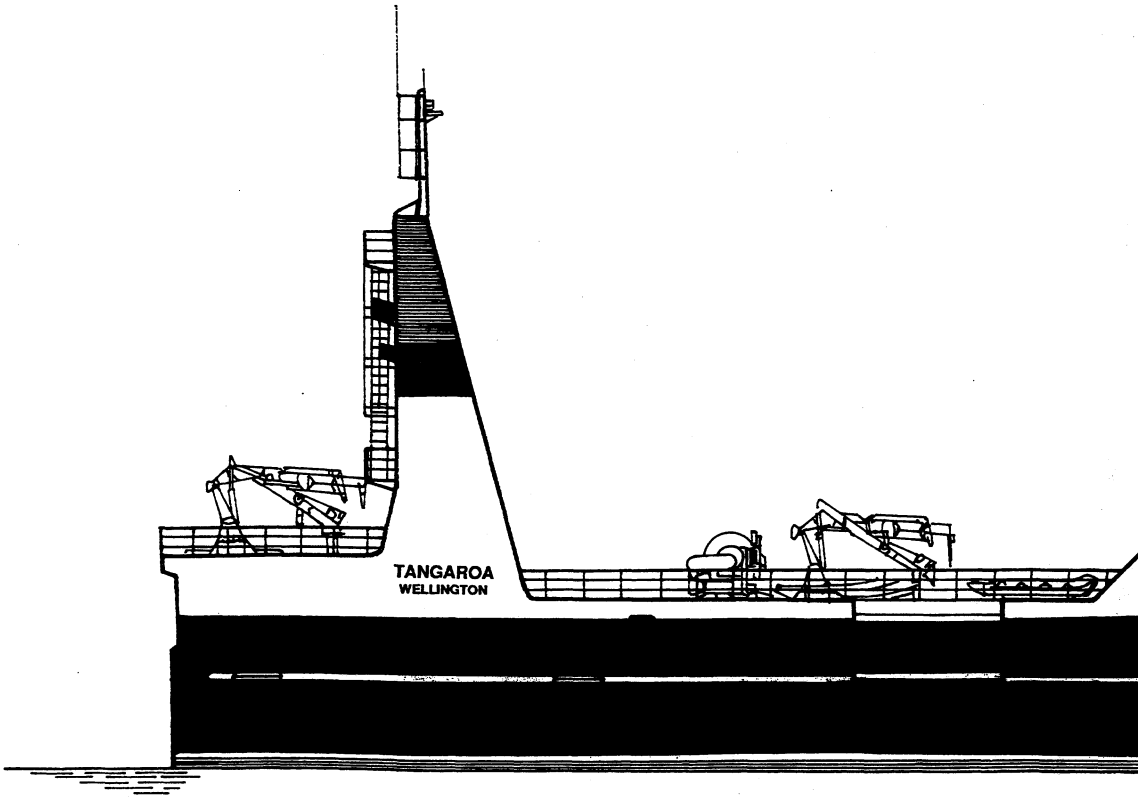
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