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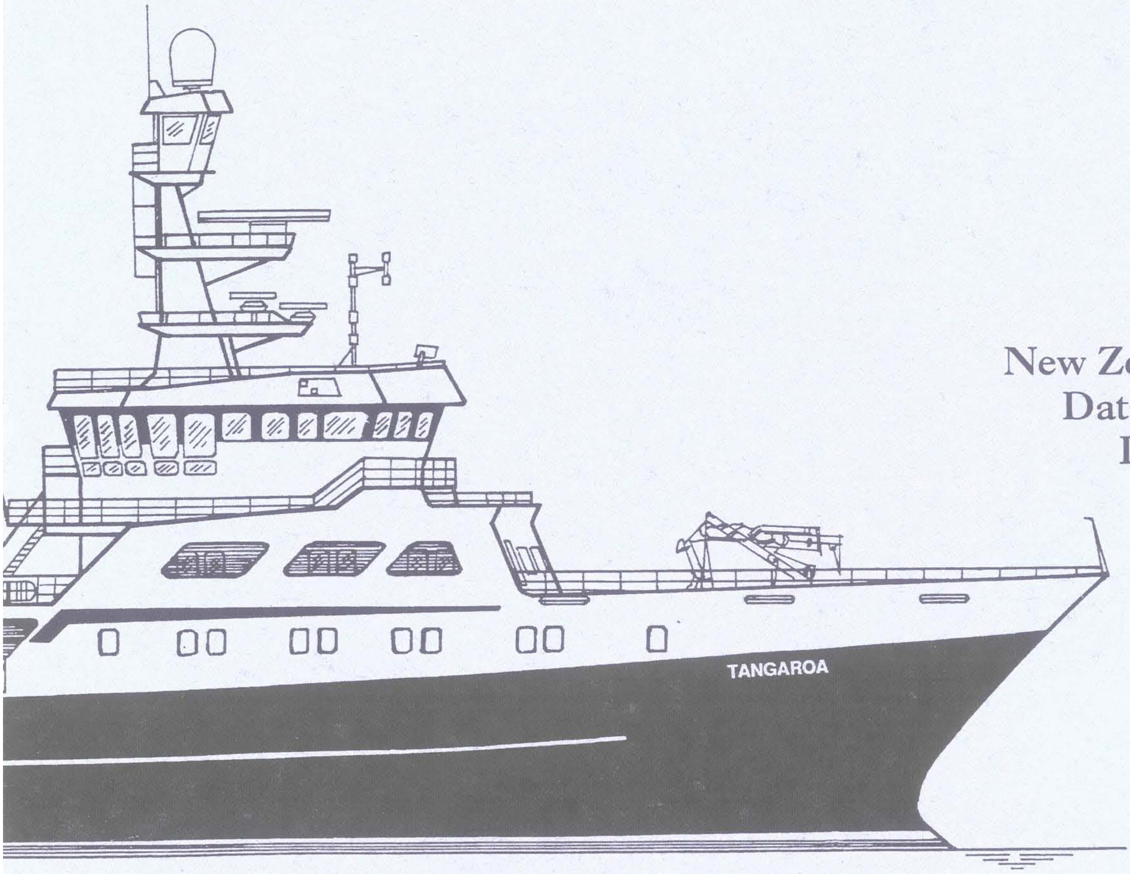
J. A. Colman



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Contents

Introduction

This report presents results from a bottom trawl survey of middle depth species carried out from 28 March to 27 April 1996 in the Southland and Sub-Antarctic areas. Its main purpose is to outline the survey design and methods and to make available data on commercially important species, including ITQ and non-ITQ species, which are relevant to stock assessment and fisheries management.

Previous surveys of these areas were carried out by *Tangaroa* in November and December 1991, 1992, and 1993 (Chatterton & Hanchet 1994, Ingerson *et al.* 1995, Ingerson & Hanchet 1995), and in April–May 1992 (Schofield & Livingston 1994a), September–October 1992 (Schofield & Livingston 1994b), and May–June 1993 (Schofield & Livingston 1994c). Originally it was intended to continue the time series in November and December, but both ling and hake appeared to be less evenly distributed at this time compared with April, May, and June. It was decided to change the time of the survey series to April, at which time both hake and ling were expected to be more evenly distributed through the survey area.

The surveys in April–May 1992 and in May–June 1993 are regarded as two of a comparable series of which this survey is the third. However, it is possible that in the May–June 1993 survey some part of the hoki population may have already left the area for the west coast spawning grounds.

The main objectives of the programme are:

1. to determine the distribution and develop a time series of relative abundance indices for ling, hake and hoki in the Southland and Sub-Antarctic QMAs; and

2. to collect data for determining the population structure and reproductive biology of hake, ling and hoki.

The main objectives of this survey were:

1. to continue a time series of relative abundance indices for hake and ling at a time when these species are dispersed;

2. to estimate the relative biomass of hoki and other middle depth species;

3. to collect biological data including length, sex, gonad state, and otoliths from middle depth species of commercial interest; and

4. to collect bathymetric data in order to refine stratum boundaries.

Voyage personnel

J. A. Colman was the project leader and the voyage leader; the skipper was R. Goodison.

Methods

Survey area and design

The survey was of a single-phase stratified design (*after* Francis 1981), stratified by area and depth (300–600, 600–800, 800–900, and 900–1000 m). Other similar surveys have usually been in two phases, with second phase stations being added to strata where biomass and the *c.v.* of the biomass were high. In this survey, however, the number of stations in the strata previously occupied (in depths of 300–800 m) was reduced to allow coverage of strata down to 1000 m in depth. This was because catch rates of hake have generally been higher in deeper water in previous surveys. Because of the reduction in station numbers, distances between stations were greater; revisiting areas to occupy second phase stations would have involved additional time on passage between stations. It was decided that the efficiency gains from planning an optimal route over a single phase series of stations outweighed the possible advantage of adding second phase stations. The allocation of stations to strata took into account the distribution of the main species, especially hake, in previous surveys in the area.

The depth range for this survey was extended to 1000 m, except for the more easterly parts of the survey area where hake are scarce. In addition, strata 1,2, 18, and 18a at Puysegur were extended to include the western parts of Puysegur Bank.

Twenty-four strata were originally planned (Figure 1 and Table 1), but stratum 20 (in 800–900 m to the east of the Campbell Plateau) was omitted because of the low probability of there being significant quantities present of any of the main species (hoki, hake, ling); hoki and ling were in low abundance in other deep strata, and hake were scarce in other strata in the south and east of the survey area. Station allocation in the various strata was optimised for hake, for which the biomass estimate had the highest *c.v.* among the main species in earlier surveys in these waters. Known areas of foul ground were excluded from the survey.

Vessel and gear specifications

Tangaroa is a purpose-built research stern trawler of 70 m overall length and a beam of 14 m, with 3000 kW of power. The net was the same as that used on previous surveys of middle depth species by *Tangaroa,* i.e., the eight-seam hoki bottom trawl with a 58.8 m groundrope and 45 m headline (*see* Chatterton & Hanchet (1994) for net plan and rigging details). The codend mesh was 60 mm. The sweeps were 100 m, bridles were 50 m, and backstrops were 12 m long. The trawl doors were Super Vee type with an area of 6.1 m^2. Wingspread measurements were not available, but doorspread, measured with Scanmar, and headline height from the net monitor were recorded every 5 min during each tow and the average values for each tow were calculated.

Trawling procedure

Station positions were selected randomly before the voyage, with a minimum distance between stations of 3 n. miles. If a station was found to be on foul ground, a search was made within 3 n. miles of the station position for suitable ground. If no suitable ground could be found, the station was abandoned and another random position was substituted. Trawling was carried out only during daylight; if time was running short at the end of the day and it was not possible to reach the last station, the vessel headed towards the station and the trawl was shot on that course in time to complete the tow before sunset.

At each station it was planned to tow for 3 n. miles at a speed over the ground of 3.5 knots. However, if foul ground was encountered during trawling and it was necessary to curtail the tow, the tow was included as a valid station only if at least 2 n. miles had been covered. Tows of less than 2 n. miles were considered to have been aborted and were replaced with alternative random stations.

Towing speed and gear configuration were maintained as constant as was possible during the survey. Parameters are summarised in Table 2.

Hydrology

Surface temperatures were obtained during each tow from a temperature sensor mounted on the hull at a depth of about 5 m. Neither the Scanmar sensor nor the trawl-mounted CTD sensor were available, and bottom temperatures were not collected.

Catch sampling

At each station the catch was sorted into species and weighed on motion-compensating electronic scales accurate to within 0.3 kg. The weights of a few large individual fish (e.g., skates) were estimated by hand and eye.

For each species of commercial importance, samples of up to 200 fish were randomly selected from the catch for measuring and determining sex and gonad stage. Individual fish weights were also recorded for these species. For hoki, hake, ling, and occasionally for southern blue whiting, more detailed biological data were collected, including fish length, weight, sex, gonad stage, gonad weight, stomach fullness and contents, prey condition; otoliths were taken for age determination. A macroscopic description of the gonad stages used is given in Table 3.

Data analysis

Biomass was estimated by the swept area method of Francis (1981, 1989). The *c.v.* of the biomass was calculated, overall and for each stratum separately, from:

$$c.v. \ (\%) = 100 \ S_B \ / \ B$$

where B is biomass and S_B is the standard error of the biomass.

The catchability coefficient (an estimate of the proportion of fish in the path of the net which are caught) is the product of vulnerability, vertical availability, and areal availability. These factors were set at 1 for the purpose of analysis, the assumptions being that fish were randomly distributed over the bottom, that no fish were present above the height of the headline, and that all fish within the path of the doors were caught.

Scaled length frequencies were calculated for the main species with the Trawlsurvey Analysis Program, version 3.2, as documented by Vignaux (1994), using length-weight data from this survey when data were adequate, or data from other sources otherwise (Table 4).

For hoki, the biomasses of fish above 55 cm and above 65 cm were also calculated. These lengths roughly equate to fish in year classes 2+ and over, and 3+ and over, respectively. The biomass of hoki over 74 cm in length was also calculated, this being the length above which the industry prefer hoki for filleting.

Data from all stations where the gear performance was satisfactory (codes 1 or 2) were included for the purposes of estimating biomass and calculating length frequencies.

Results

Survey area and stations sampled

A total of 102 stations was occupied during the voyage (Appendix 1), distributed through 23 strata (*see* Table 1). One station (number 60, in stratum 13) was not included in the analysis because gear performance was affected by a large catch of sponges. The total area of the strata covered was 321 957 km^2. Strata 1–15 (in depths of 300–800 m) were occupied in previous surveys, but strata in depths over 800 m had not been included previously. Direct comparisons of the results of this survey with those of previous surveys, therefore, should include only strata 1 to 15. Strata 1 and 2 on Puysegur Bank were extended to include the western side of the bank, but because they are small, particularly stratum 2, the overall effect on the biomass estimates is small. The only notable effect is that the estimate of juvenile hoki is larger than it would have been if the original strata 1 and 2 had been used.

Gear performance

The headline height was obtained for every tow, but the doorspread was not available for three tows. Wingspread measurements were not taken. Both headline height and door spread were very similar to those obtained on other voyages of *Tangaroa* on which the same gear was used.

Catch

A list of all species caught, their species codes, and the number of stations at which they occurred is given in Appendix 2.

Biomass estimates

Biomass estimates and catch weights of the 28 most abundant species are given in Table 5. Estimates of hoki biomass by stratum and size class, and in total, are given in Table 6. Biomass estimates by stratum are given for six other ITQ species and for five other species of commercial value in Table 7a, and for eight other, non-commercial species in Table 7b.

