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Taihoro Nukurangi

Trawl survey of middle depth and inshore bottom species off Southland, February-March 1996 (TAN9604)

N. W. Bagley
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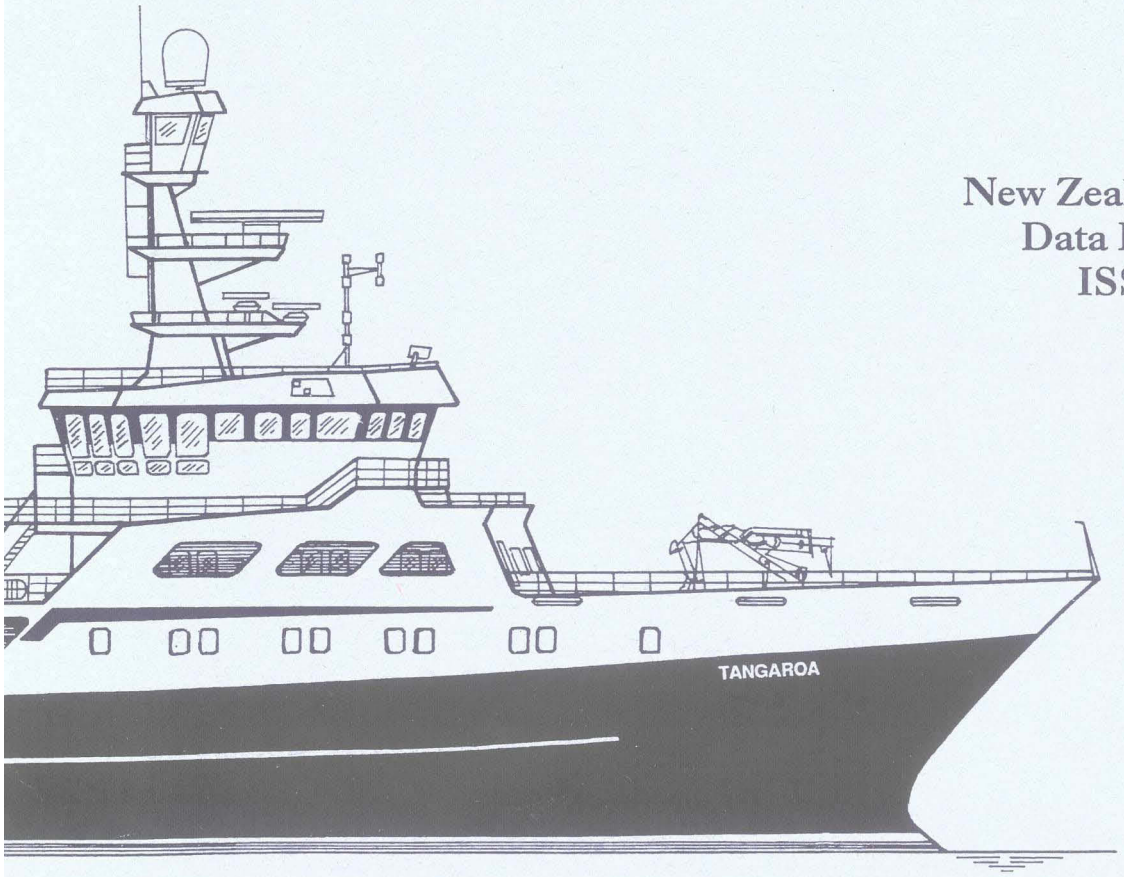

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Contents

Introduction

This report presents results from the fourth in a time series of trawl surveys of inshore and middle depths (30–600 m) finfish species off Southland, New Zealand. The combined annual catch of these species usually exceeds 20 000 t and, for six of the main commercial species (barracouta, blue warehou, gemfish, ling, school shark, and stargazer), the Southland area is (or has been) of major importance.

The background to the development of this time series and previous research in the area were described by Hurst & Bagley (1994). The second survey report (Bagley & Hurst 1995) detailed changes to the stratification of the survey area along the eastern edge of the shelf in an attempt to increase the intensity of sampling and precision of the biomass estimates for warehou species. The main development for the third survey was the optimisation of station allocation for key species, based on the results of previous *Tangaroa* surveys Bagley & Hurst (1996). Station allocation for 1996 was optimised using this procedure. The survey is primarily designed to obtain relative abundance indices and biological data for key species, but also provides the opportunity to carry out a range of work for other research projects.

Project objectives

1. To develop for stock assessment a time series of relative biomass estimates for the major commercial middle depth and inshore species on the Southland shelf, i.e., banded stargazer, giant stargazer, barracouta, blue warehou, silver warehou, gemfish, hapuku, ling, school shark, and (perhaps) jack mackerels.
2. To develop a time series of prerecruit biomass indices for middle depth and inshore species (as appropriate) on the Southland shelf for stock modelling.
3. To determine growth rates, productivity, and stock relationships of the main middle depth and inshore species from biological data.

Voyage objectives

1. To conduct the fourth survey in the time series.
2. To record the catch weights of all species or items caught.
3. To collect length, sex, gonad state, stomach contents data, and otoliths of selected commercial species.
4. To survey areas of untrawlable foul ground and record bathymetric data to better define survey depths and stratum boundaries.
5. To define major water mass characteristics within the survey area by recording bottom and surface temperatures and salinities.
6. To tag school shark to determine the extent and direction of their movements.
7. To collect spines from elephantfish for age validation studies (by M. Francis, NIWA).
8. To collect a range of inshore and middle depth species for training courses.
9. To collect sounder paper traces from the EK500 for acoustic mark identification (by P. Cordue, NIWA)
10. To collect samples as requested for the Museum of New Zealand Te Papa Tongarewa.

Timetable and personnel

The voyage was divided into two parts: the first started from Wellington on 24 February and ended in Port Chalmers on 11 March; the second started from Port Chalmers on 11 March and finished in Dunedin on 26 March.

R. Hurst was the project leader and voyage leader for part 2; N. Bagley was voyage leader for part 1 and responsible for final database editing. The skipper was A. Leachman.

Methods

Survey area and design

The survey was of a two-phase stratified random design (*after* Francis 1984). The rationale for the area, depths, and strata was given by Hurst & Bagley (1994) and strata alterations to optimise for warehou species were described by Bagley & Hurst (1995). No changes were made to the strata for this survey.

The resulting survey area (Figure 1) was divided into 22 strata by area and depth (30–100, 100–200, 200–400, and 400–600 m). A total of 104 tows was planned for phase 1 and up to 40 stations were anticipated for phase 2. The allocation of stations in phase 1 was designed to optimise the sampling strategy for eight of the main species — barracouta, blue warehou, gemfish, hapuku, ling, school shark, giant stargazer, and banded stargazer — using results from the three previous *Tangaroa* surveys and the procedure outlined by Hurst & Bagley (1994).

Stratum areas and planned station densities for phase 1 are given in Table 1. In phase 2, extra computer-generated stations were allocated to strata providing high catch rates of the main species with high coefficients of variation (Francis 1984).

Standardised procedures for gear set-up and deployment, sampling, data analysis, and data reporting followed guidelines developed and documented for hoki/middle depth trawl surveys (Hurst *et al.* 1992).

Vessel specifications

RV *Tangaroa* is a purpose-built, research stern trawler with the following specifications: length overall, 70 m; beam, 14 m; gross tonnage, 2280 t; power, 3000 kW. It is equipped with Simrad EK500 and Kaijo Denki echo sounders, Magnavox and Furuno GPS, Scanmar trawl monitoring (doorspread, wingspread, temperature, and trawl-eye) equipment, and Kaijo Denki and Furuno net monitors.

Net features

The eight-seam hoki bottom trawl used was described by Hurst & Bagley (1994). Variable parameters such as headline height and speed were averaged for each tow from records taken at 5 min intervals. A summary of the variation in gear parameters by depth is given in Table 2. Tow speed was recorded on all tows and headline height on all but one tow. Doorspread

was recorded on only 34 tows because of problems with the sensor during part 1 of the survey. Doorspread was calculated for other tows using data for the appropriate depth range from all four surveys.

Trawling procedure

Procedures for deployment of the hoki bottom trawl were established from gear trials as described by Hurst *et al.* (1992) and Hurst & Bagley (1994). These procedures aim to minimise variation in gear parameters on the survey.

Other procedures were as recommended by Hurst *et al.* (1992), i.e., daylight tows of 3 n. miles (timed from the gear reaching the bottom to the start of hauling) at 3.5 kn (speed over the ground), either following the bottom contour or in the direction of the next tow if time was limiting. If foul ground was encountered, a search was made within a 5 n. mile radius for suitable ground. If the ground was still unsuitable, the next alternative from the random stations list was chosen.

Catch size recording

All items in the catch were sorted and weighed for every tow using Seaway motion-compensating scales. Finfish, squids, and crustaceans were classified by species, other benthic fauna by family, and rubbish items by general categories. Two methods were used to estimate large catches of spiny dogfish: dogfish were counted on the conveyor and the weight was estimated from the mean weight of fish in the length frequency sample or, for large catches (usually over 5 t), the catch was estimated by the number of full beckets on the codend. All school shark tagged were weighed individually before release.

Biomass estimation

Doorspread biomass was estimated for finfish and squid species (*after* Francis 1981, 1989). The coefficient of variation (*c.v.*), a measure of the precision of the biomass estimate, was calculated by:

$$c.v. = S_B / B \times 100$$

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

The following assumptions were made.

1. The effective seabed area swept was the distance between the trawl doors multiplied by the distance towed.
2. The catchability coefficient for doorspread estimates was 1.0. This assumes that:
   i. the vulnerability of all fish in the area swept by the doors was 100%;
   ii. vertical availability was 100%;
   iii. areal availability was 100% in the survey area, as defined in Table 1, which includes areas of flat foul ground which were untrawlable but similar in appearance to

surrounding trawlable ground. Areas of rough foul ground, significantly different from surrounding trawlable areas, were excluded as fish density and species composition could not be expected to be the same as on surrounding trawlable ground.

Biological measurements

Details of the species, numbers sampled, data collected, and measurement methods are given in Table 3. For all commercially important fish and arrow squid, up to 200 individuals of each species were randomly selected from each tow (for recommendations on sample sizes, *see* appendix 3 of Hurst *et al.* 1992). Length was measured to the nearest centimetre below. All species measured were sexed, except for leatherjacket and flatfish. The spawning condition of most commercial species was recorded.

Individual fish weights were collected from the more common species measured to enable length-weight relationships to be determined for scaling length frequency data. In addition, one or more of gonad stage and weight, stomach contents and state of digestion, and otoliths were collected from selected commercial species. Samples were usually of up to 20 fish per tow, except for gonad stages which were often recorded for every fish in the length frequency sample.

Spines were collected from elephantfish for other studies not reported on here.

Hydrological observations

Sea surface temperatures were recorded at each station from water entering a vessel intake pipe at a depth of about 2 m. Bottom temperatures were recorded from the Furuno net monitor up to tow 49, when the headline transducer failed. It was intended to record salinity and temperature at each station using a headline-mounted data logger, but this was achieved on only six tows because of battery problems.

Results

Survey area and design

Station positions are shown in Figure 2; individual station data are given in Appendix 1. A total of 124 successful tows was completed, 106 in phase 1 (stations 1–113) and 18 in phase 2 (stations 114–134). There was an additional successful tow (station 131) for spiny dogfish, which caught an estimated 30 t, for which the bycatch species could not be estimated. The anticipated number of phase 2 stations was not achieved because of winch problems. Unsuccessful tows not included in biomass calculations were 13, 19, 31, 64, 66, 75, 92, 128, 131 (for species other than spiny dogfish), and 132. Tows near known foul ground to the south of the survey area were reduced to 2 n. miles. Large hauls of spiny dogfish caused problems, so tows with heavy dogfish marks were also shortened to 2 n. miles.

These tows have been included as successful for biomass calculations.

Phase 2 stations were allocated to target species which had coefficients of variation on the biomass estimates of over 20% after phase 1 of the survey, i.e., blue warehou (44%), banded stargazer (36%), gemfish (25%), and barracouta (21%). This slightly improved the precision of the biomass estimates for blue warehou (40%), banded stargazer (34%), gemfish (23%), and barracouta (19%).

Catch composition, distribution, and biomass

One hundred and two species were recorded: 70 teleosts, 21 elasmobranchs, 5 cephalopods, and 6 crustaceans. Other benthic and pelagic organisms and rubbish items were recorded in broader groupings (Appendix 2). Table 4 shows the total catch and biomass for the 20 most abundant and other commercially important species and the number of stations at which they occurred. About half the total catch (198 t) and the total biomass (177 072 t) was made up of spiny dogfish. The distribution of catch rates for the 15 major species of interest (i.e., those most abundant in the 1993 survey) is shown in Figure 3, and the biomass by stratum in Table 5. The distribution of red cod is also shown, as this was the second most abundant species in this survey.

Biological data

Details of the number of samples and total sample size are given in Table 3; length-weight relationships used to scale length frequencies are given in Appendix 3.

Length frequency data for the 15 major species of interest are shown in Figure 4, by depth range where significant depth differences were apparent. Data for red cod are also given as the sample size measured was reasonable (over 500 fish) and the survey encompassed a significant part of the distribution of this species. Rough and smooth skate data are given because this was the first time such data have been recorded for these species, which are becoming of increasing commercial importance. All length frequencies have been scaled by the percentage of fish sampled per tow, the area swept by the trawl doors, and stratum area.

Prerecruit modal groups which it may be possible to monitor over time were determined from length frequency data for six species. The numbers of fish, biomass, and associated *c.v.* for these modal groups are given in Table 6.

A summary of stomach contents data for 13 species is given in Table 7. The percentage of fish at each gonad stage by sex is given in Table 8 for 15 species. Otoliths were collected from barracouta, banded stargazer, giant stargazer, blue warehou, hapuku, gemfish, jack mackerel, hake, ling, silver warehou, and white warehou and have yet to be processed. Silver warehou otoliths collected from 1993 to 1995 have been used to validate ageing techniques (Horn & Sutton 1995).

One hundred and eighteen school shark in lively condition were measured, sexed, tagged using Floy lock-on and dart tags, and released.

Temperature data

Surface temperatures were recorded from the bridge readout on 132 tows, of which 105 records were in phase 1. Bottom temperatures were recorded during 49 tows, of which all records were in phase 1. Phase 1 data are shown in Figure 5. Temperature and salinity from the data logger were collected on only six tows and are not shown.

Discussion and conclusions

Gear damage continued to be a problem, as in previous surveys, but was minimised by increasing knowledge and experience and approaches outlined by Bagley & Hurst (1995).

For most of the key species we are interested in monitoring over time (*see* project objective 1), the *c.v.*s of the biomass estimates continued to be acceptable (i.e., under 20%) and should allow us to monitor biomass changes. Biomass estimates for spiny dogfish, tarakihi, rough skate, and smooth skate may also be useful for future stock assessment. The *c.v.* for blue warehou was again larger than desirable (40%), possibly partly due to the reduced number of phase 2 stations. There was no attempt in this survey to improve the precision of the biomass estimates for silver warehou or jack mackerels. Other commercial species were either out of their main areas or depth ranges and the time series will probably not be meaningful for them.

This survey was the last proposed annual survey in this time series and there will be no survey in 1997. A full comparison of the results of the four surveys will be made during 1996 and recommendations for the continuation and frequency of the surveys will be included in a detailed report.

Acknowledgements

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Table 1: Stratum areas, numbers of stations, and station densities*

Stratum	Depth range (m)	Total area (km^2)	Foul area (km^2)	No. of stations			Station density (1 : km^2)
					Phase 1	Phase 2	
				Planned	Actual	Actual	
1	30–100	2 360	0	7	8	0	1 : 295
2	30–100	2 137	0	4	4	2	1 : 356
3	30–100	2 317	0	6	6	0	1 : 386
4a	100–200	1 095	0	3	3	0	1 : 365
4b	100–200	1 058	0	3	3	0	1 : 353
5a	100–200	3 832	0	4	4	2	1 : 639
5b	100–200	1 417	0	4	4	0	1 : 354
6a	100–200	4 321	928	8	8	0	1 : 540
6b	100–200	1 230	0	4	4	9	1 : 95
7	100–200	4 009	1 915	5	6	0	1 : 668
8a	100–200	3 049	1 516	4	3	0	1 :1 016
8b	100–200	351	0	3	3	0	1 : 117
9	100–200	4 071	692	6	6	2	1 : 509
10a	100–200	2 882	230	7	7	1	1 : 360
10b	100–200	3 089	174	4	4	2	1 : 515
11	100–200	2 577	66	8	9	0	1 : 286
12	100–200	1 003	0	5	5	0	1 : 200
13	200–400	876	0	3	3	0	1 : 292
16	200–400	2 320	0	4	4	0	1 : 580
17	400–600	1 820	0	3	3	0	1 : 607
18	200–600	1 750	0	5	5	0	1 : 350
20	400–600	2 103	0	4	4	0	1 : 525
Totals		49 667	5 521	104	106	18	1 : 401

* The foul area has been included in the stratum areas for biomass calculations except for strata 3 where the ground is rough and probably has a different species composition.
Station density is given as a proportion of the total stratum area used for biomass calculation.

Table 2: Gear and tow parameters (recorded values only) by depth range (*n* = number of tows)

	Depth range (m)												Total
	30–100			100–200			200–400			400–600			
	n	Mean	*s.d.*	*n*	Mean	*s.d.*	*n*	Mean	*s.d.*	*n*	Mean	*s.d.*	*n*
Headline height (m)	21	7.4	0.90	85	7.5	0.47	6	7.4	0.33	11	7.4	0.31	123
Tow speed (kts)	21	3.6	0.17	86	3.6	0.17	6	3.6	0.17	11	3.5	0.09	124
Doorspread (m)	9	87.0	8.62	24	98.9	7.00	-	-	–	1	121.0	–	34

Table 3: Species and numbers of fish and squid measured*

		Length frequencies				Biological data				
Species code	Measurement method	No. of tows sampled	No. of fish	No. of males	No. of females	No. of tows sampled	No. of fish	No. of males	No. of females	No. of otoliths
BAR‡	1	87	4 117	2 065	2 042	54	1 110	543	562	538
BCO	2	35	358	219	138	26	332	205	126	–
BGZ‡	2	26	98	50	47	21	78	42	36	74
ELE	2	10	49	27	22	9	45	26	19	–
ESO	2	1	5	–	–	–	–	–	–	–
GFL	2	3	23	–	–	–	–	–	–	–
GSH	5	10	330	97	232	5	190	49	140	–
GSP	5	8	138	74	64	6	135	74	61	–
GUR	2	21	349	158	191	13	311	138	173	–
HAK	2	11	69	18	51	11	69	18	51	67
HAP‡	2	76	303	153	148	52	231	116	113	63
HOK‡	2	16	2 127	1 101	1 069	–	–	–	–	–
JDO	2	1	1	1	0	–	–	–	–	–
JMD	1	30	297	152	145	4	24	15	9	–
JMM‡	1	69	2 339	1498	836	12	205	132	73	33
LDO	2	12	94	43	51	3	54	23	31	–
LEA	2	4	193	–	–	–	–	–	–	–
LIN‡	2	73	1 010	497	512	23	590	311	287	87
LSO	2	15	79	1	-	–	–	–	–	–
NOS‡	4	108	5 272	2 218	2 564	9	537	206	331	–
RBM	1	14	70	31	37	–	–	–	–	–
RBT	1	10	113	4	4	3	96	2	1	–
RCO‡	2	30	543	301	233	6	339	199	134	–
RIB	2	4	13	0	13	2	3	0	3	–
RSK‡	5	81	287	170	116	81	287	170	116	–
SBW	2	1	2	2	0	–	–	–	–	–
SCH‡	2	64	235	116	116	65	239	117	119	–
SKI‡	1	31	105	56	49	32	107	58	49	102
SPD‡	2	106	5 444	2 178	3 265	23	852	377	475	–
SPE‡	2	38	843	458	375	12	401	212	189	–
SPO	2	8	17	6	11	7	13	3	10	–
SSK‡	5	28	44	27	17	27	43	26	17	-
STA‡	2	97	895	518	375	76	575	310	265	462
SWA‡	1	64	1 191	812	772	16	633	258	323	169
TAR‡	1	41	1 023	532	450	14	486	245	241	–
TRU	1	5	9	3	3	–	–	–	–	–
TUR	2	1	1	0	1	–	–	–	–	–
WAR‡	1	23	700	277	422	22	337	133	204	240
WIT	2	1	1	–	–	–	–	–	–	–
WWA	1	4	59	41	18	3	58	41	17	28

* Species codes are given in Appendix 2.
Measurement methods: 1, fork length; 2, total length; 4, mantle length; 5, total length excluding tail filament.
Biological data include one or more of the following: fish weight, gonad stage, gonad weight, stomach contents and state of digestion, otoliths.

‡ Length frequency data are presented in Figure 5.

– no data.

Table 4: Total catch, number of stations at which each species occurred (Occ.), and estimated doorspread biomass and coefficients of variation (*c.v.*) of the 20 most abundant and other commercially important species*

	Catch			Biomass		
	Weight (kg)	% of total	Occ.	Weight (t)	*c.v.* (%)	% of total
Spiny dogfish	106 205	53.6	107	89 818	29	50.7
Red cod	14 074	7.1	30	33 390	94	18.9
Hoki	12 681	6.4	16	9 717	16	5.5
Jack mackerel *(Trachurus murphyi)*	10 314	5.2	71	8 609	29	4.9
Barracouta	9 958	5.0	89	7 693	19	4.3
Arrow squid	7 284	3.7	112	4 392	23	2.5
Blue warehou	5 707	2.9	23	1 628	40	0.9
Silver warehou	4 287	2.2	65	3 705	40	2.1
Ling	3 254	1.6	75	2 315	16	1.3
Dark ghost shark	3 203	1.6	10	1 865	63	1.1
Giant stargazer	2 436	1.2	101	1 733	11	1.0
School shark	2 422	1.2	65	1 936	16	1.1
Rough skate	1 464	0.7	84	1 055	11	0.6
Tarakihi	1 294	0.7	42	910	31	0.5
Hapuku	1 196	0.6	78	820	14	0.5
Sea perch	849	0.4	39	480	29	0.3
Smooth skate	736	0.4	29	504	29	0.3
Red bait	603	0.3	65	440	70	0.3
Gemfish	568	0.3	33	529	23	0.3
Blue cod	495	0.3	35	343	30	0.2
Hake	421	0.2	11	286	27	0.2
Banded stargazer	384	0.2	26	232	34	0.1
Jack mackerel *(T. declivis)*	357	0.2	30	305	45	0.2
Red gurnard	293	0.2	21	257	39	0.2
Pale ghost shark	239	0.1	9	185	29	0.1
White warehou	174	<0.1	4	102	87	<0.1
Elephantfish	168	<0.1	10	137	46	<0.1
Lookdown dory	101	<0.1	13	78	37	<0.1
Spotted dogfish	82	<0.1	9	66	46	<0.1
Ray's bream	73	<0.1	14	40	40	<0.1
Leatherjacket	58	<0.1	4	49	68	<0.1
Lemon sole	42	<0.1	16	30	35	<0.1
Ribaldo	36	<0.1	4	29	74	<0.1
Green flounder	28	<0.1	3	17	99	<0.1
Trumpeter	14	<0.1	5	12	47	<0.1
Other species	2 149	1.2				
All species	198 016 #		124	177 072	23	

* Includes all species for which more than 10 kg were caught.
Catch details of other species are given in Appendix 2.

\# Excludes all sponges, salps, corals and rubbish.
Spiny dogfish results are from 125 stations all other species are from 124 stations.

Table 5: Estimated biomass (t) and coefficient of variation (*c.v.*, in parentheses) by stratum for the 15 major species*

	Species code														
Stratum	BAR	BGZ	HAP	HOK	JMM	LIN	NOS	SCH	SKI	SPD	SPE	STA	SWA	TAR	WAR
1	900	0	86	0	4073	18	673	150	0	8 943	51	50	974	215	260
	(28)		(38)		(52)	(30)	(32)	(48)		(36)	(100)	(67)	(57)	(60)	(100)
2	719	0	47	0	1776	83	26	236	0	18 281	0	123	16	175	10
	(83)		(51)		(59)	(70)	(50)	(38)		(37)		(59)	(89)	(89)	(64)
3	239	0	82	0	153	36	20	101	0	464	4	186	9	345	7
	(64)		(78)		(71)	(50)	(26)	(100)		(39)	(64)	(22)	(56)	(56)	(100)
4a	715	0	15	0	83	199	435	38	7	23 169	14	27	210	2	0
	(75)		(14)		(59)	(72)	(56)	(100)	(100)	(98)	(100)	(53)	(79)	(69)	
4b	5	2	8	2	35	26	46	12	0	73	0	8	0	0	0
	(61)	(100)	(51)	(100)	(100)	(69)	(46)	(100)		(59)		(51)			
5a	192	0	57	0	1160	92	47	50	63	29 550	0	164	1110	10	0
	(44)		(44)		(45)	(46)	(39)	(85)	(67)	(36)		(17)	(96)	(59)	
5b	27	0	9	0	16	9	15	8	0	216	0	22	0	0	0
	(94)		(100)		(100)	(100)	(43)	(100)		(15)		(31)			
6a	163	8	122	0	80	92	47	437	114	1 412	68	127	819	3	313
	(52)	(66)	(36)		(57)	(42)	(81)	(50)	(59)	(46)	(55)	(33)	(98)	(66)	(100)
6b	15	9	21	0	24	6	12	18	1	2 016	19	20	12	+	872
	(53)	(33)	(30)		(58)	(48)	(42)	(35)	(100)	(58)	(33)	(20)	(37)	(100)	(59)
7	200	9	23	0	4	60	11	15	0	786	69	25	1	0	32
	(99)	(100)	(75)		(100)	(48)	(62)	(100)		(96)	(55)	(64)	(100)		(100)
8a	78	0	19	0	0	25	9	26	7	946	13	1	0	0	0
	(100)		(100)			(53)	(23)	(62)	(100)	(70)	(100)	(100)			
8b	1	2	11	0	0	0	165	2	0	1	52	5	4	0	0
	(51)	(100)	(87)				(89)	(100)		(100)	(96)	(41)	(73)		
9	356	0	41	0	324	294	68	265	128	1 718	10	37	15	0	11
	(66)		(27)		(89)	(89)	(61)	(21)	(60)	(23)	(83)	(35)	(76)		(66)
10a	715	120	61	0	180	184	164	210	52	772	2	49	9	19	0
	(60)	(56)	(28)		(72)	(45)	(31)	(43)	(28)	(31)	(80)	(38)	(67)	(51)	
10b	832	19	80	0	279	134	135	150	66	575	0	96	24	+	4
	(66)	(75)	(38)		(88)	(75)	(41)	(64)	(75)	(34)		(29)	(78)	(100)	(100)
11	1 798	35	71	0	396	16	138	94	8	405	144	632	66	124	50
	(48)	(99)	(35)		(57)	(42)	(40)	(54)	(67)	(26)	(69)	(22)	(37)	(39)	(63)
12	85	24	55	0	4	25	247	69	18	41	4	17	131	2	16
	(95)	(47)	(63)		(90)	(89)	(98)	(45)	(61)	(55)	(69)	(28)	(99)	(61)	(100)
13	27	0	0	59	0	145	752	0	0	1	0	12	1	0	
	(51)			(79)		(46)	(97)			(100)		(53)	(86)		