Catch rates

The catch rates of the 12 most abundant commercial species and of the 8 most abundant non-commercial species are given in Tables 8a and 8b. Catch rates of hoki and hake were highest in the northwest of the area, but ling were fairly evenly distributed throughout all strata in less than 800 m. Catch rates of hoki and ling were low in the deeper strata, but those for hake were relatively high, particularly in strata 18 and 18a (Puysegur) and 22 and 22a (east of Stewart Island). High catch rates for southern blue whiting were achieved in only two strata (12, Pukaki Rise area and 14, east of Campbell Island).

The catch rates at each station for the above four species are summarised in Figure 2.

Hydrology

Surface temperatures (Figure 3) varied from 8.2 °C, in the south of the survey area at about 54° S, to over 14.3 °C on Puysegur Bank in the northwest. Bottom temperatures were not collected.

Biological data

The numbers of fish of each species measured or examined in more detailed are shown in Table 9. Length frequency histograms, for each sex separately, are shown for the principal species in Figure 4.

The hoki length frequencies show three juvenile cohorts (the 1992, 1993, and 1994 year classes) quite clearly, with modes at about 65, 52, and 40 cm respectively. The 1991 cohort is also detectable in the female length frequency distribution with a mode at about 70 cm. There is a further mode at about 85 cm (males) and 90 cm (females) which represents the adults. The younger fish were present only in the vicinity of Puysegur and the Snares shelf in depths of less than 600 m, but the 1992 year class and older fish were widely distributed through most of the survey area, mainly in depths of less than 800 m.

The hake length frequencies showed a drop in numbers of large fish and an increase in smaller fish compared with earlier surveys. Numbers were similar to those in earlier surveys but, because of the smaller size of fish, the biomass was lower.

The southern blue whiting length frequency distribution was dominated by males from 32 to 39 cm and females from 35 to 42 cm. These are the very strong 1991 year class (S. M. Hanchet, NIWA, pers. comm.)

A summary of the gonad stages of hoki, hake, ling, southern blue whiting, orange roughy, and stargazer is shown in Table 10. Most hoki and southern blue whiting were resting (stage 2); female hake were also mainly resting, with some in stage 3, but among the males there were a number of partially spent fish (stage 6). Other species were mainly resting or (male ling and both sexes of orange roughy) in stage 3.

Discussion

Hoki was the most abundant species with an estimated biomass of 96 320 t. This is higher than the biomass estimated in the voyages in April–May 1992 (67 832 t) and May–June 1993 (59 814 t), which are the voyages most comparable in timing to this one. The increase is mainly due to growth of the strong 1991 year class (4+) and to continuing strong recruitment in the following years, particularly from the 1992 year class.

Of the commercially important species, southern blue whiting biomass (45 608 t) was much higher than in other recent surveys. The biomass of ling was slightly lower than in the April–May 1992 and May–June 1993 surveys. Hake was substantially lower, with a biomass of 2051 t in the strata covered by these previous surveys (cf. 5028 t in 1992 and 3602 t in 1993). However, a further 799 t of hake (28% of the total) were estimated for the strata deeper than 800 m which had not been sampled on these earlier voyages.

In this survey the distribution of stations was designed to reduce the *c.v.* of the biomass estimate of hake, or at least to maintain the *c.v.* at levels comparable with previous surveys, without significantly increasing the *c.v.* of the estimates of biomass of other species, particularly ling and hoki. This was to be achieved with a smaller number of stations in strata 1–15 (the strata occupied in previous surveys) to allow sampling in deeper strata.

The *c.v.* for hoki was about the same as on previous surveys, and that for ling was slightly higher, though still low. The *c.v.* for hake was low, but the biomass was also lower than on all previous surveys except for that in November–December 1992. For strata 1–15 (those which are comparable with previous surveys) the *c.v.* was 13%, which is comparable with previous surveys in April–May 1992 and May–June 1993, but the 79 stations occupied in these strata in this survey were fewer than previously (90 in 1992; 100 in 1993). It was concluded that the estimate of hake biomass in these strata had been achieved from fewer stations with no loss of precision. The reduction in the number of stations in strata 1–15 allowed the inclusion of the deeper strata which held 28% of the hake biomass in this survey.

The length frequency data for hoki showed strong recruitment from each of the 1991 to 1994 year classes. With most of the hoki in a resting condition, it seems unlikely that many would have begun to migrate to the west coast and therefore likely that the survey included the whole of the hoki stocks on the Southern Plateau.

Ling and hake were both dispersed through the survey area; no large catches of either species were taken. The length frequency of ling was similar to those of past surveys, but among the hake there were fewer large fish than before. This raises the question of whether some of the large hake were missed, perhaps because they were spawning in areas not sampled. However, there was no indication of any spawning taking place (no females were found at any stage other than 1, 2, or 3) and it seems unlikely that there were any large hake spawning aggregations in the area. It is more likely that the decline in numbers of large hake is due to natural and fishing mortality of the strong 1979 year class identified by Horn (1996). However, until a further survey is carried out (the next one is planned for 1998) it is impossible to estimate the level of any decline precisely.

Acknowledgments

Thanks to the scientific staff who participated in this voyage and to the Master, officers, and crew of *Tangaroa*.

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Table 1: Stratum areas, depths, number of stations occupied, and station densities

Stratum		Depth (m)	Area (km^2)	No. of stations	Station density (per km^2)
1	Puysegur Bank	300–600	4 498	3	1 : 1 499
2	Puysegur Bank	600–800	1 314	3	1 : 438
3	Stewart-Snares	300–600	5 130	3	1 : 1 710
4	Stewart-Snares	600–800	20 727	8	1 : 2 591
5	Snares–Aucklands	600–800	6 279	6	1 : 1 047
6	Auckland Is.	300–600	16 767	5	1 : 3 353
7	South Aucklands	600–800	8 372	4	1 : 2 093
8	NE Aucklands	600–800	17 349	10	1 : 1 735
9	N. Campbell I.	300–600	27 359	5	1 : 5 472
10	S. Campbell I.	600–800	11 145	3	1 : 3 715
11	NE Pukaki Rise	600–800	23 120	9	1 : 2 569
12	Pukaki	300–600	45 226	6	1 : 7 537
13	NE Camp. Plateau	300–600	36 090	5	1 : 7 218
14	E Camp. Plateau	300–600	27 403	6	1 : 4 567
15	E Camp. Plateau	600–800	15 033	3	1 : 5 011
18	Puysegur Bank	800–900	695	3	1 : 232
18a	Puysegur Bank	900–1000	1 201	2	1 : 600
19	SW Campbell I.	800–900	8 673	3	1 : 2 891
19a	SW Campbell I.	900–1000	21 771	3	1 : 7 257
21	NE Pukaki	800–900	9 003	3	1 : 3 001
21a	NE Pukaki	900–1000	6 389	3	1 : 2 130
22	E. Stewart I.	800–900	5 694	3	1 : 1 898
22a	E. Stewart I.	900–1000	2 719	2	1 : 1 359
Total			321 957	101	1 : 3 188

(Does not include station 60, stratum 13, for which gear performance was not satisfactory)

Table 2: Tow and gear parameters in each depth range. Values are number of tows (*n*), and the mean, standard deviation (*s.d.*), and range of observations for each parameter

	n	Mean	*s.d*	Range
Tow parameters				
Tow length (n.miles)	102	2.98	0.13	2.24–3.25
Tow speed (knots)	102	3.45	0.16	2.9–3.9
Gear parameters (m)				
300–600 m				
Headline height	34	6.9	0.20	6.4–7.4
Doorspread	32	121.5	6.81	99.9–134.4
600–800 m				
Headline height	46	6.9	0.29	6.0–7.9
Doorspread	45	124.3	5.37	113.1–133.9
800–900 m				
Headline height	11	6.8	0.27	6.6–7.6
Doorspread	11	124.3	4.02	114.8–129.4
900–1000 m				
Headline height	11	7.0	0.32	6.5–7.8
Doorspread	11	121.5	4.26	115.3–130.7
300–1000 m				
Headline height	102	6.9	0.26	6.0–7.9
Doorspread	99	123.1	5.75	99.9–134.4

Table 3. Stages of gonad development used for male and female gonads

Gonad Stage		Males	Females
1	Immature	Testes small and translucent, threadlike or narrow membranes.	Ovaries small and translucent. No developing oocytes.
2	Resting	Testes are thin and flabby; white or transparent.	Ovaries are developed, but no developing eggs are visible.
3	Ripening	Testes are firm and well developed, but no milt is present.	Ovaries contain visible developing eggs, but no hyaline eggs present.
4	Ripe	Testes large, well developed; milt is present and flows when testis is cut, but not when body is squeezed.	Some or all eggs are hyaline, but eggs are not extruded when body is squeezed.
5	Running-ripe	Testis is large, well formed; milt flows easily under pressure on the body.	Eggs flow freely from the ovary when it is cut or the body is pressed.
6	Partially spent	Testis somewhat flabby and may be slightly bloodshot, but milt still flows freely under pressure on the body.	Ovary partially deflated, often bloodshot. Some hyaline and ovulated eggs present and flowing from a cut ovary or when the body is squeezed.
7	Spent	Testis is flabby and bloodshot. No milt in most of testis, but there may be some remaining near the lumen. Milt not easily expressed even when present.	Ovary bloodshot; ovary wall may appear thick and white. Some residual ovulated eggs may still remain but will not flow when body is squeezed.

Table 4: Length-weight regression coefficients *a* and *b* used in the Trawlsurvey Analysis Program to calculate scaled length frequencies *

Species code	Regression coefficients *a*	*b*	r^2	*n*	Range (cm)	Data source
GSH	0.003549	3.1455	0.9678	298	32–73	TAN9605
GSP	0.008680	2.9003	0.9745	488	28–82	TAN9605
HAK	0.002582	3.2276	0.0799	222	46–121	TAN9605
HOK	0.006998	2.8028	0.9537	1059	38–97	TAN9605
LDO	0.025379	2.9874	0.9866	130	17–53	TAN9605
LIN	0.001425	3.2756	0.9553	651	38–124	TAN9605
RBM	0.024210	2.9059	0.9687	63	28–47	TAN9605
RIB	0.003406	3.2985	0.9594	203	28–71	TAN9605
SBW	0.003814	3.1532	0.9741	143	31–56	TAN9605
BOE	0.024800	2.9500	0.98	9790	11–44	Schofield & Livingston 1996
SSO	0.030900	2.8950	0.98	9147	10–57	Schofield & Livingston 1996
NOS	0.029000	3.0000	–	–	–	Annala 1995
ORH	0.092100	2.7100	–	–	–	Annala 1995

* Full names for species are given in Appendix 2

Table 5: Biomass estimates, coefficients of variation, and catch of the major species

	Species code	Biomass (t)	c.v(%)	Catch (kg)
ITQ species				
Hoki (> 74 cm)		54 981	7.1	–*
Hoki (> 65 cm)		74 964	7.6	–*
Hoki (> 55 cm)		89 219	8.3	–*
Hoki (all)	HOK	96 320	8.9	26 598
Ling	LIN	32 520	7.8	6 093
Smooth oreo	SSO	10 867	20.5	4 077
Black oreo	BOE	5 241	41.5	1 415
Hake	HAK	2 850	11.8	1 264
Orange roughy	ORH	1 105	44.5	410
Arrow squid	NOS	768	63.0	271
Commercial non-QMS species				
Southern blue whiting	SBW	45 608	31.1	6 063
Pale ghost shark	GSP	16 382	9.9	3 234
Ghost shark	GSH	3 084	47.6	1 015
Ribaldo	RIB	1 135	15.2	629
Look-down dory	LDO	1 082	17.5	212
Smooth skate	SSK	842	38.5	254
Non-commercial species				
Javelinfish	JAV	24 298	12.2	5 537
Ridge-scaled rattail	MCA	9 213	9.2	1 302
Smallscaled brown slickhead	SSM	4 387	18.8	812
Caelorinchus aspercephalus	CAS	3 352	14.7	499
Baxter's dogfish	ETB	3 214	13.2	932
Caelorinchus fasciatus	CFA	2 875	11.7	703
Silverside	SSI	2 725	16.2	387
Warty squid	WSQ	2 162	8.1	497
Caelorinchus oliverianus	COL	1 993	16.0	620
Centroscymnus crepidater	CYP	1 883	29.6	1 309
Longnosed chimaera	LCH	1 711	34.8	241
Spineback	SBK	980	16.7	267
Shovelnosed dogfish	SND	784	25.3	921
Plunket's shark	PLS	731	34.6	446
Centroscymnus owstoni	CYO	270	49.2	224

* Catch was not calculated for separate hoki size classes.