Table 5 — *continued*

Stratum	Species code														
	BAR	BGZ	HAP	HOK	JMM	LIN	NOS	SCH	SKI	SPD	SPE	STA	SWA	TAR	WAR
16	623	3	14	19	21	19	796	54	68	363	26	76	3	15	54
	(50)	(100)	(37)	(100)	(74)	(100)	(26)	(45)	(29)	(56)	(100)	(88)	(58)	(87)	(87)
17	0	0	0	699	0	227	499	0	0	6	0	10	7	0	0
				(75)		(30)	(97)			(100)		(55)	(100)		
18	0	0	0	1413	1	505	7	0	0	5	0	21	296	0	0
				(60)	(100)	(13)	(66)			(72)		(43)	(100)		
20	2	0	0	7525	0	121	80	0	0	72	5	27	0	0	0
	(100)			(15)		(24)	(42)			(79)	(45)	(60)			

* Species codes are given in Appendix 2.

\+ less than 0.5 t.

Table 6: Estimated number of fish, biomass, and coefficients of variation (*c.v.*) for prerecruit modal groups evident from length frequency data *

	Estimated year class	Modal length range (cm)	No. of fish (scaled)	Biomass (t)	Biomass *c.v.* (%)
Barracouta	1994	28–43	220 887	64	21
	1993	44–54	207 511	115	27
	1992	53–58	64 981	55	44
Blue warehou	1994?	25–34	5 095	3	89
Hoki	1994	30–45	7 004 415	1 521	14
	1993	46–58	10 270 333	4 232	7
Red cod	1994	20–39	1 651 946	736	99
Silver warehou	1994	13–24	888 726	116	24
	1993	25–37	2 318 418	1 312	45
	1992	38–43	79 575	112	56
Tarakihi	1995?	10–14	5 636	< 1	57
	1994?	15–21	371 534	48	58
	1993?	22–26	218 205	59	62

* Number of fish scaled by percentage sampled, area swept, and area surveyed.

Table 7: Percentage occurrence of food items in teleost stomachs *

	No. of items	Crustacean: Euphausiid	Crustacean: Other	Fish	Salps	Mollusc: Squid	Mollusc: Other	Unidentified	Other
Banded stargazer	78	0	3	42	1	28	15	10	0
Barracouta	162	53	5	30	1	11	0	0	0
Blue warehou	50	0	0	4	96	0	0	0	0
Dark ghost shark	40	0	58	10	5	0	15	13	0
Gemfish	51	2	0	63	0	35	0	0	0
Hake	24	0	0	75	0	25	0	0	0
Giant stargazer	439	0	11	45	3	32	3	6	0
Hapuku	10	0	20	60	0	20	0	0	0
Jack mackerel (*T. murphyii*)	39	13	10	18	54	0	0	5	0
Ling	4	0	25	75	0	0	0	0	0
Red cod	23	0	52	35	0	13	0	0	0
Silver warehou	25	0	0	0	100	0	0	0	0
White warehou	4	0	0	0	100	0	0	0	0

* Unidentified includes unidentifiable because digested.

Table 8: Reproductive state of teleost species*

Species code	Sex	No. of fish	Percentage of fish at each gonad stage 1	2	3	4	5	6	7
BAR	M	466	7	14	7	38	11	11	12
	F	407	10	48	25	3	1	8	6
BCO	M	39	0	8	28	51	10	0	3
	F	29	3	3	14	31	17	27	3
BGZ	M	40	10	80	5	0	0	0	5
	F	34	0	21	24	24	0	9	24
GUR	M	42	2	67	24	7	0	0	0
	F	117	0	0	94	5	0	1	0
HAK	M	18	0	17	5	11	44	11	11
	F	53	2	45	21	0	0	4	28
HAP	M	46	74	22	4	0	0	0	0
	F	39	54	44	3	0	0	0	0
JMD	M	8	0	75	0	13	0	0	13
	F	4	0	75	25	0	0	0	0
JMM	M	48	2	75	2	0	0	0	21
	F	29	0	100	0	0	0	0	0
LIN	M	118	27	48	15	10	0	0	0
	F	140	19	80	1	0	0	0	0
RCO	M	63	11	25	5	59	0	0	0
	F	56	7	91	2	0	0	0	0
SKI	M	55	0	38	55	4	0	4	0
	F	49	0	94	2	0	0	0	4
STA	M	249	8	52	37	2	0	1	1
	F	220	5	45	36	2	0	7	5
SWA	M	109	23	70	1	0	0	0	6
	F	157	11	88	1	0	0	1	0
TAR	M	21	14	29	29	29	0	0	0
	F	425	15	62	11	1	1	10	0
WAR	M	110	0	36	4	28	6	21	6
	F	95	2	55	7	13	2	13	8

* Species codes are given in Appendix 2.
Gonad stages: 1, immature; 2, resting; 3, maturing (oocytes visible in females); 4, mature (hyaline oocytes in females, milt expressible in males); 5, running ripe (eggs and milt free flowing); 6, partially spent; 7, spent.

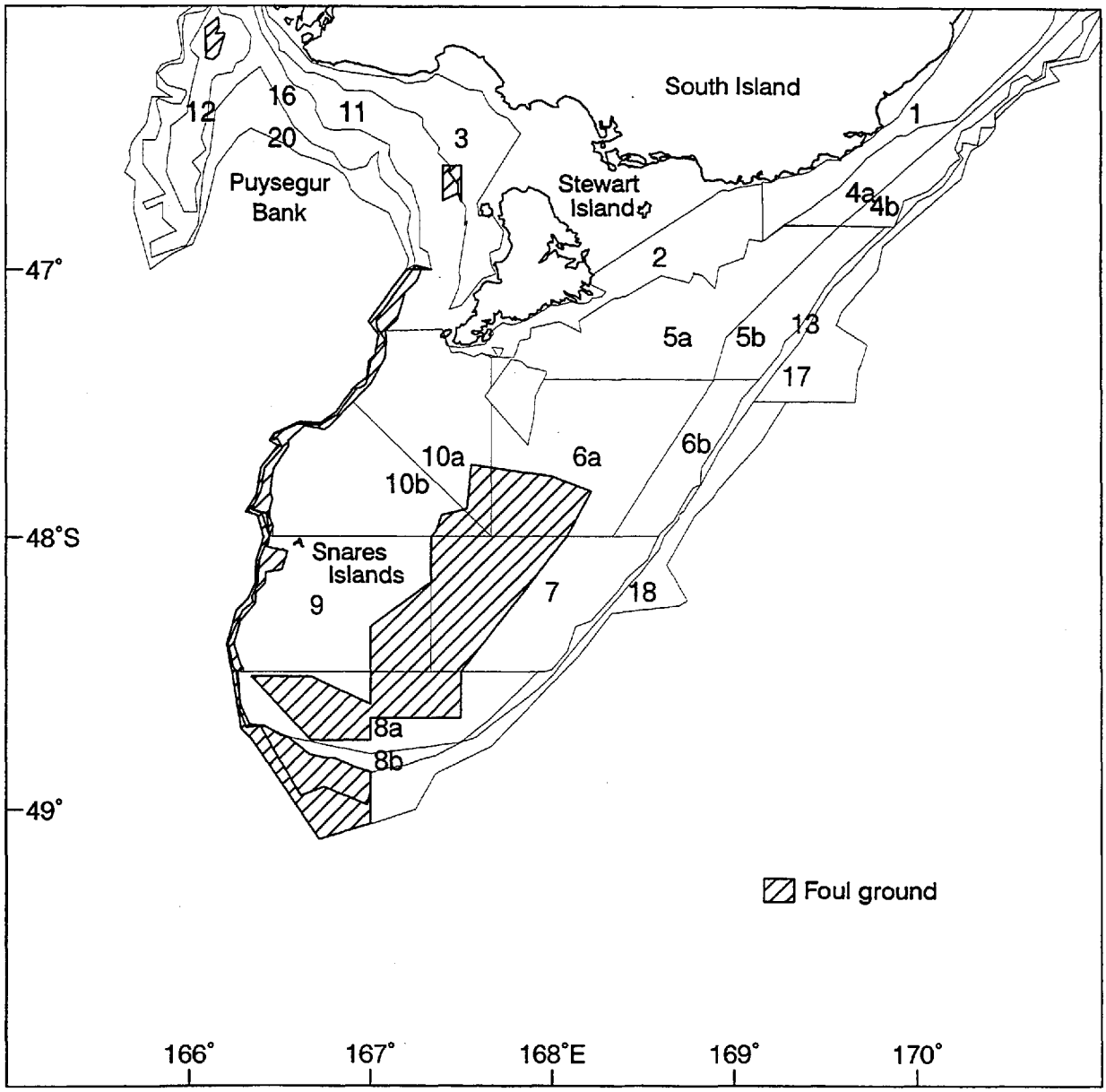


Figure 1: Survey area showing strata boundaries and numbers and foul ground.

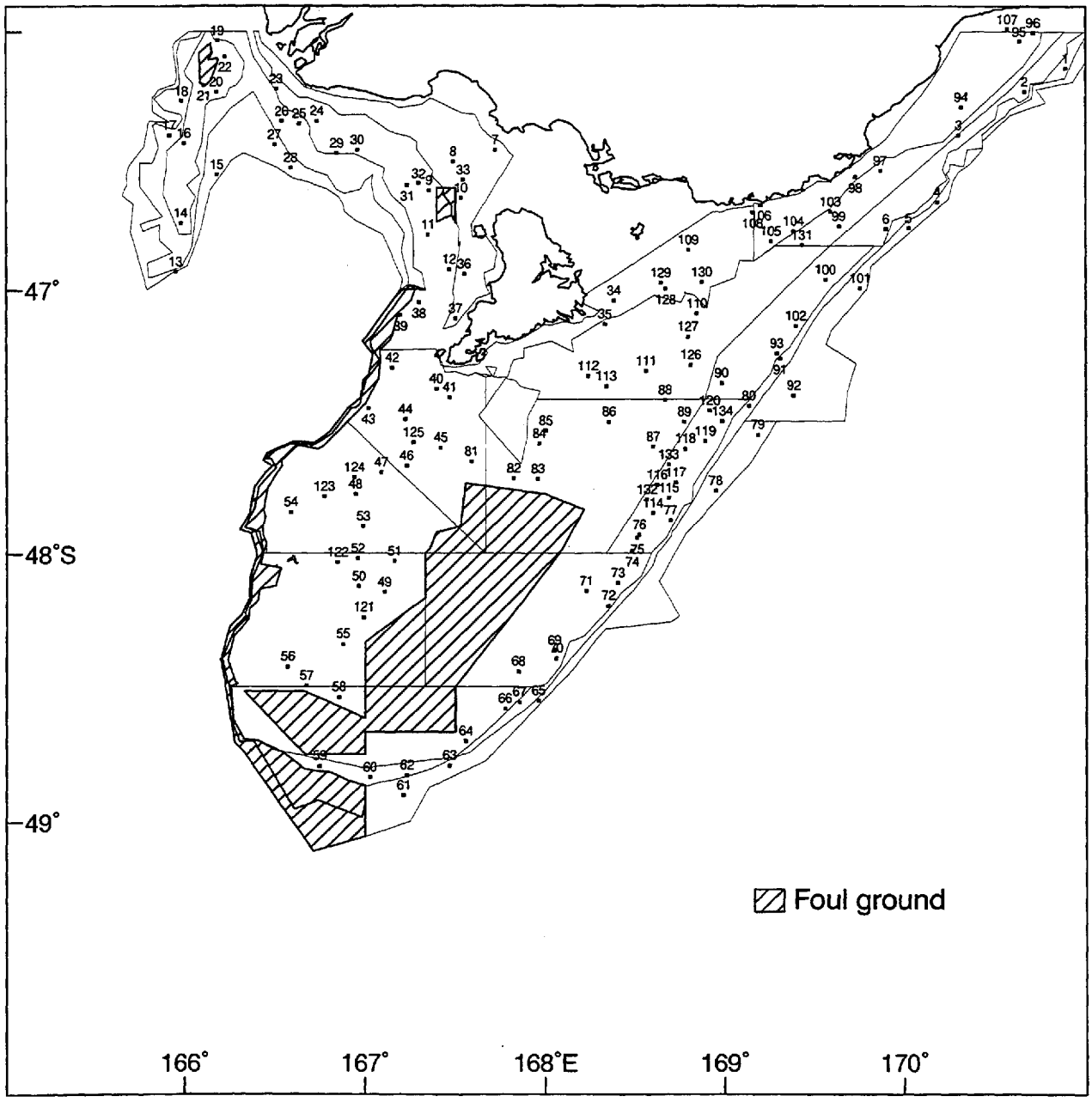


Figure 2: Station positions and numbers.

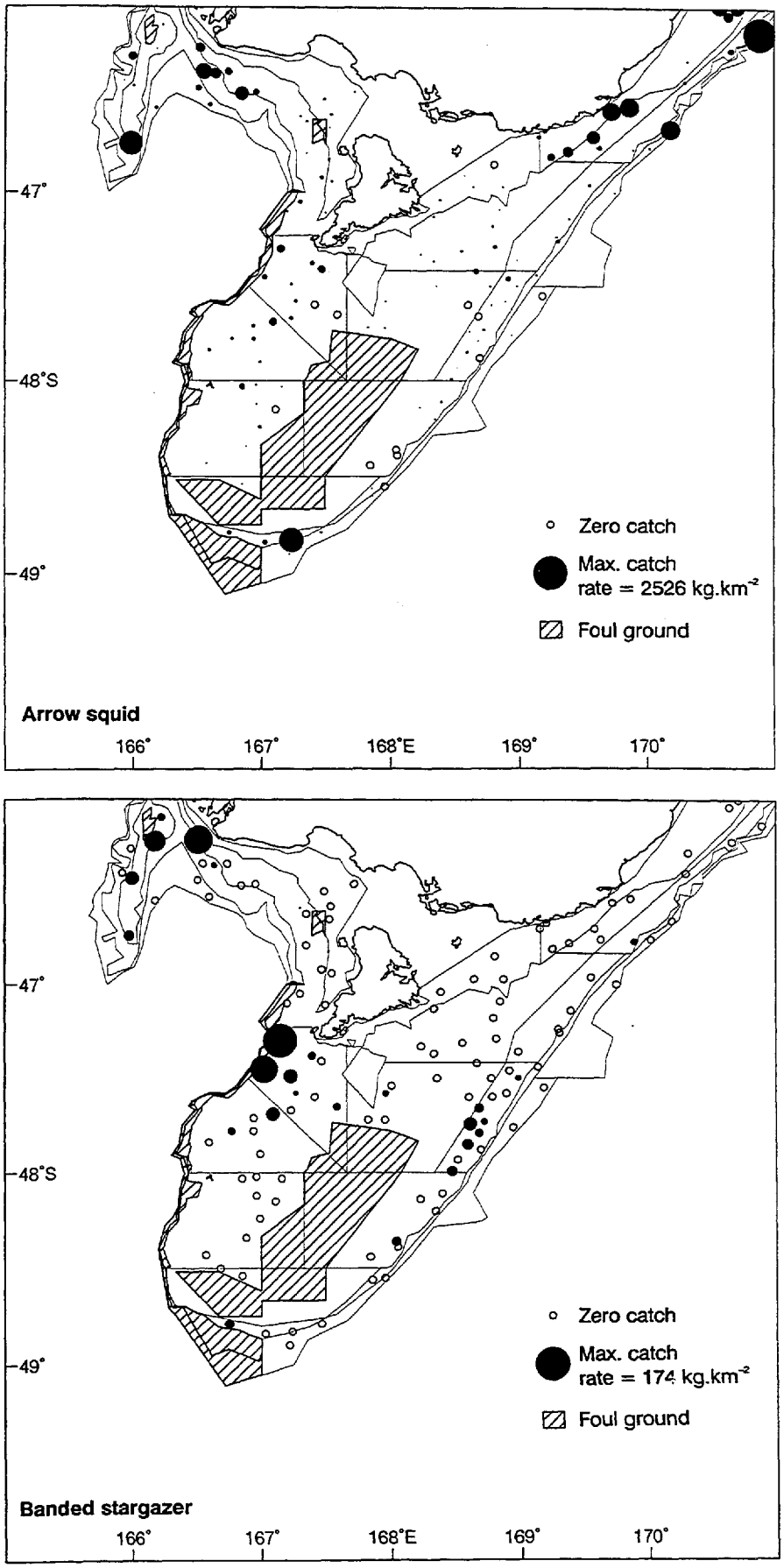
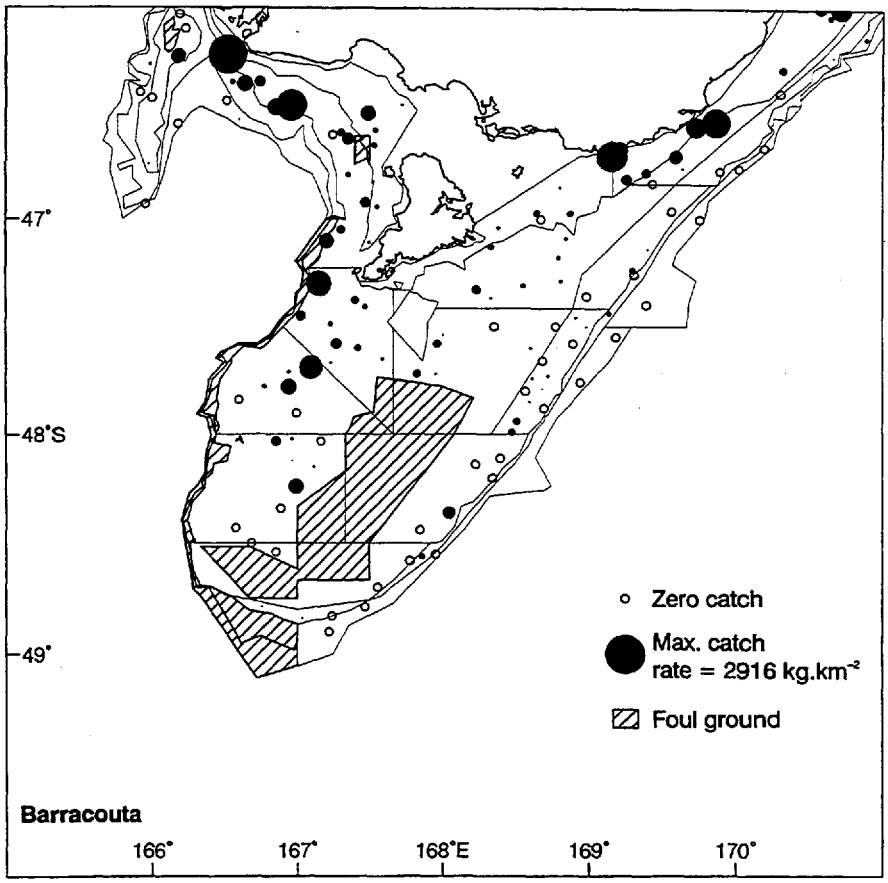


Figure 3: Catch rates of the major commercial species. Circle area is proportional to catch rate.



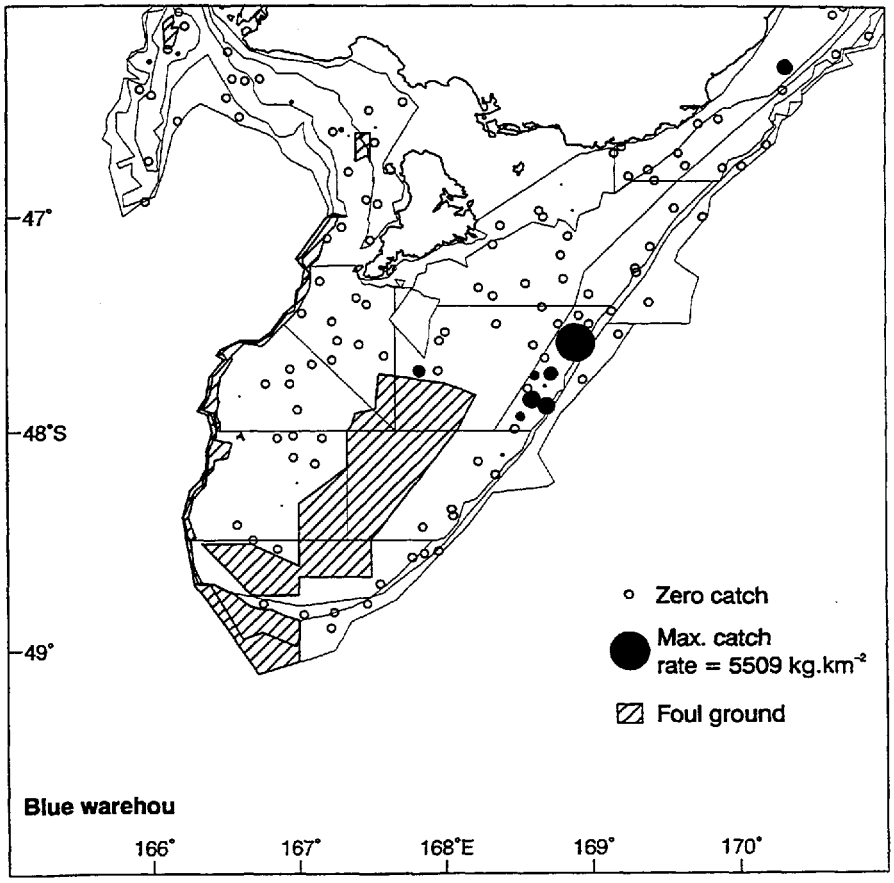
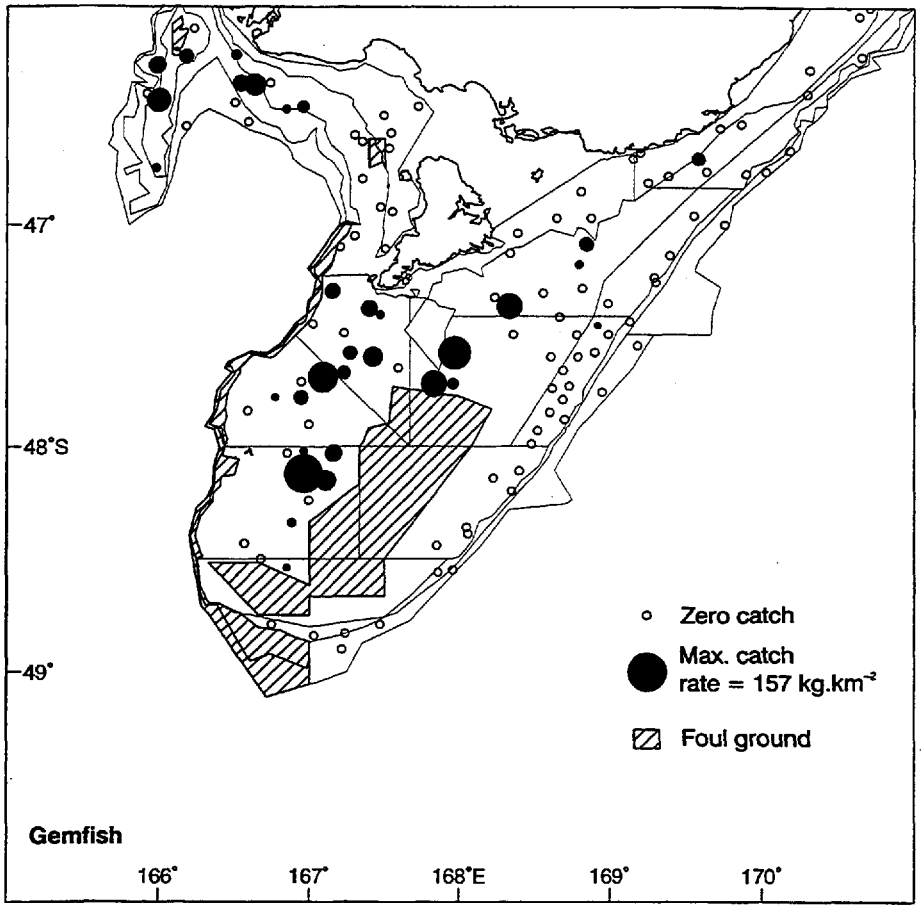