Table 6: Estimated biomass (t) of hoki by stratum and size; coefficients of variation in parentheses

Stratum	Total	Length (cm)			
		< 55	55–65	65–74	> 74
1	6 781 (44)	5 404 (34)	862 (41)	269 (34)	246 (97)
2	826 (38)	216(100)	191 (74)	243 (51)	177 (62)
3	6 336 (79)	1 132 (94)	1 591 (91)	2 168 (91)	1 445 (46)
4	9 158 (34)	296 (51)	2 949 (48)	2 311 (42)	3 602 (25)
5	5 095 (22)	31 (28)	817 (17)	1397 (27)	2 850 (42)
6	2 665 (41)	24 (47)	324 (63)	420 (56)	1 897 (51)
7	2 925 (40)	3(100)	306 (46)	700 (45)	1 917 (39)
8	10 967 (29)	17 (36)	1 318 (23)	2 553 (34)	7 080 (30)
9	9 773 (16)	33 (42)	1 600 (26)	1 968 (33)	6 173 (10)
10	2 296 (22)	0	27 (78)	796 (60)	1 474 (9)
11	8 839 (16)	1(100)	254 (36)	1 046 (30)	7 538 (18)
12	11 563 (19)	5(100)	2 490 (33)	3 463 (32)	5 605 (22)
13	8 171 (25)	6(100)	1 387 (66)	1 019 (57)	5 168 (22)
14	4 409 (26)	3(100)	150 (35)	728 (34)	3 528 (29)
15	2 894 (24)	0	36 (59)	242 (22)	2 616 (26)
Subtotal (Strata 1–15)	92 699 (9.2)	7 169 (38)	14 303 (17)	19 323 (14)	51 312 (7)
18	84 (38)	0	6 (52)	23 (48)	54 (45)
18A	101 (92)	0	0	15(100)	87 (90)
19	602 (19)	0	0	62 (50)	539 (25)
19A	253 (26)	0	0	22 (50)	231 (33)
21	1 446 (15)	0	4(100)	331 (51)	1 111 (16)
21A	89 (6)	0	0	25(100)	65 (32)
22	926 (49)	0	2(100)	193 (50)	731 (49)
22A	119 (29)	0	3 (11)	38 (17)	77 (37)
Total (All strata)	96 320 (8.9)	7 169 (38)	14 318 (17)	20 032 (14)	54 211 (7)

Table 7a: Estimated biomass (t) and coefficients of variation (%, in parentheses) of principal ITQ and other major species by stratum *

	Commercial ITQ species						Other Commercial species				
	LIN	SSO	BOE	HAK	ORH	NOS	SBW	GSP	GSH	RIB	LDO
Stratum											
1	270	0	0	39	0	101	0	57	782	0	32
	(40)			(100)		(62)		(86)	(89)		(100)
2	44	0	1	62	0	3	0	13	0	174	3
	(31)		(100)	(27)		(100)		(48)		(61)	(100)
3	931	0	0	132	0	496	0	74	1 291	12	27
	(9)			(63)		(96)		(100)	(100)	(51)	(50)
4	1 002	1 086	230	122	8	7	0	1 398	0	144	7
	(26)	(89)	(95)	(58)	(100)	(66)		(27)		(55)	(100)
5	894	0	0	101	0	16	7	960	0	62	7
	(22)			(32)		(82)	(98)	(24)		(29)	(100)
6	1 355	0	0	94	0	43	49	89	987	0	250
	(32)			(39)		(41)	(44)	(71)	(11)		(22)
7	999	0	0	115	0	4	0	238	2	96	32
	(26)			(55)		(100)		(34)	(100)	(35)	(100)
8	1 502	0	0	450	0	3	51	945	0	230	0
	(20)			(23)		(100)	(77)	(23)		(31)	
9	4 359	0	0	299	0	0	663	4 108	15	52	59
	(27)			(31)			(43)	(30)	(100)	(100)	(100)
10	419	0	0	258	30	0	0	59	0	204	0
	(38)			(35)	(50)			(14)		(11)	
11	2 575	0	0	297	0	4	124	1 411	0	18	206
	(15)			(27)		(100)	(42)	(17)		(92)	(50)
12	7 262	0	0	49	0	89	13 565	4 114	0	0	355
	(19)			(100)		(79)	(65)	(17)			(35)
13	4 889	0	0	0	0	0	620	1 285	0	0	14
	(21)						(21)	(17)			(100)
14	4 436	0	0	33	0	0	30 529	1 074	0	0	68
	(25)			(100)			(36)	(39)			(31)
15	1 340	9	0	0	0	0	0	214	0	0	0
	(40)	(100)						(65)			
Subtotal	32 124	1094	230	2 013	37	767	45 608	16 154	3 078	992	1 059
(300–800 m)	(7.8)	(89)	(94)	(13)	(45)	(63)	(31)	(10)	(48)	(17)	(18)

Table 7a: *continued*

	LIN	SSO	BOE	HAK	ORH	NOS	SBW	GSP	GSH	RIB	LDO
18	11	0	0	100	14	1	0	0	0	22	0
	(13)			(47)	(33)	(100)				(23)	
18a	0	0	0	134	86	0	0	4	0	30	0
				(59)	(93)			(80)		(98)	
19	91	120	0	141	5	0	0	43	6	40	0
	(100)	(66)		(100)	(100)			(48)	(100)	(73)	
19a	49	51	0	115	54	0	0	73	0	0	0
	(100)	(66)		(100)	(91)			(63)			
21	52	1253	3341	50	467	0	0	66	0	31	19
	(50)	(51)	(59)	(52)	(85)			(56)		(61)	(100)
21a	0	259	700	14	355	0	0	5	0	0	4
		(56)	(93)	(100)	(76)			(63)			(100)
22	8	3793	691	145	40	0	0	94	0	18	0
	(100)	(6)	(94)	(77)	(25)			(35)		(53)	
22a	19	4294	278	100	46	0	0	59	0	1	0
	(100)	(44)	(2)	(28)	(15)			(4)		(100)	
Total	32 250	10 867	5 241	2 850	1 105	768	45 608	16 382	3 084	1 135	1 082
(All strata)	(7.8)	(21)	(42)	(12)	(45)	(63)	(31)	(10)	(48)	(15)	(18)

* Full species names are given in Appendix 2.

Table 7b: Estimated biomass (t) and coefficients of variation (%, in parentheses) of other major species by stratum *

Stratum	JAV	MCA	SSM	CAS	ETB	CFA	SSI	WSQ	
1	26 (38)	0	0	20 (81)	0	1 (66)	0	3 (100)	
2	208 (32)	1 (100)	0	0	0	0	0	2 (73)	
3	175 (63)	0	0	166 (90)	37 (100)	40 (100)	1 (100)	0	
4	1 753 (44)	93 (70)	0	19 (64)	412 (24)	323 (32)	2 (100)	148 (29)	
5	485 (43)	5 (64)	0	14 (61)	98 (24)	55 (24)	1 (65)	58 (37)	
6	961 (29)	0	0	190 (55)	94 (100)	15 (72)	27 (24)	49 (33)	
7	791 (21)	0	0	2 (60)	144 (100)	40 (44)	10 (40)	50 (34)	
8	2 171 (24)	41 (35)	0	42 (80)	543 (57)	299 (27)	28 (61)	168 (19)	
9	2 773 (22)	23 (100)	0	378 (47)	9 (100)	299 (29)	656 (32)	149 (35)	
10	1 034 (37)	905 (21)	65 (71)	0	175 (51)	90 (53)	0	133 (41)	
11	2 769 (32)	97 (62)	0	50 (43)	244 (27)	345 (20)	15 (75)	269 (13)	
12	3 026 (27)	94 (100)	0	1 117 (25)	0	290 (90)	631 (34)	202 (40)	
13	4 922 (48)	0	0	554 (44)	14 (100)	78 (27)	452 (33)	245 (35)	
14	637 (37)	12 (100)	0	722 (26)	0	19 (53)	893 (32)	33 (46)	
15	863 (24)	140 (87)	0	1 (100)	261 (50)	172 (30)	4 (59)	205 (17)	
Subtotal (strata 1–15) (300 – 800 m)	(13)	22 596 (19)	1 412 (71)	65 (15)	3 275 (20)	2 030 (16)	2 066 (16)	2 721 (9)	1 716

Table 7b: *continued*

	JAV	MCA	SSM	CAS	ETB	CFA	SSI	WSQ
18	110 (31)	3 (100)	3 (50)	1 (59)	3 (87)	0	0	3 (62)
18a	104 (87)	41 (24)	31 (100)	1 (100)	0	3 (100)	0	0
19	349 (73)	457 (66)	229 (45)	0	172 (16)	43 (290	0	100 (39)
19a	118 (93)	6530 (11)	3012 (24)	0	187 (39)	105 (65)	0	54 (67)
21	836 (14)	225 (70)	0	0	313 (3)	359 (7)	0	117 (17)
21a	29 (85)	400 (34)	128 (46)	0	137 (16)	166 (17)	2 (100)	66 (37)
22	146 (54)	39 (50)	458 (70)	71 (100)	189 (7)	80 (51)	2 (100)	53 (50)
22a	10 (73)	108 (9)	460 (32)	3 (100)	182 (45)	53 (51)	0	52 (1)
Total (All strata) (300 – 1000 m)	24 298 (12)	9 213 (9)	4 387 (19)	3 352 (15)	3 214 (13)	2 875 (12)	2 725 (16)	2 162 (8)

* Full species names are given in Appendix 2.

Table 8a: Catch rates (kg.km^{-2}) and standard deviations (in parentheses) for the principal species *