Figure 3—*continued*



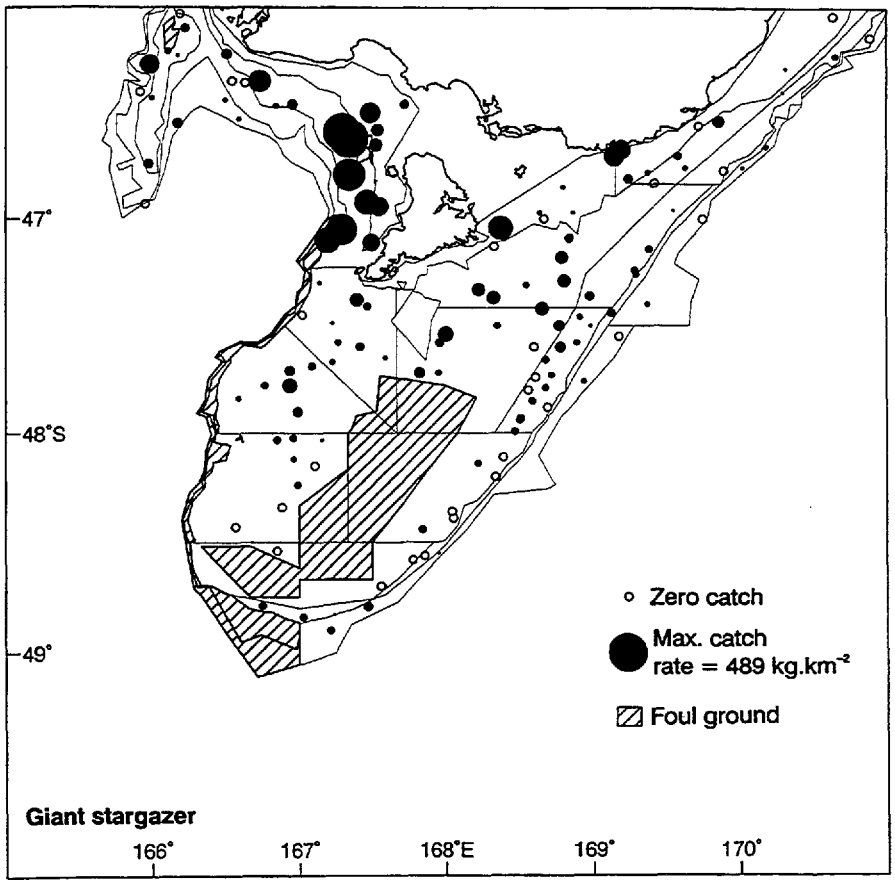
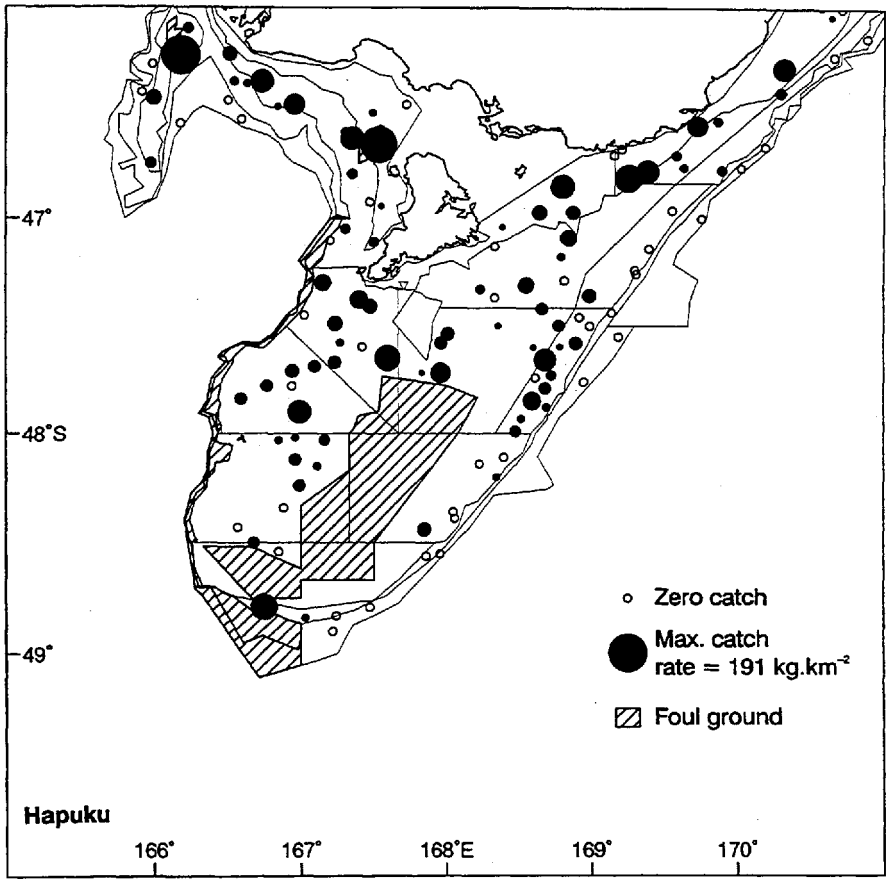


Figure 3—*continued*



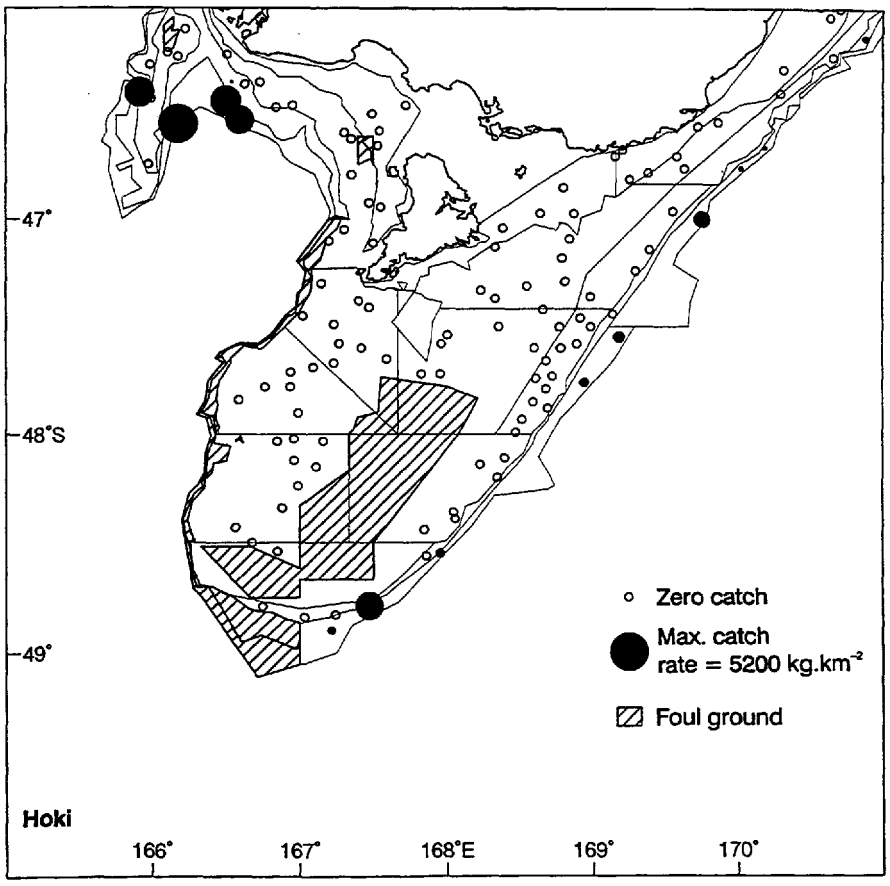
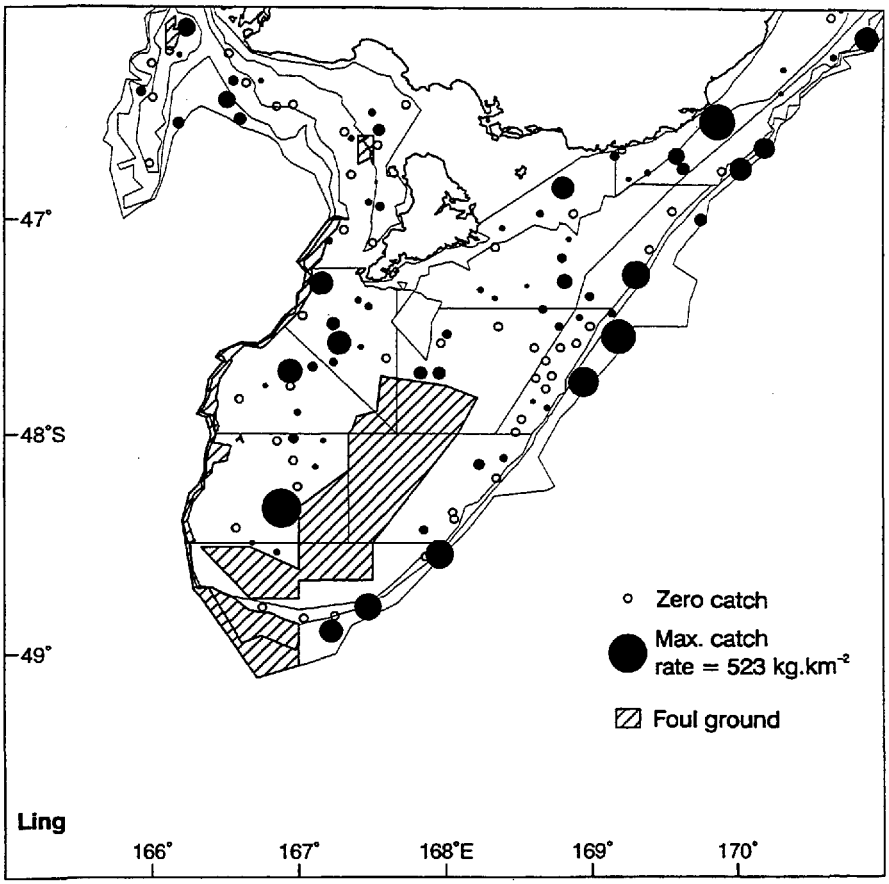


Figure 3—*continued*



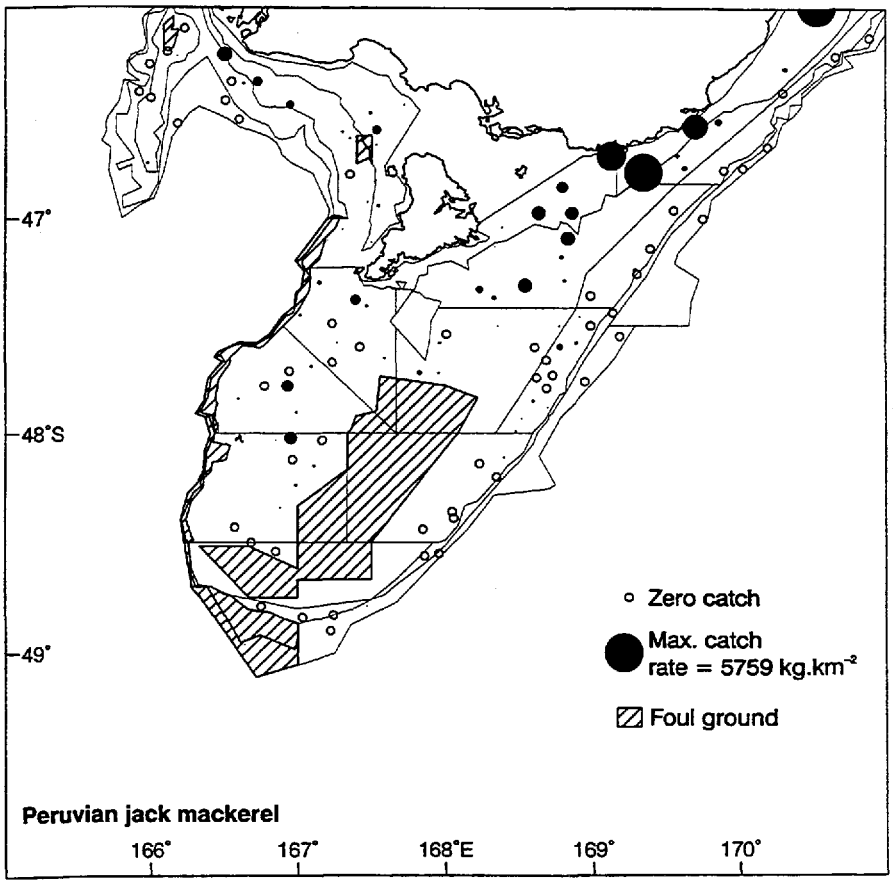
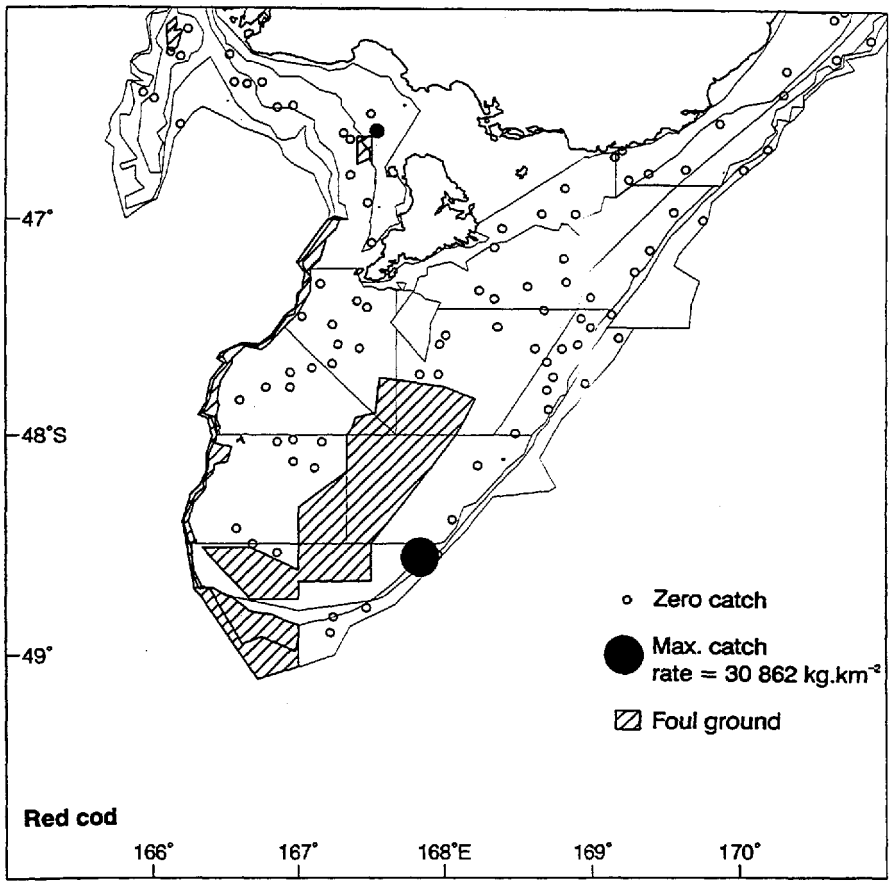