	Commercial ITQ species							Non-ITQ species				
Stratum	HOK	LIN	SSO	BOE	HAK	ORH	NOS	SBW	GSP	GSH	RIB	LDO
1	1 508	60	0	0	8.7	0	23	0	13	174	0	7.0
	(1138)	(41)			(15)		(24)		(19)	(269)		(12)
2	629	42	0	0.8	47	0	2.3	0	9.9	0	133	2.0
	(410)	(22)		(1.3)	(22)		(4.1)		(8.2)		(140)	(3.4)
3	1 235	181	0	0	26	0	97	0	14	252	2.4	5.3
	(1700)	(29)			(28)		(160)		(25)	(435)	(2.1)	(4.6)
4	442	48	52	11	5.9	0.4	0.4	0	67	0	6.9	0.4
	(420)	(36)	(132)	(30)	(9.7)	(1.1)	(0.7)		(52)		(11)	(1.0)
5	811	142	0	0	16	0	2.6	1.1	153	0	9.9	1.1
	(444)	(78)			(12)		(5.2)	(2.6)	(91		(7.0)	(2.8)
6	159	81	0	0	5.6	0	2.6	2.9	5.3	59	0	15
	(146)	(57)			(4.9)		(2.4)	(2.9)	(8.4)	(15)		(7.3)
7	349	119	0	0	14	0	0.5	0	28	0.3	11	3.9
	(283)	(62)			(15)		(1.0)		(19)	(0.6)	(8.1)	(7.7)
8	632	87	0	0	26	0	0.2	2.9	54	0	13	0
	(587)	(54)			(19)		(0.5)	(7.1)	(39)		(13)	
9	357	159	0	0	11	0	0	24	150	0.6	1.9	2.1
	(128)	(97)			(7.5)			(23)	(99)	(1.3)	(1.9)	(4.8)
10	206	38	0	0	23	2.7	0	0	5.3	0	18	0
	(79)	(25)			(14)	(2.3)			(1.3)		(3.6)	
11	382	111	0	0	13	0	0.2	5.4	61	0	0.8	8.9
	(189)	(51)			(10)		(0.60	(6.8)	(48)		(2.1)	(13)
12	256	161	0	0	1.1	0	2.0	300	91	0	0	7.9
	(119)	(74)			(2.6)		(3.8)	(480)	(38)			(6.7)
13	226	135	0	0	0	0	0	17	36	0	0	0.4
	(127)	(62)						(8.2)	(14)			(0.9)
14	161	162	0	0	1.2	0	0	1114	39	0	0	2.5
	(102)	(100)			(2.9)			(990)	(38)			(1.9)
15	193	89	0.6	0	0	0	0	0	14	0	0	0
	(81)	(61)	(1.0)						(16)			
18	120	16	0	0	144	20	0.9	0	0.7	0	32	0
	(79)	(3.5)			(118)	(11)	(1.5)		(0.60		(13)	
18a	84	0	0.2	0	112	72	0	0	3.6	0	25	0
	(109)		(0.3)		(93)	(94)			(4.1)		(35)	
19	69	10	14	0	16	0.6	0	0	4.9	0.7	4.6	0
	(22)	(18)	(16)		(28)	(1.0)			(4.1)	(1.1)	(5.8)	
19a	12	2.3	2.3	0	5.2	2.5	0	0	3.3	0	0	0
	(5.3)	(3.9)	(2.7)		(9.1)	(3.9)			(3.7)			
21	161	5.8	139	371	5.5	52	0	0	7.4	0	3.5	2.0
	(42)	(5.0)	(122)	(376)	(5.0)	(77)			(7.2)		(3.6)	(3.6)
21a	14	0	41	110	2.2	56	0	0	0.7	0	0	0.7
	(1.5)		(40)	(176)	(3.9)	(73)			(0.8)			(1.2)
22	163	1.4	666	121	25	7.1	0	0	16	0	3.2	0
	(138)	(2.5)	(73)	(198)	(38)	(3.1)			(9.9)		(2.9)	
22a	44	7.0	1 580	102	36.6	17	0	0	22	0	0.5	0
	(18)	(9.9)	(979)	(3.5)	(14)	3.6			(1.1)		(0.5)	

* Full species names are given in Appendix 2.

Table 8b: Catch rates (kg.km^{-2}) and standard deviations (in parentheses) of other major species by stratum *

Stratum	JAV	MCA	SSM	CAS	ETB	CFA	SSI	WSQ
1	5.8	0	0	4.4	0	0.2	0	0.7
	(3.8)			(6.2)		(0.3)		(1.3)
2	158	1.0	0	0.1	0	0	0	1.8
	(89)	(1.7)		(0.2)				(2.2)
3	34	0	0	32	7.2	7.8	0.3	0
	(37)			(50)	(13)	(14)	(0.5)	
4	85	4.5	0	0.9	2.0	16	0.1	7.1
	(105)	(8.8)		(1.6)	(14)	(14)	(0.3)	95.8)
5	77	0.9	0	2.3	16	8.9	0.1	9.3
	(81)	(1.3)		(3.4)	(9.1)	(5.1)	(0.2)	(8.4)
6	57	0	0	11	5.6	0.9	1.6	2.9
	(38)			(14)	(12)	(1.4)	(0.9)	(2.2)
7	95	0	0	0.3	17	4.8	1.2	6.0
	(39)			(0.3)	(34)	94.3)	(0.9)	(4.1)
8	125	2.4	0	2.4	31	17	1.6	9.7
	(94)	(2.7)		(6.2)	(56)	(15)	(3.1)	(5.7)
9	101	0.8	0	14	0.3	11	24	5.4
	(50)	(1.9)		(14)	(0.7)	(7.1)	(17)	(4.3)
10	93	81	5.9	0	16	8.0	0	12
	(59)	(29)	(7.2)		(14)	(7.4)		(8.4)
11	120	4.2	0	2.2	11	15	0.7	12
	(114)	(7.8)		(2.8)	(8.7)	(8.9)	(1.5)	(4.4)
12	67	2.1	0	25	0	6.4	14	4.5
	(44)	(5.1)		(15)		(14)	(12)	(4.4)
13	136	0	0	15	0.4	2.2	13	6.8
	(146)			(15)	(0.9)	(1.3)	(9.4)	(5.3)
14	23	0.4	0	26	0	0.7	33	1.2
	(21)	(1.1)		(17)		(0.9)	(26)	(1.4)
15	57	9.3	0	0.1	17	11	0.3	14
	(24)	(15)		(0.2)	(15)	(5.9)	(0.3)	(4.0)
18	158	4.0	4.7	2.1	4.3	0	0	4.8
	(84)	(6.9)	(4.1)	(2.2)	(6.5)			(5.2)
18a	87	34	26	0.7	0.2	2.9	0	0
	(107)	(12)	(37)	(1.0)	(0.3)	(4.1)		
19	40	52	26	0	20	4.9	0	11
	(50)	(60)	(21)		(5.4)	(2.4)		(7.6)
19a	5.4	300	138	0	8.6	4.9	0	2.5
	(8.8)	(57)	(58)		(5.9)	(5.4)		(2.9)
21	93	25	0	0	35	40	0	13
	(23)	(30)			(1.5)	(4.9)		(3.7)
21a	4.5	63	20	0	22	26	0.2	10
	(6.6)	(37)	(16)		(5.9)	(7.7)	(0.4)	(6.7)
22	26	6.8	81	12	33	14	0.3	9.3
	(24)	(5.9)	(98)	(22)	(4.1)	(13)	(0.5)	(8.0)
22a	3.6	40	169	1.1	67	20	0	19
	(3.7)	(5.2)	(77)	(1.5)	(43)	(14)		(0.1)

* Full species names are given in Appendix 2.

Table 9: Numbers of fish for which length, sex, and biological data were collected *

	Length frequency data				Biological data	
Species code	No.of samples	No.of fish	No.of males	No.of females	No.of samples	No.of fish
BAR	1	51	27	24	0	0
BOE	12	837	424	413	0	0
BTA	5	5	5	0	5	5
BTS	1	1	1	0	1	1
GSH	12	299	117	182	11	298
GSP	87	1 513	645	867	42	488
HAK	59	380	127	253	57	222
HAP	1	1	0	1	1	1
HOK	101	11 565	5 144	6 419	60	1 059
LDO	31	194	77	114	22	130
LIN	88	2 057	1 149	906	46	651
NOS	20	274	139	133	0	0
ORH	22	645	347	296	0	0
PSK	4	4	2	2	3	3
RBM	6	67	35	32	5	63
RCO	4	5	1	4	1	2
RIB	42	269	42	226	29	203
RSK	4	5	4	1	4	5
SBW	36	1 902	822	1 080	12	143
SCH	1	2	1	1	0	0
SCI	3	29	18	11	3	29
SKI	1	18	10	8		
SPD	8	24	7	17	0	0
SPE	2	56	22	34	0	0
SSK	9	11	5	6	8	10
SSO	20	1 347	723	615	1	12
STA	10	32	9	23	7	23
SWA	2	3	2	1	1	2
TAR	1	1	1	0	1	1
WWA	15	30	20	8	4	5

* Full species names are given in Appendix 2.

Table 10: Numbers of male and female hoki (HOK), hake (HAK), ling (LIN), southern blue whiting (SBW), orange roughy (ORH), stargazer (STA), and ribaldo (RIB) at each reproductive stage

		Reproductive stage							
Species		1	2	3	4	5	6	7	Total
HOK	Male	223	3 706	278	0	0	0	0	4 207
	Female	261	4 975	86	0	0	6	0	5 328
HAK	Male	9	17	12	0	4	35	2	81
	Female	24	76	41	0	0	0	0	141
LIN	Male	17	217	110	30	0	0	0	374
	Female	21	257	6	5	0	0	0	289
SBW	Male	1	65	1	0	0	0	0	67
	Female	0	111	0	0	0	0	0	111
ORH	Male	2	6	86	0	0	0	0	94
	Female	0	9	37	0	0	0	0	46
STA	Male	0	2	0	0	0	0	0	2
	Female	0	1	1	1	0	0	0	3
RIB	Male	0	5	0	0	0	0	0	5
	Female	2	7	5	0	0	0	0	14

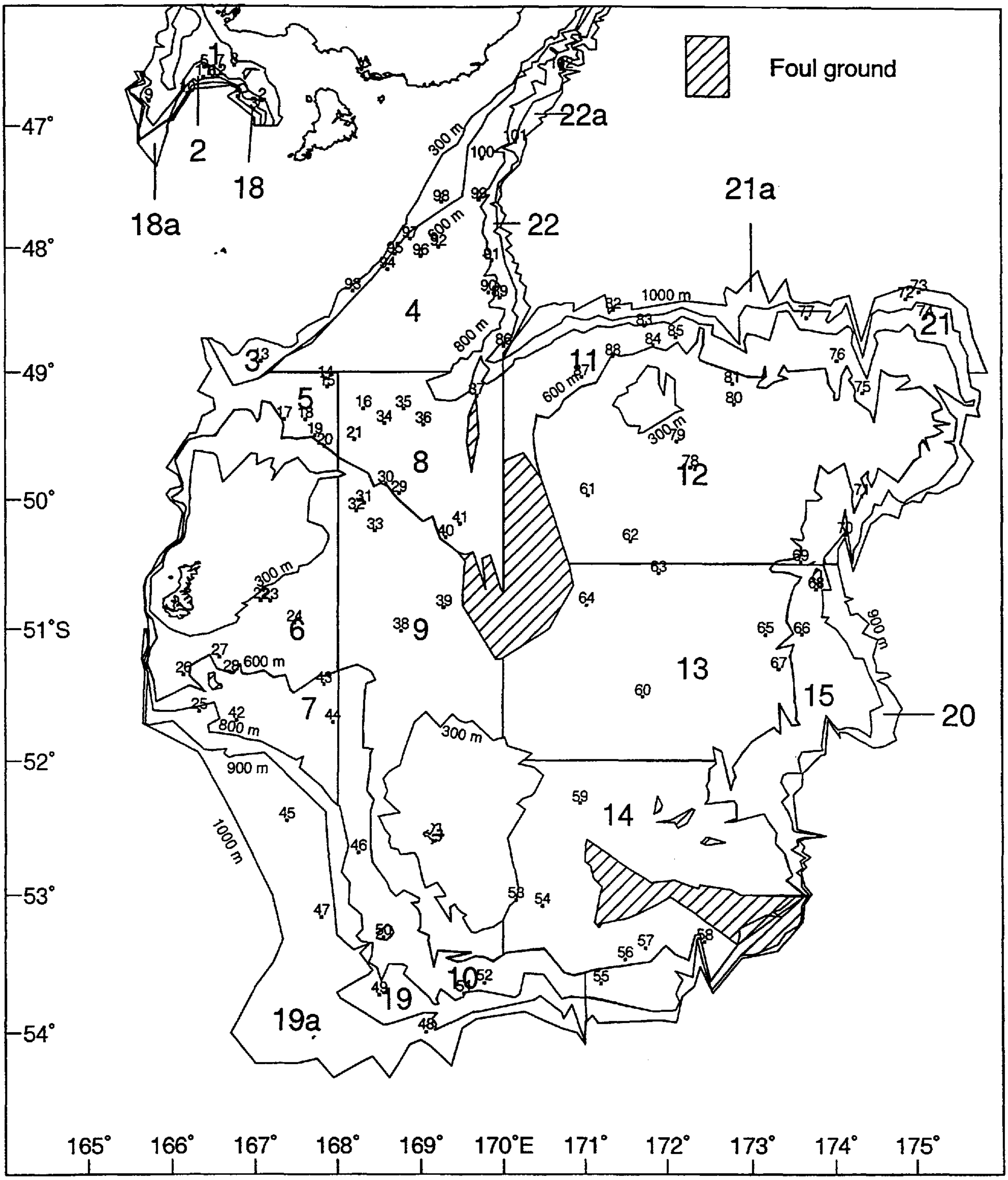


Figure 1: Survey area, depth contours, strata, and stations.