Figure 3—*continued*



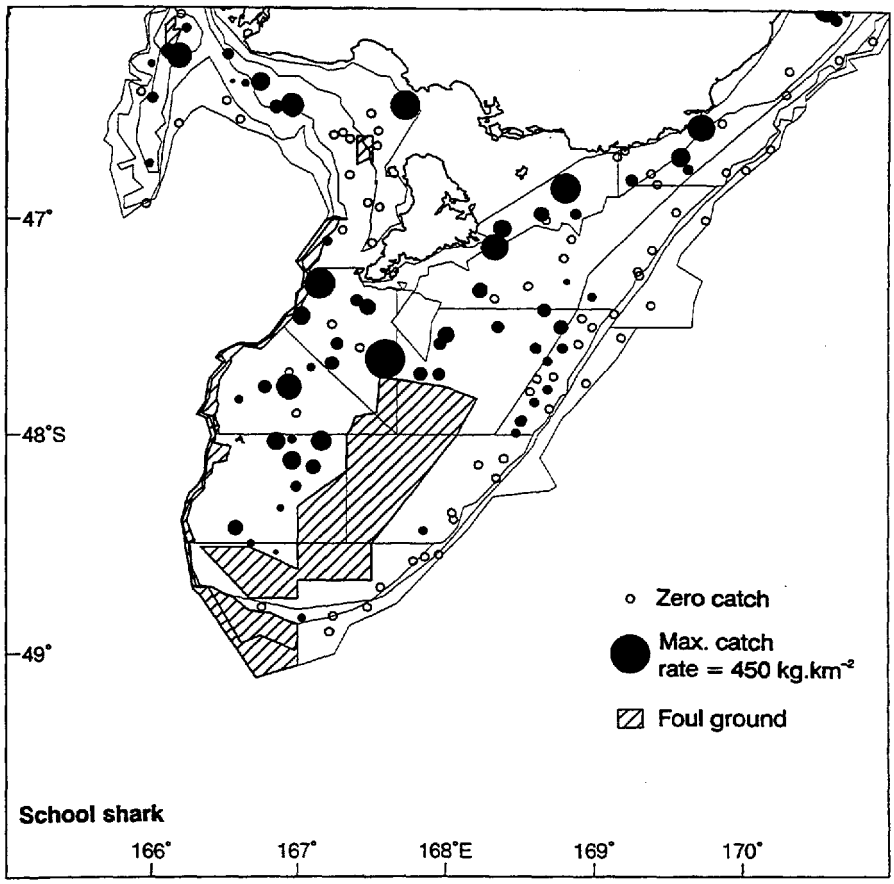
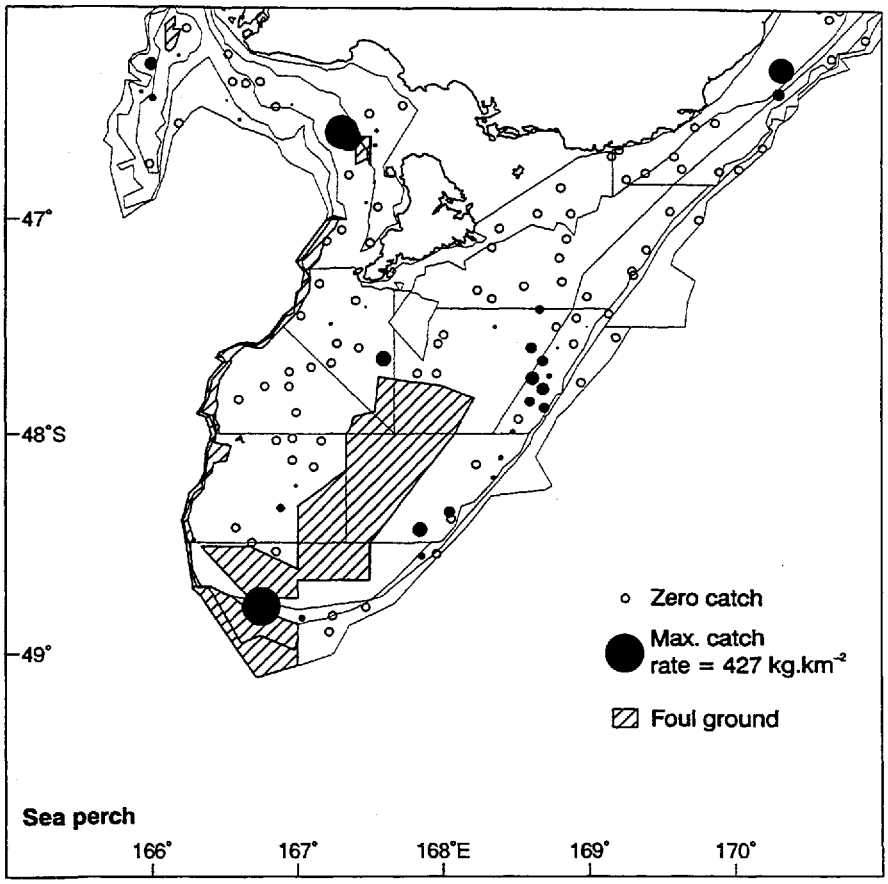