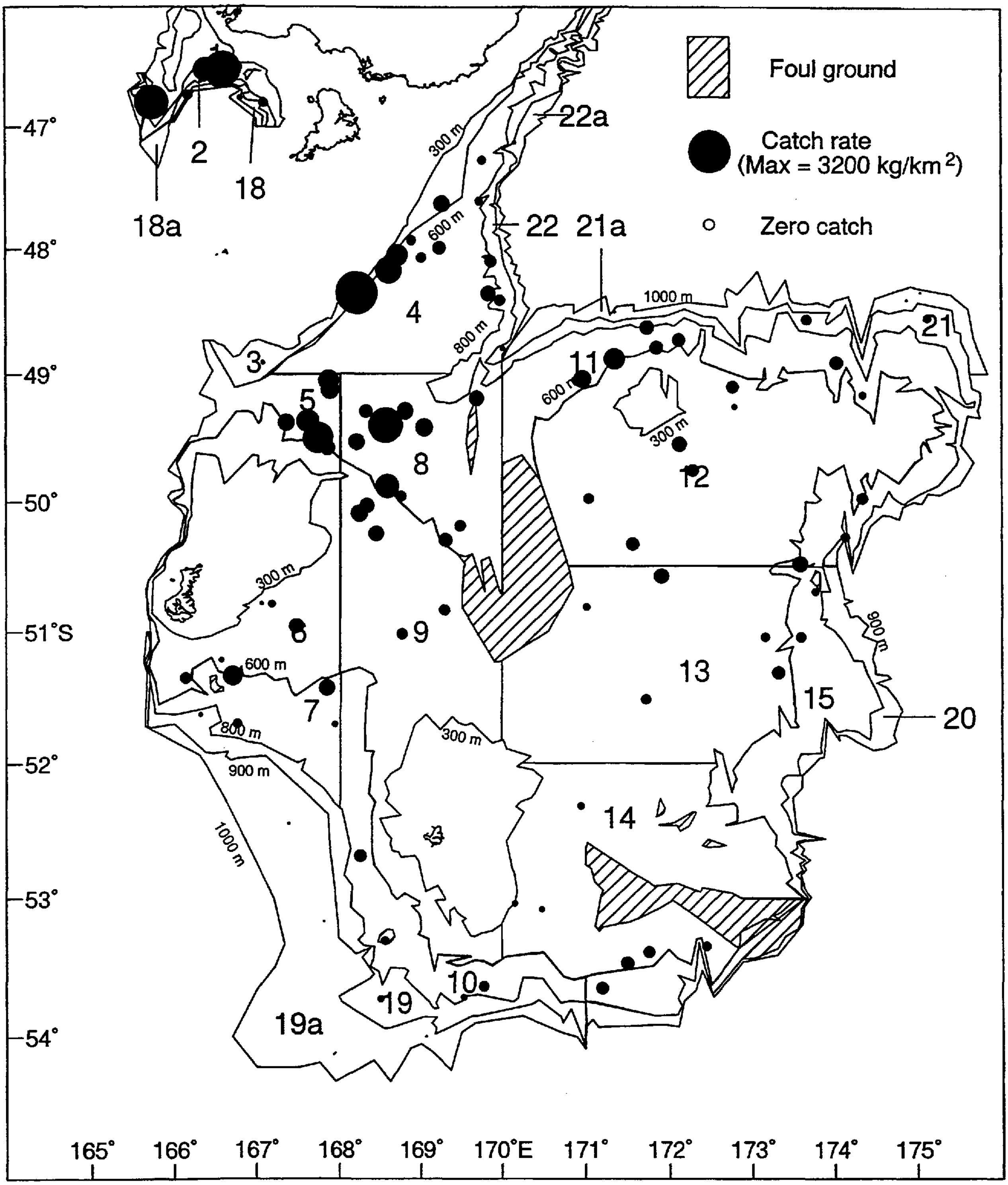


Figure 2(a): Catch rates of hoki.

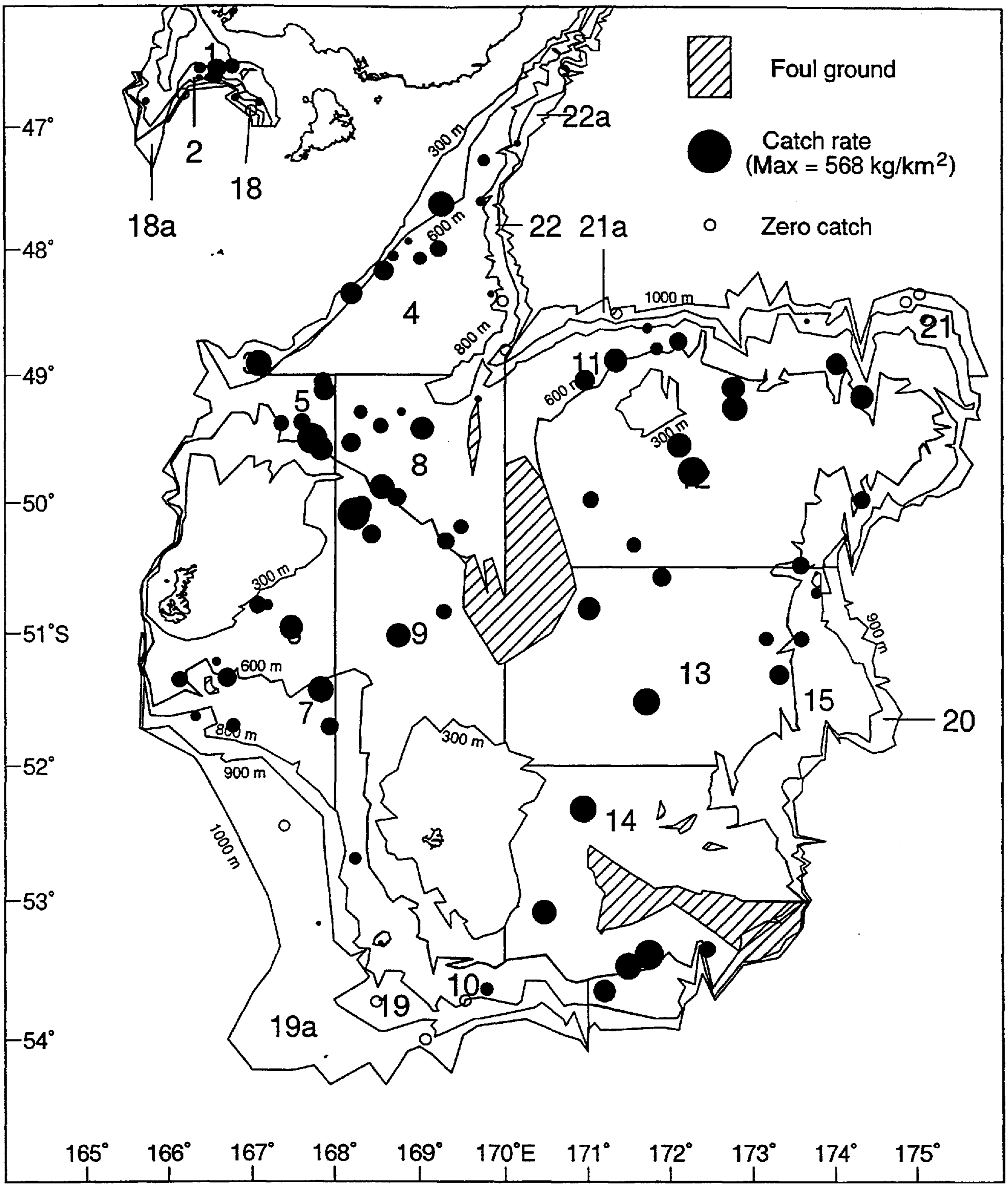


Figure 2(b): Catch rates of ling.

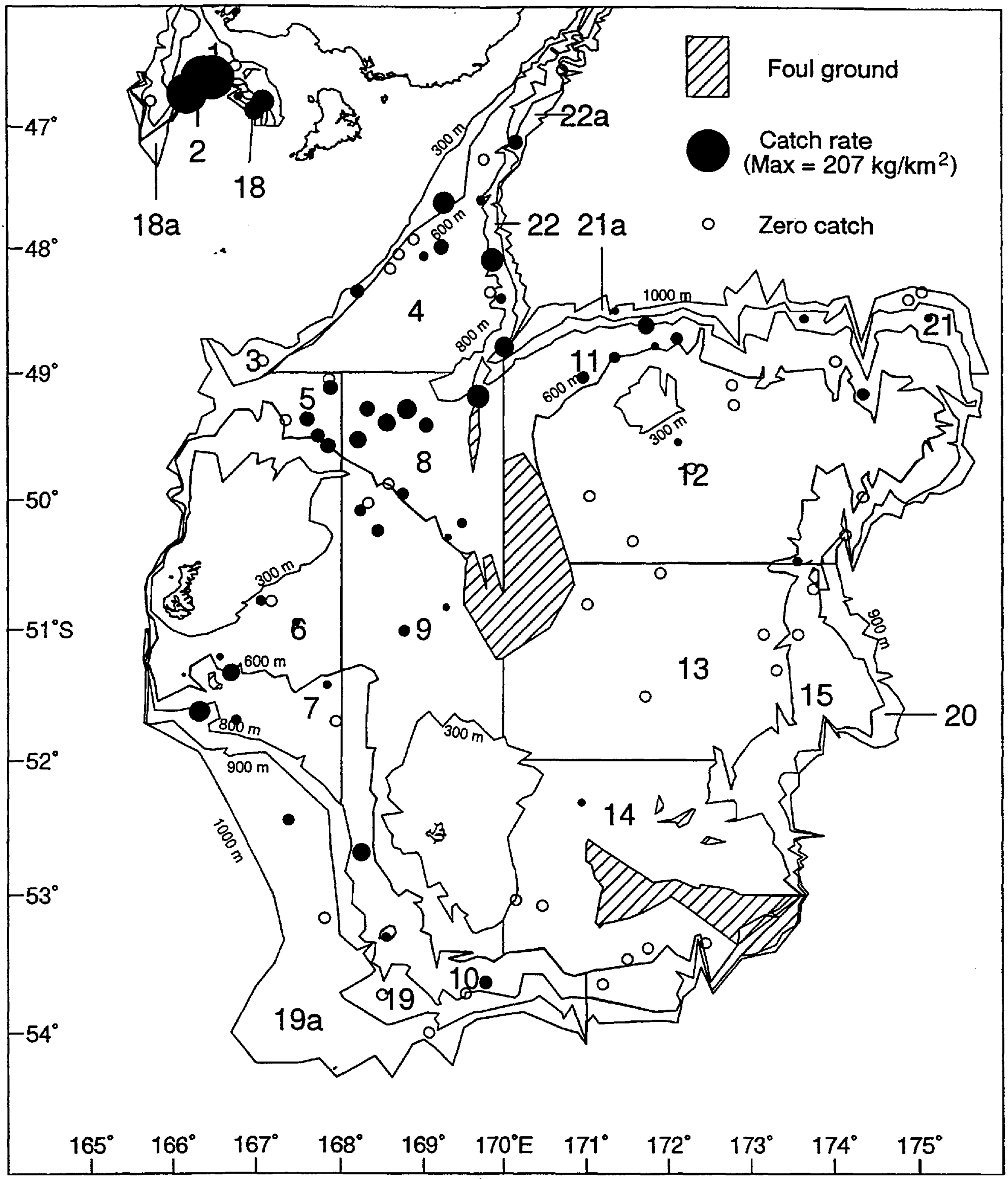


Figure 2(c): Catch rates of hake.