Figure 3—*continued*



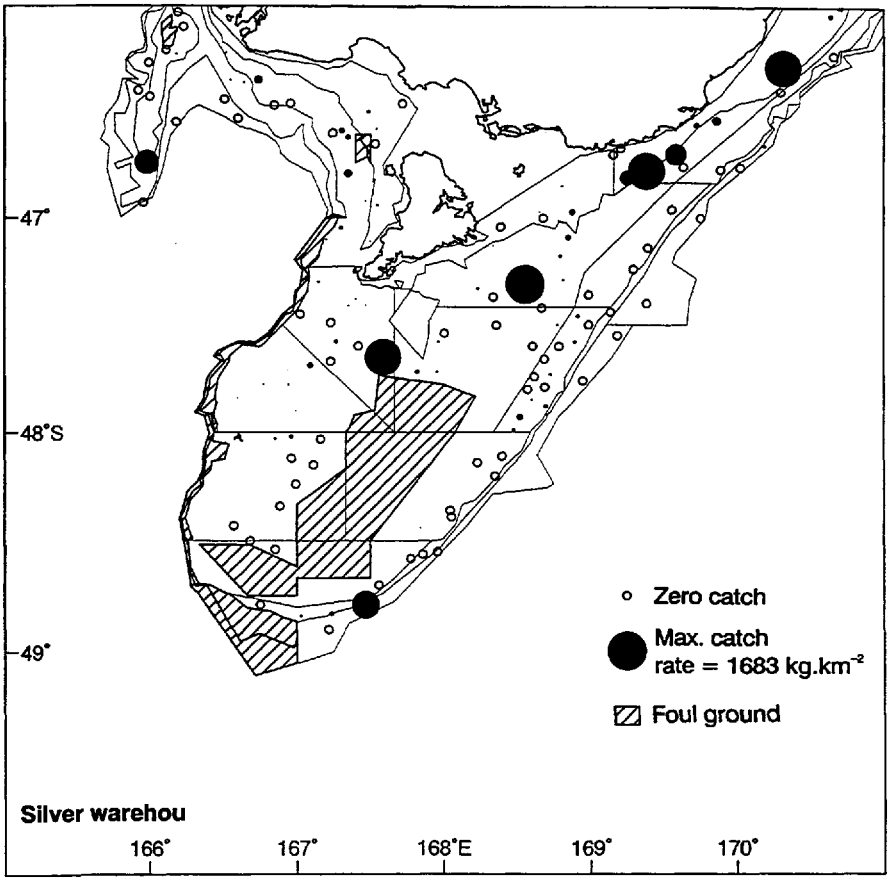


Figure 3—*continued*

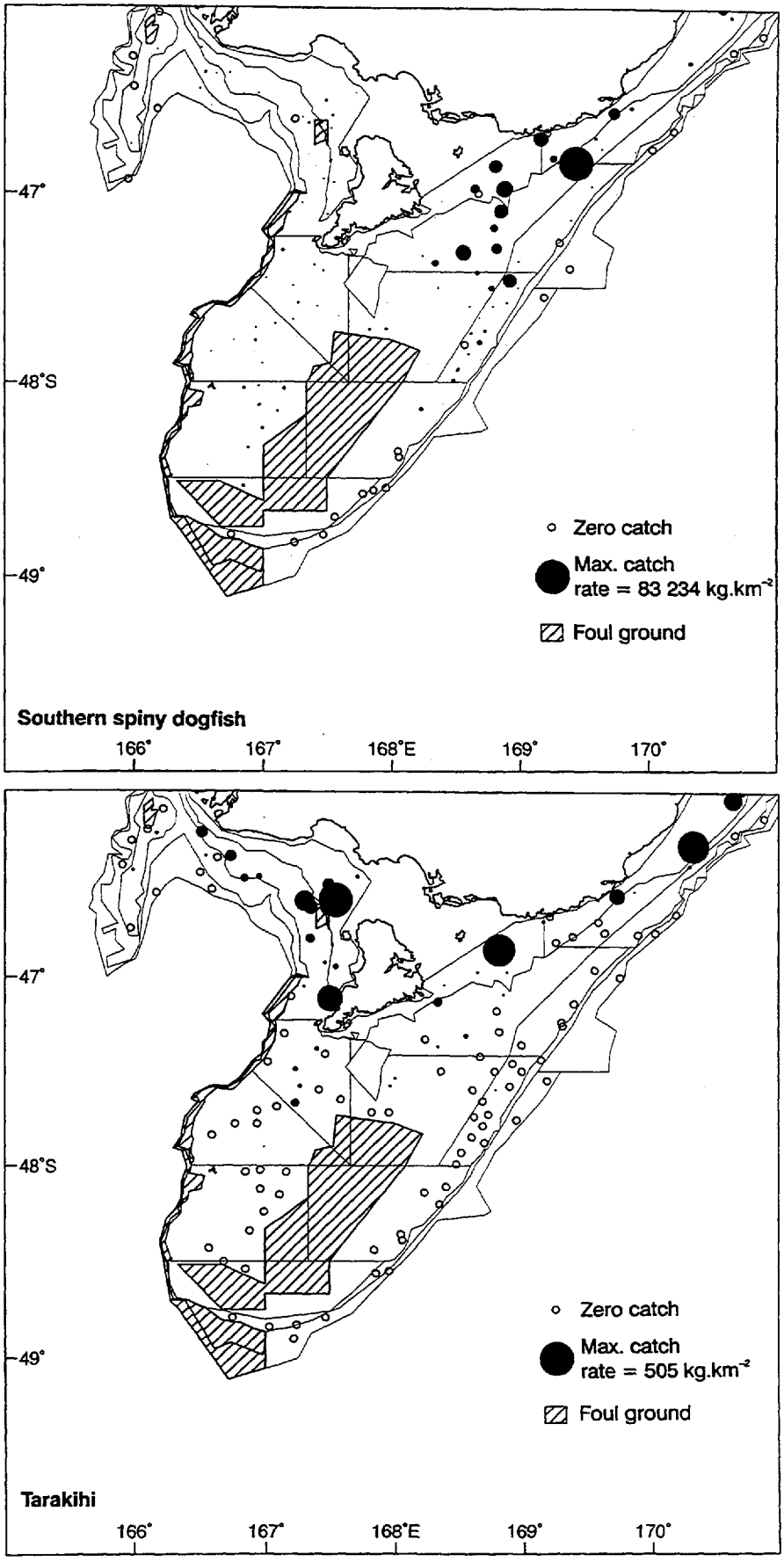


Figure 3—*continued*

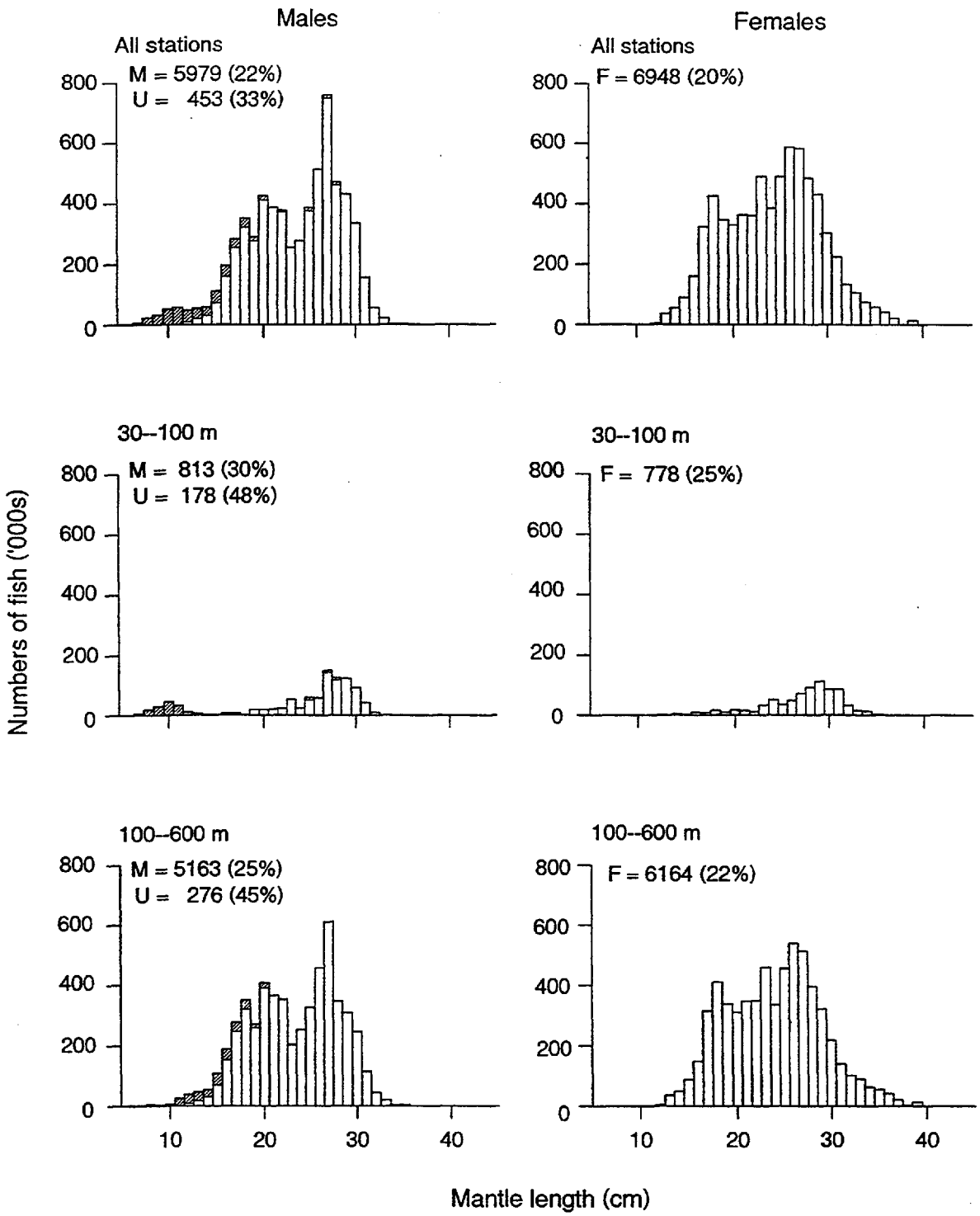


Figure 4: Length frequencies of major commercial species, by depth where appropriate. (M, males; F, females; U, unsexed; numbers are scaled to represent the estimated population size; coefficents of variation in parentheses).
Arrow squid