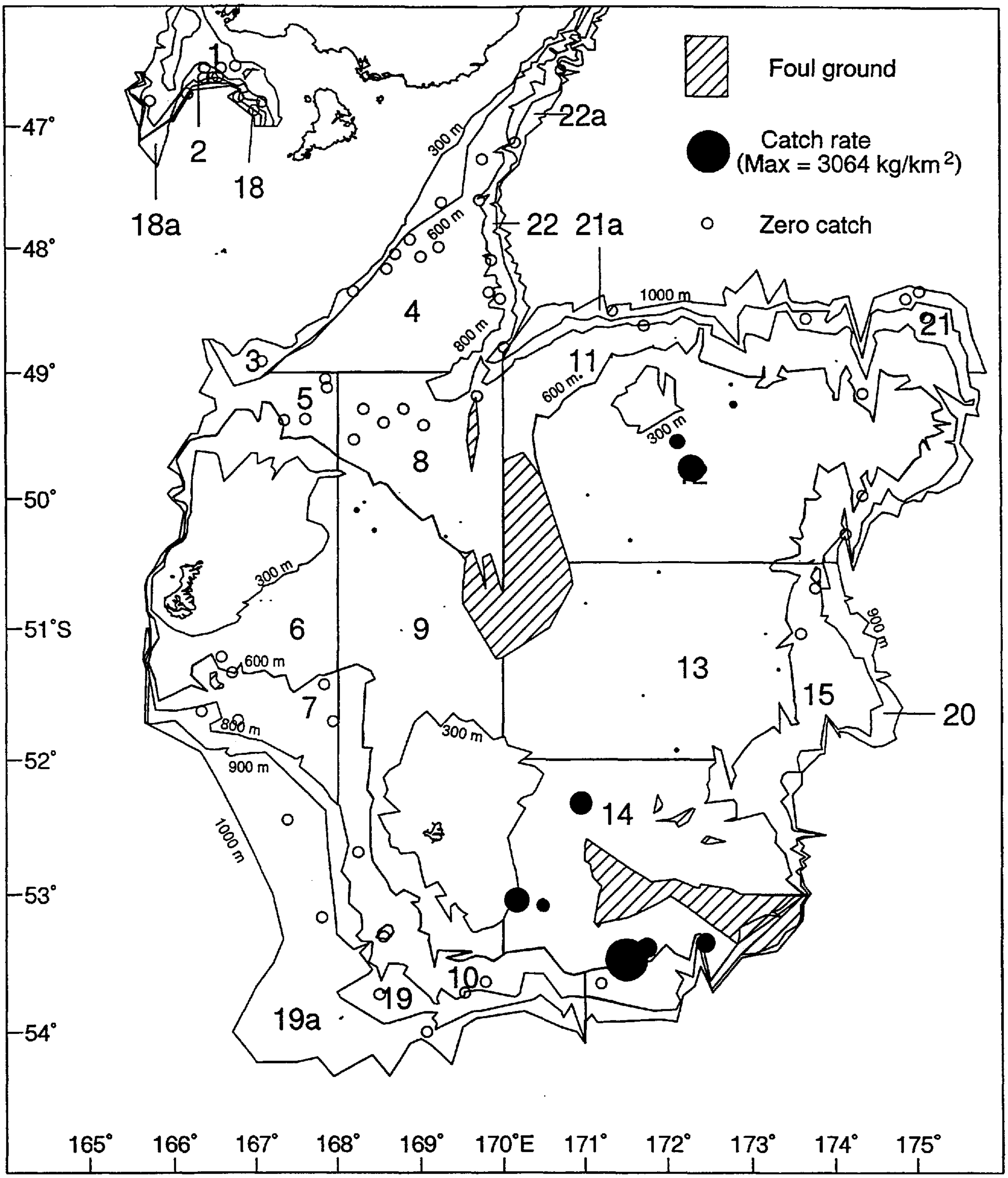


Figure 2(d): Catch rates of southern blue whiting.

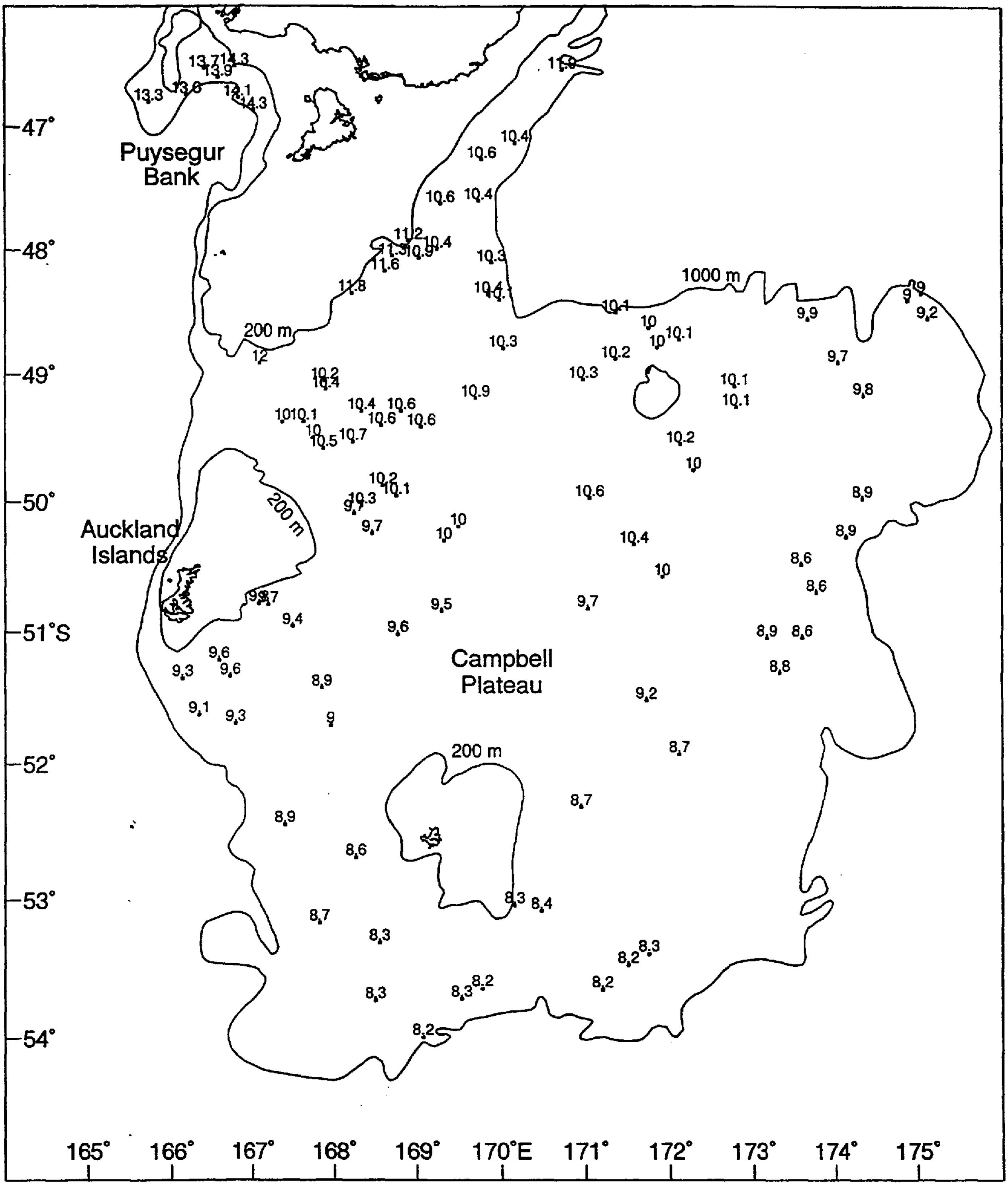


Figure 3: Surface water temperatures.

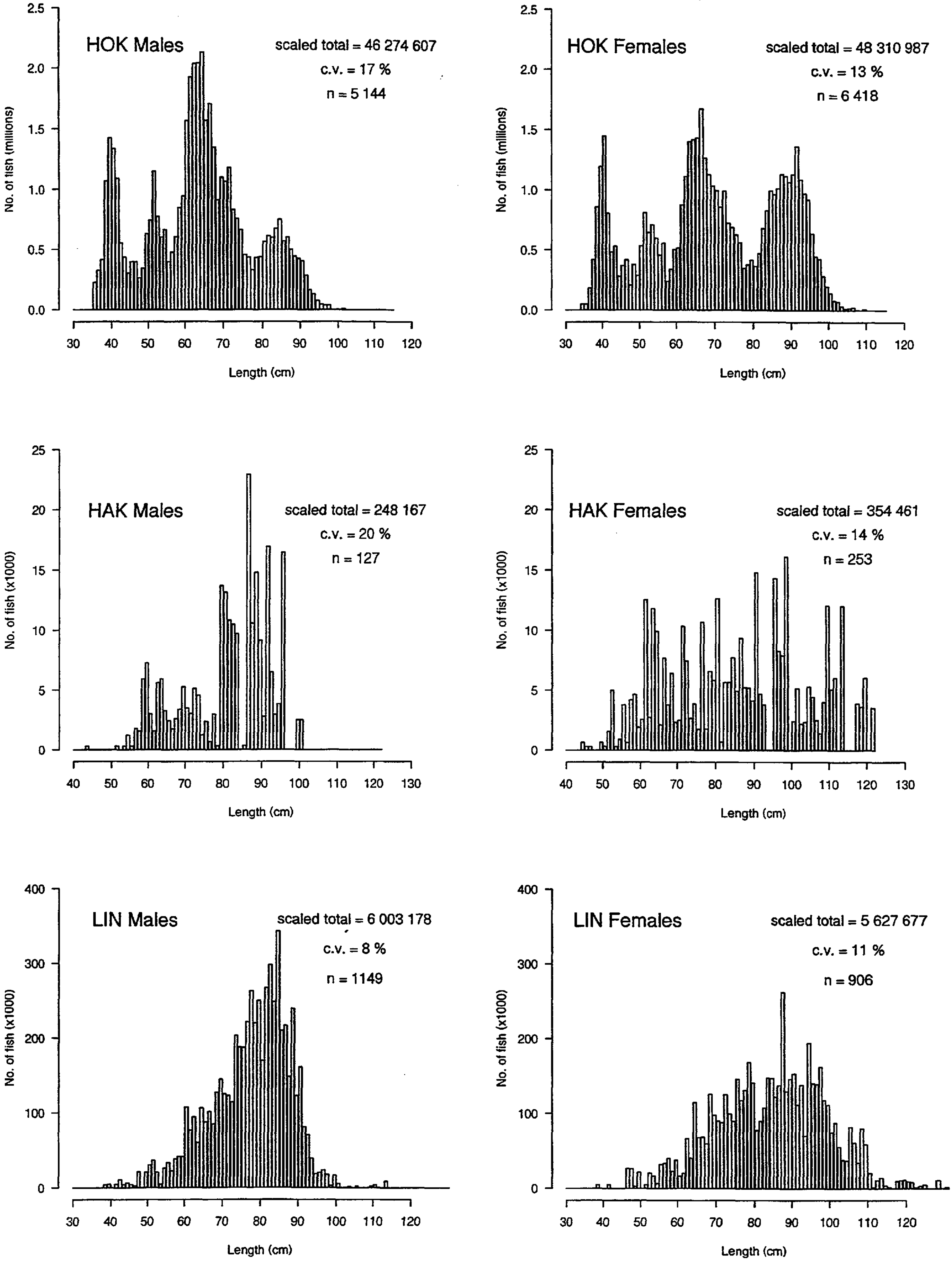


Figure 4(a): Scaled length frequency distributions, *c.v.* of the estimated number of fish, and number of fish measured (n), for hoki (HOK), hake (HAK), and ling LIN).

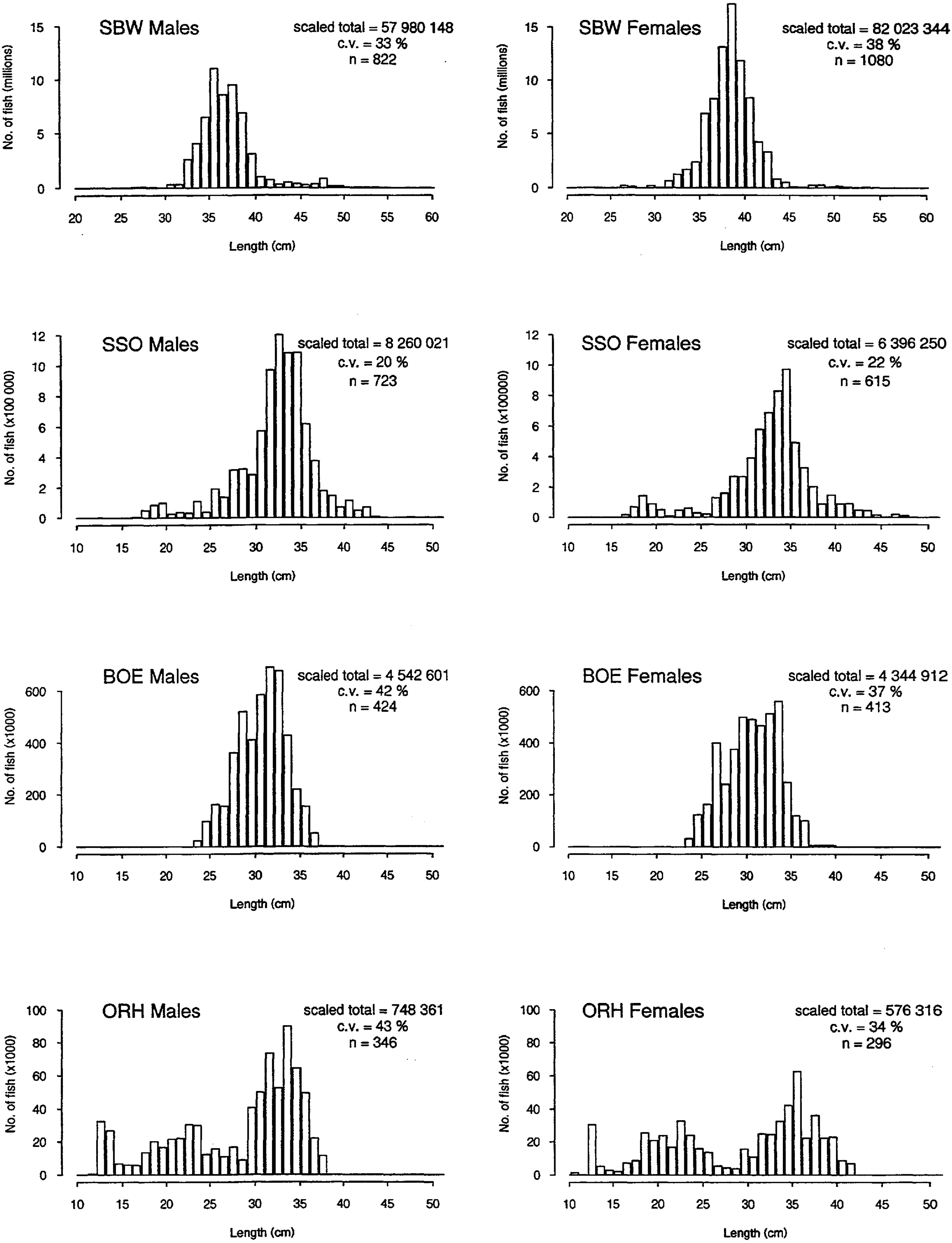


Figure 4(b): Scaled length frequency distributions, *c.v.* of the estimated number of fish, and number of fish measured (n), for southern blue whiting (SBW), smooth oreo (SSO), black oreo (BOE), and orange roughy (ORH).

Appendix 1: Date, position, depth, and gear parameters for individual trawl stations

Station	Stratum	Date	Start of tow Latitude ° 'S	Longitude ° 'E	Depth Min.	Max.	Headline height (m)	Doorspread (m)
1	22	28 Mar 96	46 31.83	170 43.10	894	900	7.8	115.3
2	2	29 Mar 96	46 47.79	167 03.82	702	722	6.0	126.0
3	18A	29 Mar 96	46 52.09	166 57.84	969	983	7.0	118.9
4	18	29 Mar 96	46 45.65	166 46.14	845	850	6.7	123.9
5	2	30 Mar 96	46 31.12	166 22.44	626	639	6.7	123.1
6	18	30 Mar 96	46 36.09	166 27.82	812	878	6.6	123.2
7	1	30 Mar 96	46 30.97	166 33.59	495	523	6.9	121.2
8	1	30 Mar 96	46 30.13	166 43.60	301	336	6.8	108.2
9	1	31 Mar 96	46 47.60	165 43.92	439	509	7.2	99.9
10	18A	31 Mar 96	46 44.03	166 10.47	920	966	7.0	121.5
11	18	31 Mar 96	46 36.11	166 21.81	833	848	7.6	114.8
12	2	31 Mar 96	46 35.62	166 31.90	708	756	7.0	116.9
13	3	1 Apr 96	48 54.88	167 03.37	340	368	7.0	114.3
14	5	1 Apr 96	49 03.05	167 50.95	655	664	7.1	133.9
15	5	1 Apr 96	49 07.11	167 52.30	662	671	7.4	131.1
16	8	1 Apr 96	49 17.38	168 18.43	647	676	7.4	130.0
17	5	2 Apr 96	49 22.51	167 20.15	679	710	6.6	130.3
18	5	2 Apr 96	49 22.49	167 35.80	641	660	7.0	132.3
19	5	2 Apr 96	49 29.90	167 43.01	612	633	7.3	132.1
20	5	2 Apr 96	49 35.02	167 50.41	601	641	7.9	132.8
21	8	2 Apr 96	49 31.83	168 12.08	672	678	7.2	123.1
22	6	3 Apr 96	50 47.17	167 03.20	417	434	7.2	128.2
23	6	3 Apr 96	50 47.49	167 10.33	433	459	7.0	126.0
24	6	3 Apr 96	50 57.62	167 28.13	491	498	6.9	NR
25	19	4 Apr 96	51 37.77	166 19.49	810	829	6.8	129.4
26	6	4 Apr 96	51 21.19	166 07.88	544	572	6.4	124.9
27	6	4 Apr 96	51 13.09	166 33.40	479	488	7.2	134.4
28	7	4 Apr 96	51 20.39	166 41.58	605	608	6.9	129.5
29	8	5 Apr 96	49 57.32	168 44.28	617	617	6.9	126.5
30	8	5 Apr 96	49 52.58	168 34.35	613	617	6.6	125.0
31	9	5 Apr 96	50 01.78	168 19.01	577	581	7.4	124.5
32	9	5 Apr 96	50 05.39	168 13.53	546	571	7.0	112.4
33	9	5 Apr 96	50 14.73	168 26.62	567	582	6.9	121.1
34	8	6 Apr 96	49 24.18	168 33.29	712	728	6.8	128.2
35	8	6 Apr 96	49 17.43	168 47.34	773	788	6.6	NR
36	8	6 Apr 96	49 25.00	169 02.09	722	726	7.0	124.8
37	8	6 Apr 96	49 11.27	169 40.83	787	792	7.0	124.0
38	9	7 Apr 96	51 01.15	168 45.80	577	578	7.2	114.7
39	9	7 Apr 96	50 50.60	169 16.93	581	584	6.9	119.2
40	8	7 Apr 96	50 18.10	169 18.13	600	610	7.0	121.2
41	8	7 Apr 96	50 11.65	169 28.66	614	622	7.1	118.9
42	7	8 Apr 96	51 41.76	166 45.69	686	789	7.1	119.4
43	7	8 Apr 96	51 25.68	167 50.02	637	642	7.0	125.2
44	7	8 Apr 96	51 42.65	167 56.57	652	658	6.9	119.4
45	19A	9 Apr 96	52 26.85	167 22.77	984	989	7.0	122.9
46	10	9 Apr 96	52 41.32	168 15.17	752	756	7.0	117.6
47	19A	9 Apr 96	53 10.04	167 48.35	933	942	6.9	121.2
48	19A	10 Apr 96	53 59.75	169 04.16	978	999	6.8	130.7
49	19	10 Apr 96	53 43.89	168 30.12	845	862	6.7	122.8
50	10	10 Apr 96	53 18.67	168 32.83	784	790	6.8	122.1
51	19	11 Apr 96	53 43.16	169 31.61	817	829	6.8	128.6
52	10	11 Apr 96	53 38.63	169 46.64	737	764	6.6	126.3

Appendix 1 (continued)

Station	Stratum	Date	Start of tow Latitude ° 'S	Longitude ° 'E	Depth Min.	Max.	Headline Height (m)	Doorspread (m)
53	14	11 Apr 96	53 02.36	170 09.36	326	335	6.8	118.9
54	14	11 Apr 96	53 04.88	170 28.89	431	441	7.0	120.8
55	15	12 Apr 96	53 39.03	171 11.86	626	666	6.7	127.1
56	14	12 Apr 96	53 28.41	171 30.06	482	503	6.5	125.7
57	14	12 Apr 96	53 23.44	171 44.83	439	459	7.0	122.0
58	14	12 Apr 96	53 20.73	172 27.00	495	509	6.9	120.9
59	14	13 Apr 96	52 19.34	170 56.73	485	488	6.9	124.5
*60	13	13 Apr 96	51 55.81	172 06.82	544	556	6.8	120.4
61	13	13 Apr 96	51 31.46	171 42.94	524	528	7.0	120.3
62	12	14 Apr 96	49 58.56	171 02.56	519	521	6.9	127.4
63	12	14 Apr 96	50 19.89	171 34.19	514	519	6.7	126.0
64	13	14 Apr 96	50 34.84	171 54.41	506	506	6.7	126.8
65	13	14 Apr 96	50 49.48	171 01.39	506	528	6.8	124.4
66	13	15 Apr 96	51 03.06	173 10.22	584	589	6.9	127.5
67	15	15 Apr 96	51 02.88	173 35.69	632	635	6.6	128.6
68	13	15 Apr 96	51 19.01	173 19.30	569	575	7.0	121.9
69	15	16 Apr 96	50 42.15	173 45.99	712	725	7.0	121.5
70	11	16 Apr 96	50 29.43	173 35.03	653	656	6.8	125.6
71	21	16 Apr 96	50 16.55	174 08.15	814	820	7.0	124.4
72	11	16 Apr 96	49 58.70	174 20.39	700	702	6.9	122.8
73	21A	17 Apr 96	48 24.64	174 52.82	907	933	7.1	125.0
74	21A	17 Apr 96	48 21.15	175 02.49	900	920	6.5	117.2
75	21	17 Apr 96	48 33.49	175 06.98	812	821	6.8	127.8
76	11	18 Apr 96	49 10.07	174 20.91	600	612	6.6	132.2
77	11	18 Apr 96	48 54.60	174 02.09	621	636	6.5	133.8
78	21	18 Apr 96	48 33.98	173 39.56	810	824	6.7	126.4
79	12	19 Apr 96	49 45.33	172 17.60	453	464	6.8	126.4
80	12	19 Apr 96	49 33.19	172 07.67	404	419	6.6	119.6
81	12	19 Apr 96	49 15.51	172 48.16	470	481	6.9	124.7
82	12	19 Apr 96	49 05.81	172 47.03	522	549	6.9	129.5
83	21A	20 Apr 96	48 30.58	171 21.47	930	960	6.9	122.0
84	11	20 Apr 96	48 38.07	171 44.27	752	777	6.8	119.0
85	11	20 Apr 96	48 47.36	171 50.81	632	636	7.0	124.8
86	11	20 Apr 96	48 43.59	172 06.96	666	686	6.8	125.0
87	22A	21 Apr 96	48 47.78	170 00.54	919	937	7.0	117.9
88	11	21 Apr 96	49 02.65	170 57.95	611	634	6.9	124.6
89	11	21 Apr 96	48 52.74	171 20.91	617	636	6.9	123.4
90	22	22 Apr 96	48 24.47	169 57.95	805	853	6.8	124.5
91	4	22 Apr 96	48 21.74	169 49.87	778	779	6.7	122.9
92	22	22 Apr 96	48 06.20	169 51.89	826	843	6.9	121.7
93	4	22 Apr 96	47 59.54	169 13.06	661	665	7.0	116.5
94	3	23 Apr 96	48 20.97	168 11.29	387	415	7.0	NR
95	4	23 Apr 96	48 10.39	168 35.52	619	633	7.0	115.5
96	4	23 Apr 96	48 02.98	168 41.14	613	651	7.0	122.5
97	4	23 Apr 96	48 03.98	169 00.00	654	659	7.0	121.7
98	4	24 Apr 96	47 55.53	168 52.40	643	655	7.0	114.3
99	3	24 Apr 96	47 37.59	169 15.28	585	598	7.1	112.1
100	4	24 Apr 96	47 36.42	169 42.89	778	780	6.9	120.2
101	4	24 Apr 96	47 15.99	169 44.81	610	667	6.9	113.1
102	22A	25 Apr 96	47 08.05	170 09.14	936	954	6.8	123.9

* Gear performance was unsatisfactory for this tow; data from the tow were not used.
NR Doorspread data were not available for these tows.

Appendix 2: Species caught. Taxonomic names follow Paulin *et al.* (1989). Occ., number of tows in which each species was recorded (= 101)

Scientific name	Common name	Species code	Occ.
Chondrichthyes			
Squalidae			
Centroscymnus owstoni	Owston's dogfish	CYO	8
C. crepidater	deepwater dogfish	CYP	22
Deania calcea	shovelnosed dogfish	SND	15
Etmopterus baxteri	Baxter's dogfish	ETB	57
E. lucifer	Lucifer dogfish	ETL	36
Scymnorhinus licha	black shark	BSH	8
Scymnodon plunketi	Plunket's shark	PLS	14
S. ringens		SRI	1
S. macracanthus	roughskin dogfish	SCM	3
Squalus acanthias	spiny dogfish	SPD	8
Oxynotidae			
Oxynotus bruniensis	prickly dogfish	PDG	1
Scyliorhinidae			
Apristurus sp.	deepsea catshark	APR	6
Halaelurus dawsoni	Dawson's catshark	DCS	4
Triakidae			
Galeorhinus galeus	school shark	SCH	1
Arhynchobatidae			
Arhynchobatis asperrimus	longtailed skate	LSK	1
Rajidae			
Bathyraja shuntovi	longnosed deepsea skate	PSK	6
Pavoraja asperula	smooth deepsea skate	BTA	12
P. spinifera	prickly deepsea skate	BTS	4
Raja innominata	smooth skate	SSK	13
R. nasuta	rough skate	RSK	4
Chimaeridae			
Hydrolagus novaezelandiae	dark ghost shark	GSH	12
Hydrolagus sp.	pale ghost shark	GSP	93
Hydrolagus sp.	purple finned hydrolagus	HYP	1
Rhinochimaeridae			
Harriotta raleighana	longnosed chimaera	LCH	45
Rhinochimaera pacifica	widenosed chimaera	RCH	13
Teleostei			
Notacanthidae			
Notacanthus sexspinis	spineback	SBK	52
Synaphobranchidae			
Diastobranchus capensis	basketwork eel	BEE	23
Congridae			
Bassanago bulbiceps	swollenheaded conger	SCO	44
B. hirsutus	hairy conger	HCO	39
Argentinidae			
Argentina elongata	silverside	SSI	47
Alepocephalidae			
Alepocephalus australis	smallscaled brown slickhead	SSM	19
Xenodermichthys socialis	black slickhead	BSL	1

Appendix 2: *continued*

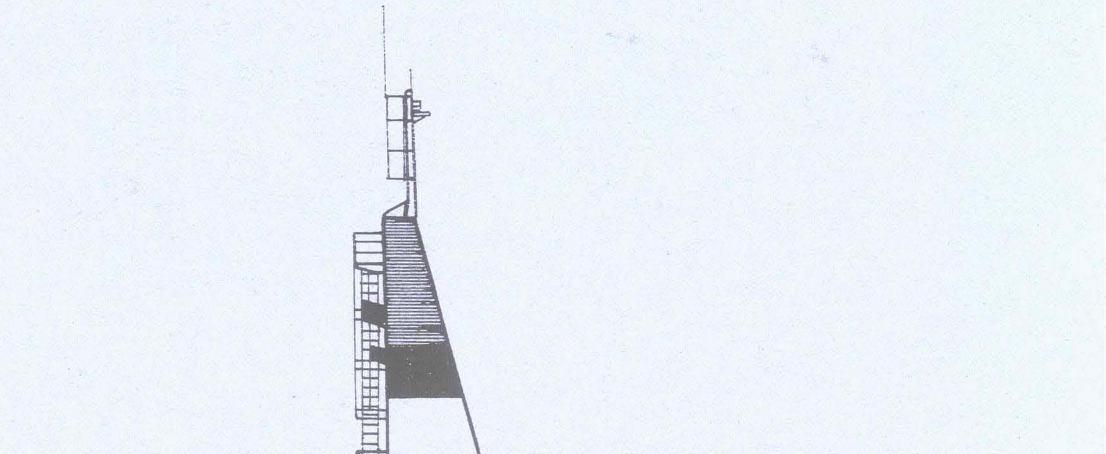
Gonostomatidae			
Species not identified		GST	8
Sternoptychidae			
Argyropelecus hemigymnus	hatchetfish	AHE	1
Astronesthidae			
Species not identified	snaggletooth	AST	2
Paralepidae			
Magnisudis prionosa	barracudina	BCA	3
Arctozenus rissoi	barracudina	ARR	1
Myctophidae			
Species not identified		LAN	2
Muraenolepididae			
Muraenolepis marmoratus	moray cod	MUR	1
Moridae			
Antimora rostrata	violet cod	VCO	14
Halargyreus johnsoni	Johnson's cod	HJO	15
Lepidion microcephalus	smallheaded cod	SMC	2
Mora moro	ribaldo	RIB	46
Pseudophycis bachus	red cod	RCO	5
Laemonema sp.		LAE	1
Gadidae			
Micromesistius australis	southern blue whiting	SBW	39
Merlucciidae			
Macruronus novaezelandiae	hoki	HOK	101
Merluccius australis	hake	HAK	59
Lyconus sp.		LYC	2
Macrouridae			
Caelorinchus aspercephalus	oblique banded rattail	CAS	54
C. acanthiger	spottyfaced rattail	CKX	2
C. bollonsi	bigeyed rattail	CBO	20
C. fasciatus	banded rattail	CFA	85
C. innotabilis	notable rattail	CIN	2
C. kaiyomaru	Kaiyomaru rattail	CKA	23
C. matamua	Mahia rattail	CMA	13
C. oliverianus	Oliver's rattail	COL	58
Coryphaenoides murrayi	abyssal rattail	CMU	1
C. serrulatus	serrulate rattail	CSE	40
C. subserrulatus	four-rayed rattail	CSU	9
Coryphenoides sp. A	slender rattail	CSL	1
Coryphenoides sp. B	longbarbelled rattail	CBA	12
Lepidorhynchus denticulatus	javelin fish	JAV	97
Macrourus carinatus	ridgescaled rattail	MCA	40
Ventrifossa nigromaculata	blackspot rattail	VNI	14
Trachyrincus aphyodes	white rattail	WHX	11
Mesobius antipodum	black javelinfish	BJA	5
Ophidiidae			
Genypterus blacodes	ling	LIN	89
Regalecidae			
Regalecus glesne	oarfish	OAR	1
Trachichthyidae			
Hoplostethus atlanticus	orange roughy	ORH	22
H. mediterraneus	silver roughy	SRH	1
Zeidae			
Capromimus abbreviatus	capro dory	CDO	1

Appendix 2: *continued*

Cyttus novaezelandiae	silver dory	SDO	1
C. traversi	lookdown dory	LDO	31
Zenopsis nebulosus	mirror dory	MDO	3
Oreosomatidae			
Allocyttus niger	black oreo	BOE	14
Neocyttus rhomboidalis	spiky oreo	SOR	4
Pseudocyttus maculatus	smooth oreo	SSO	22
Macrorhamphosidae			
Centriscops obliquus	banded bellowsfish	BBE	2
Scorpaenidae			
Helicolenus sp.	sea perch	SPE	2
Congiopodidae			
Alertichthys blacki	alert pigfish	API	2
Congiopodus coriaceus	deepsea pigfish	DSP	1
Hoplichthyidae			
Hoplichthys haswelli	deepsea flathead	FHD	2
Psychrolutidae			
Neophrynichthys angustus	pale toadfish	TOP	22
N. latus	dark toadfish	TOD	7
Psychrolutes sp.	blobfish	PSY	9
Percichthyidae			
Polyprion oxygeneios	hapuku	HAP	1
Apogonidae			
Epigonus lenimen	bigeyed cardinalfish	EPL	9
Bramidae			
Brama brama	Ray's bream	RBM	8
Cheilodactylidae			
Nemadactylus macropterus	tarakihi	TAR	1
Zoarcidae			
Melanostigma gelatinosum	limp eelpout	EPO	1
Nototheniidae			
Paranotothenia microlepidota	smallscaled cod	SCD	1
Uranoscopidae			
Kathetostoma giganteum	giant stargazer	STA	10
Gempylidae			
Rexea solandri	gemfish	SKI	1
Thyrsites atun	barracouta	BAR	1
Trichiuridae			
Benthodesmus elongatus	bigeye scabbard fish	BNE	1
Centrolophidae			
Centrolophus niger	rudderfish	RUD	13
Icichthys australis	ragfish	RAG	3
Seriolella caerulea	white warehou	WWA	17
S. punctata	silver warehou	SWA	2
Tubbia tasmanica		TUB	1
Bothidae			
Arnoglossus scapha	witch	WIT	1
Neoachiropsetta milfordi	finless flounder	MAN	40
Cephalopoda			
Octopoda			
Octopus sp.	octopus	OCT	10

Appendix 2 : *continued*

Histioteuthidae			
Histioteuthis miranda	violet squid	VSQ	11
Ommastrephidae			
Nototodarus sloanii	arrow squid	NOS	21
Onychoteuthidae			
Moroteuthis ingens	warty squid	WSQ	84
Crustacea			
Lithodidae			
Lithodes murrayi	southern stone crab	LMU	24
Neolithodes brodiei		NEB	7
Paralomis zelandica		PZE	2
Majidae			
Jacquinotia edwardsi	giant spider crab	GSC	5
Leptomithrax australis	giant masking crab	SSC	3
Decapoda			
Metanephrops challengeri	scampi	SCI	4
Species not identified	prawn	PRA	31
Species not identified	crab	CRB	2
Other marine organisms			
Porifera	sponges	ONG	30
Coelenterata			
Anthozoa	anemones	ANT	45
Scyphozoa	jellyfish	JFI	2
Mollusca			
Gastropoda		GAS	1
Molluscs unidentified		MOL	5
Echinodermata			
Asteroidea	starfish	SFI	85
Holothurians	sea cucumbers	SCC	65
Echinoidea unidentified	sea urchins	ECH	16
Thaliacea			
Salpidae unidentified	salps	SAL	1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