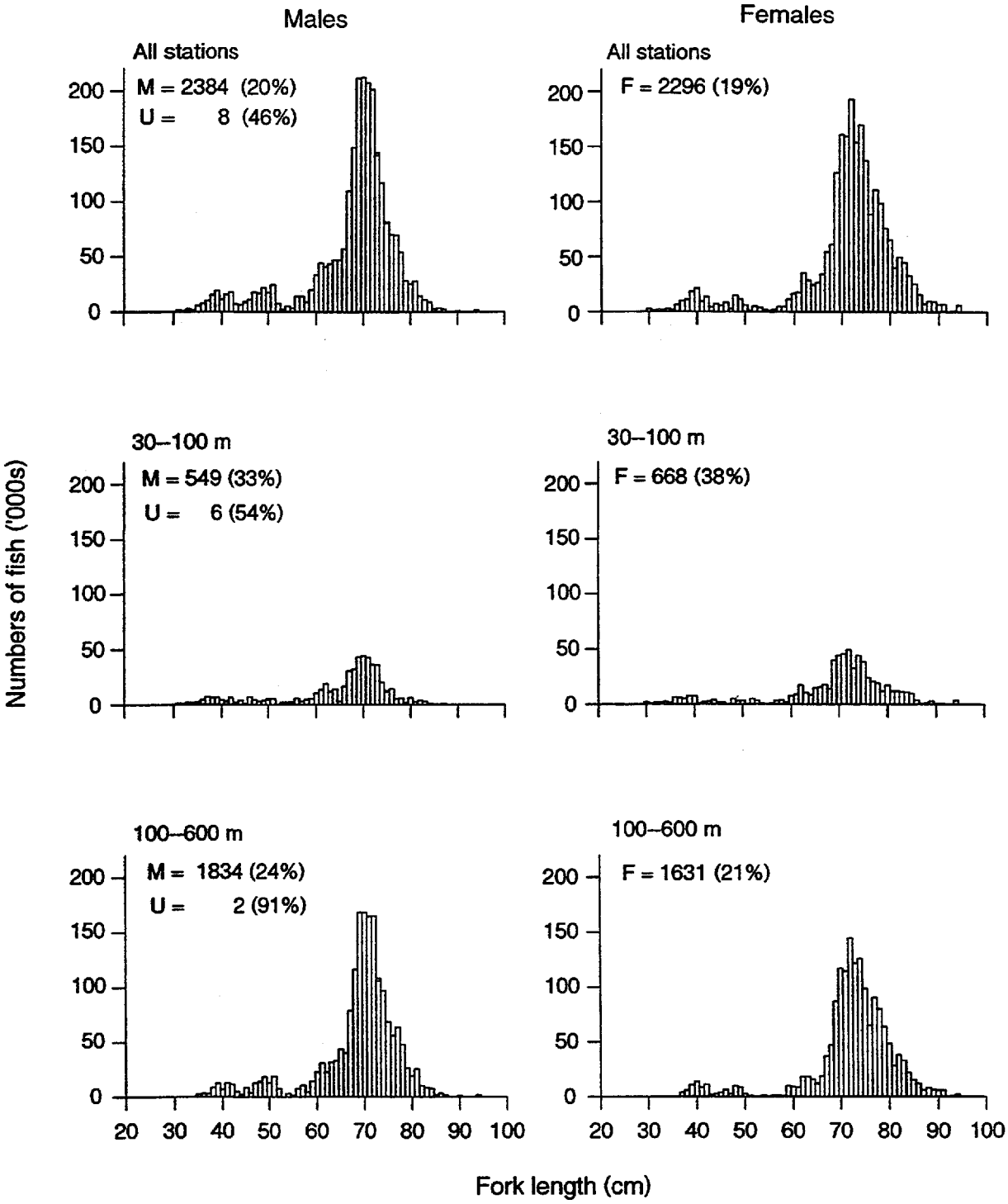


Figure 4—*continued*: Barracouta

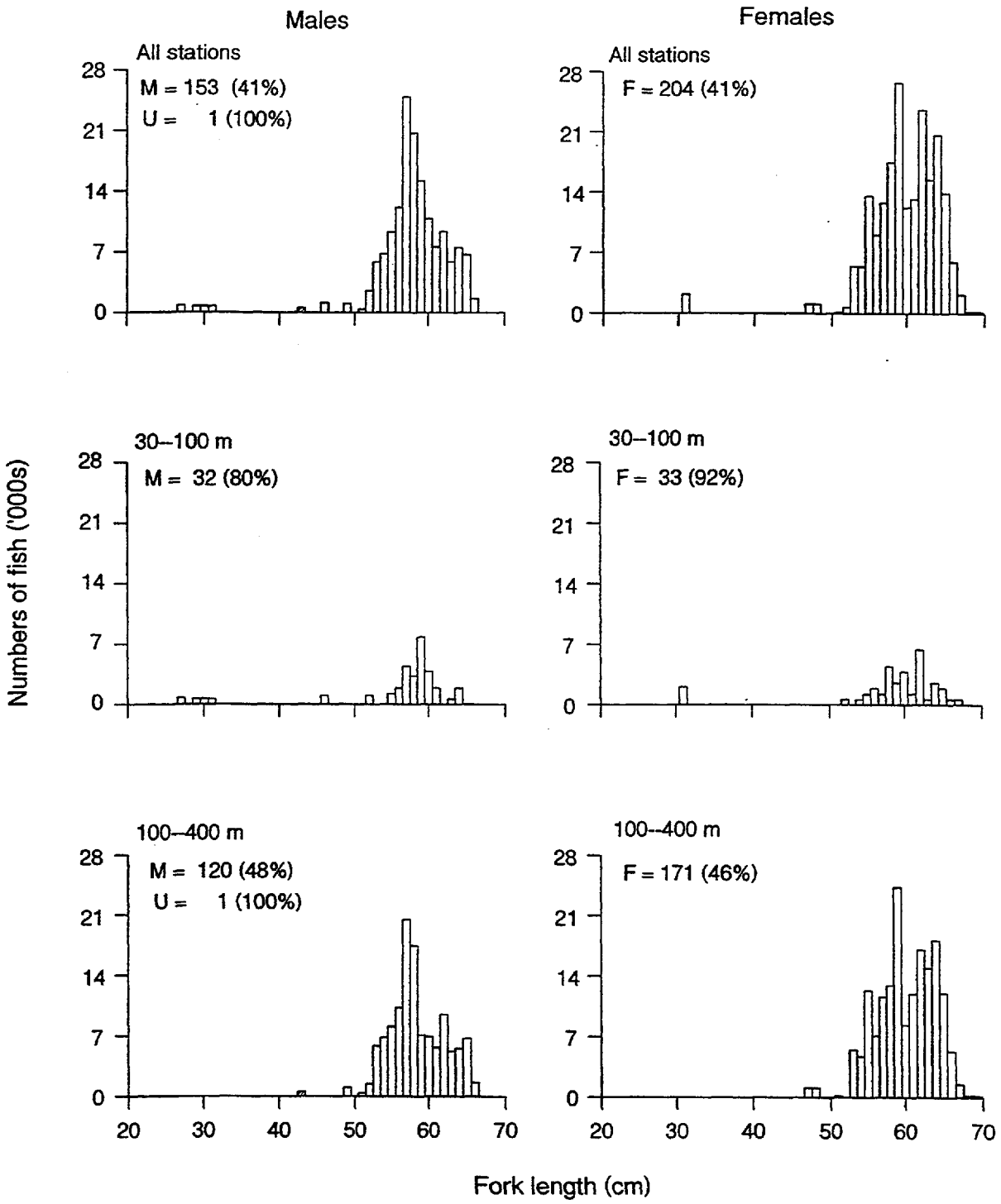


Figure 4—*continued*: Blue warehou

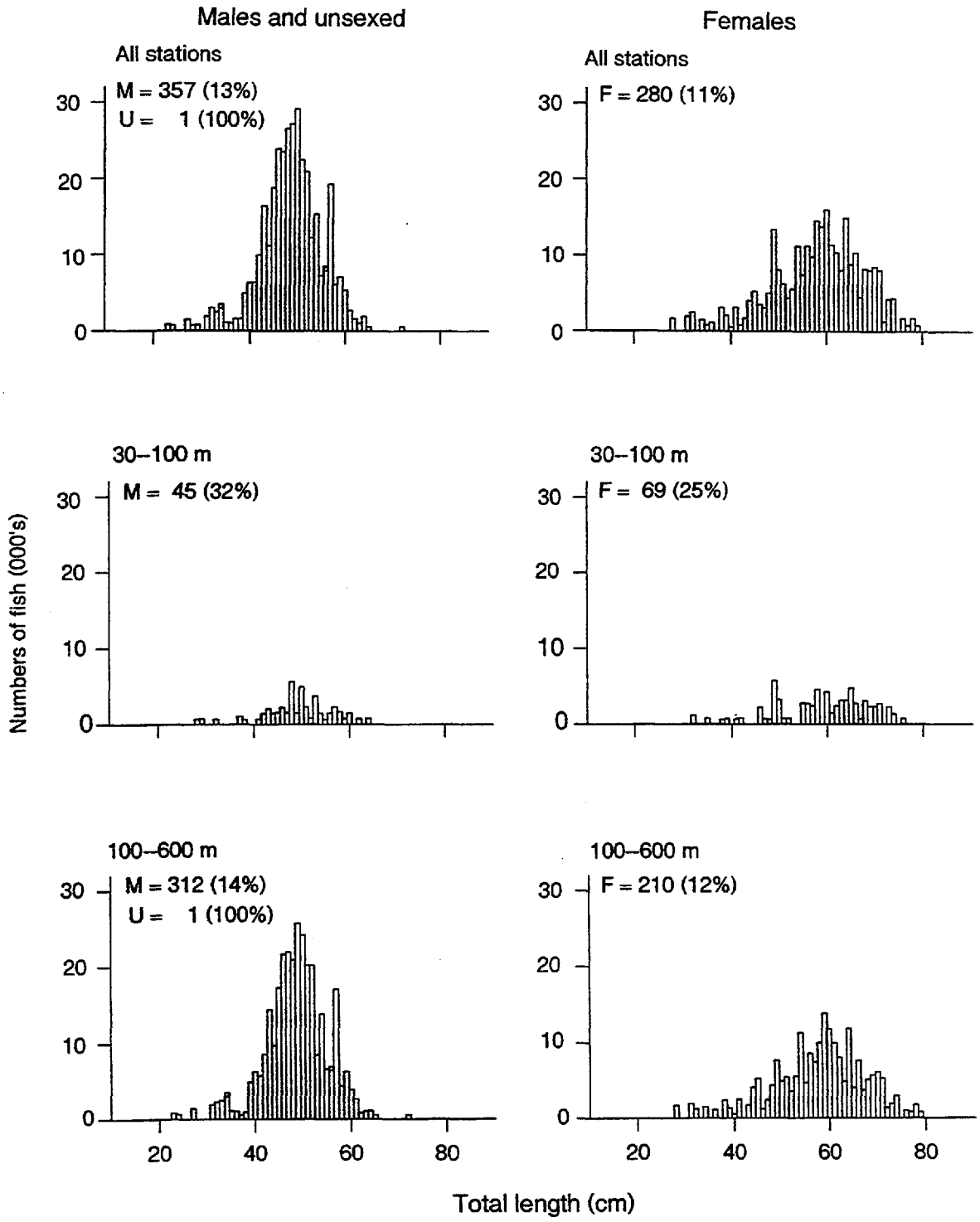


Figure 4—*continued*: Giant stargazer

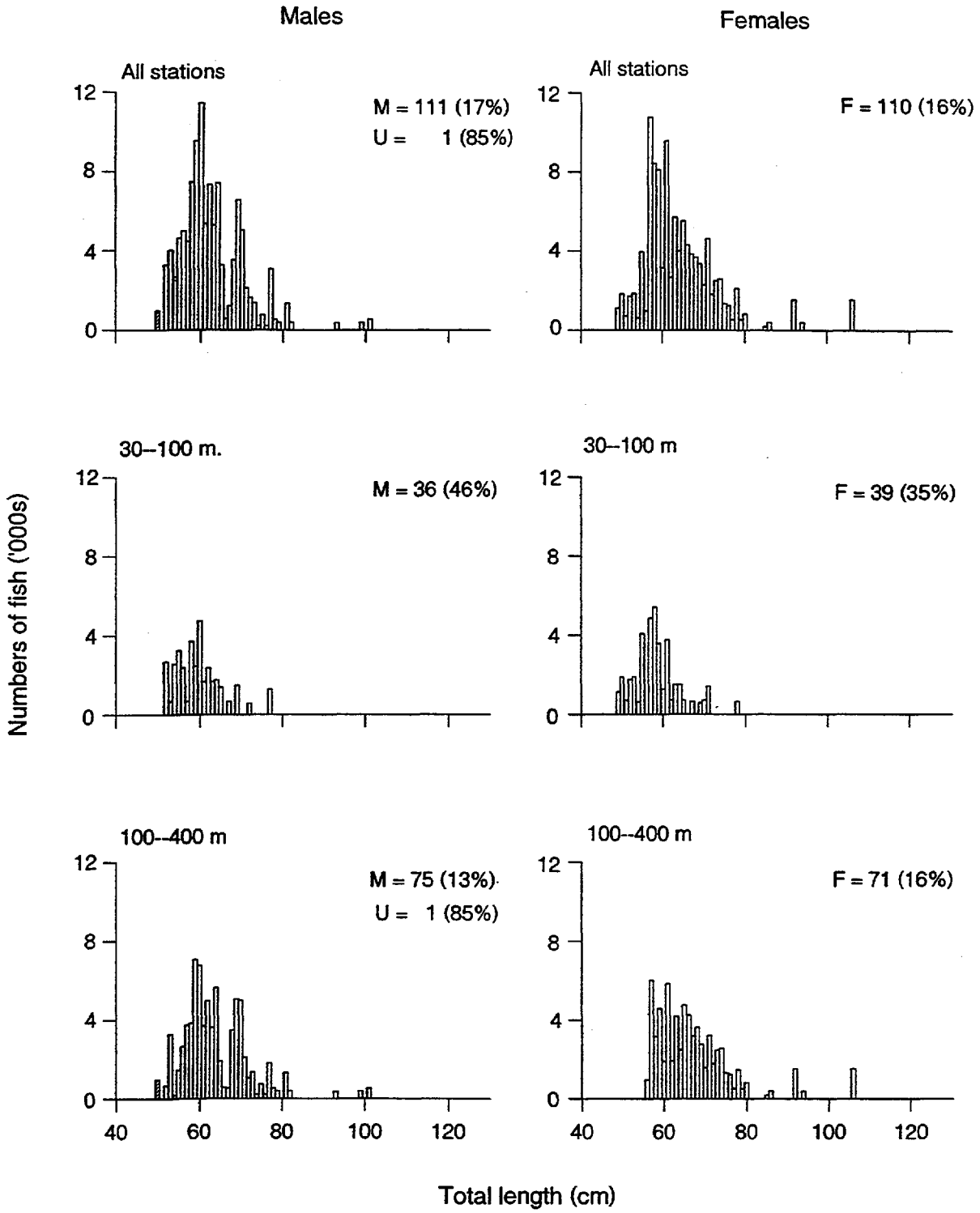


Figure 4—*continued*: Hapuku

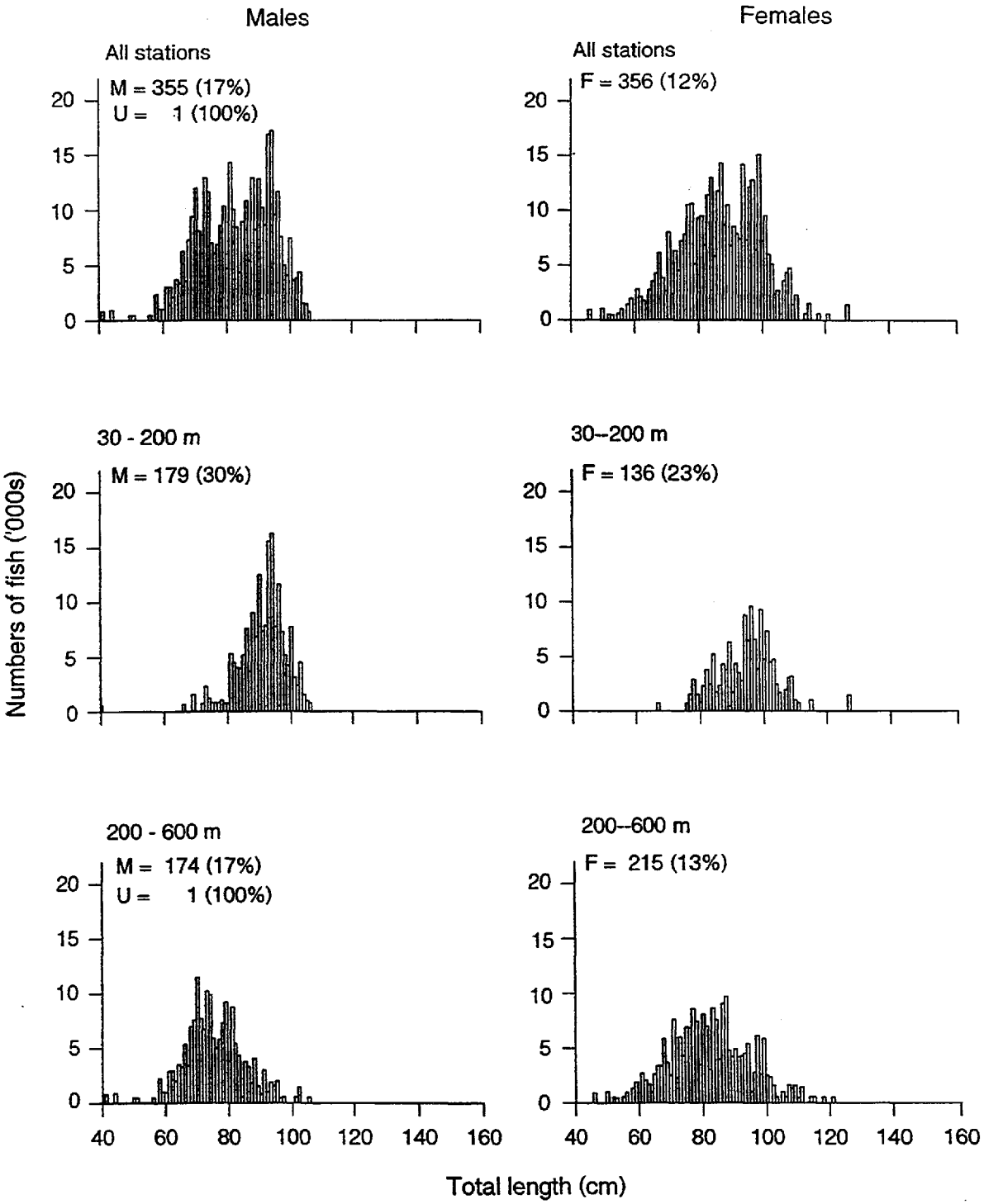


Figure 4—*continued*: Ling

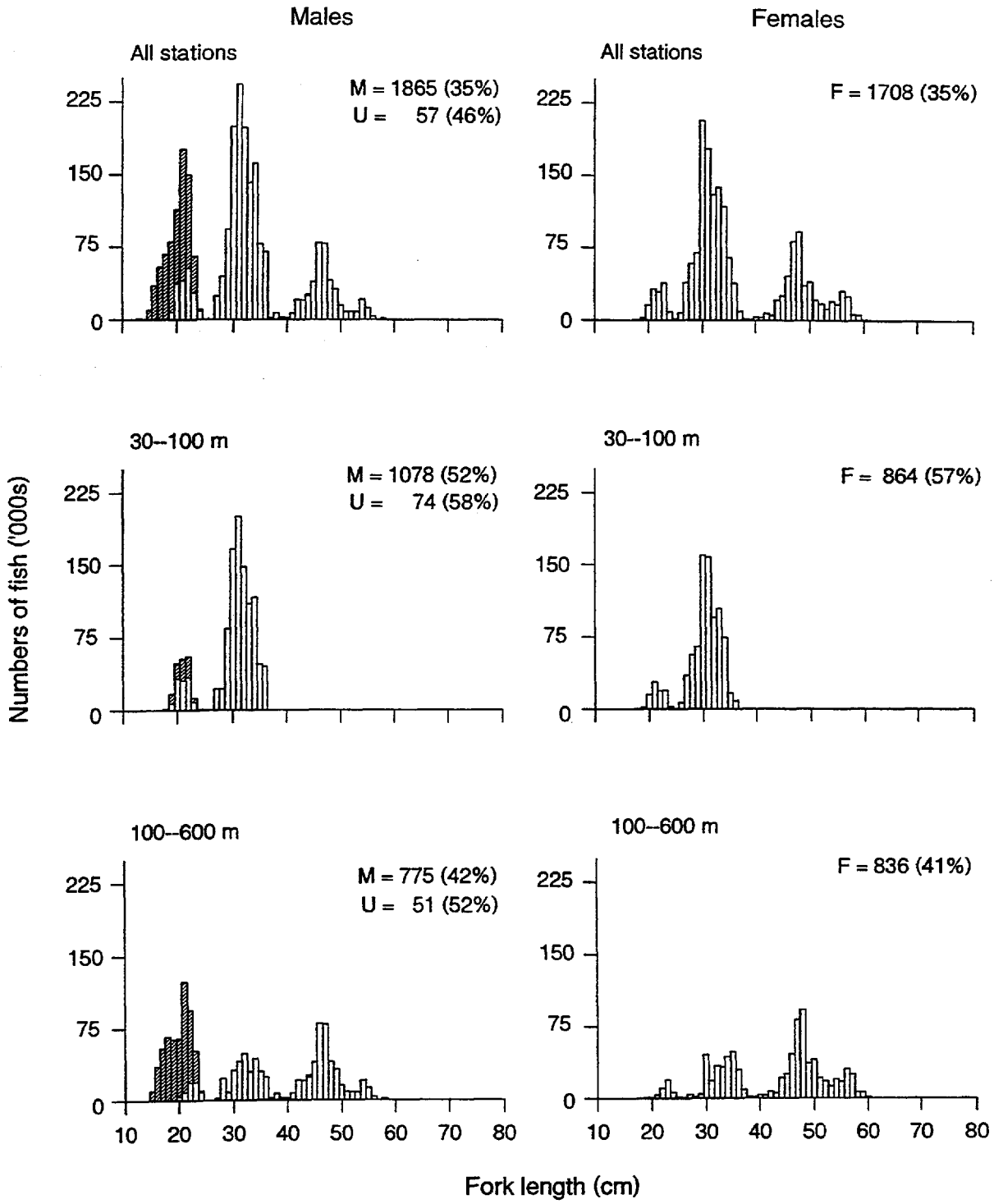


Figure 4—*continued*: Silver warehou

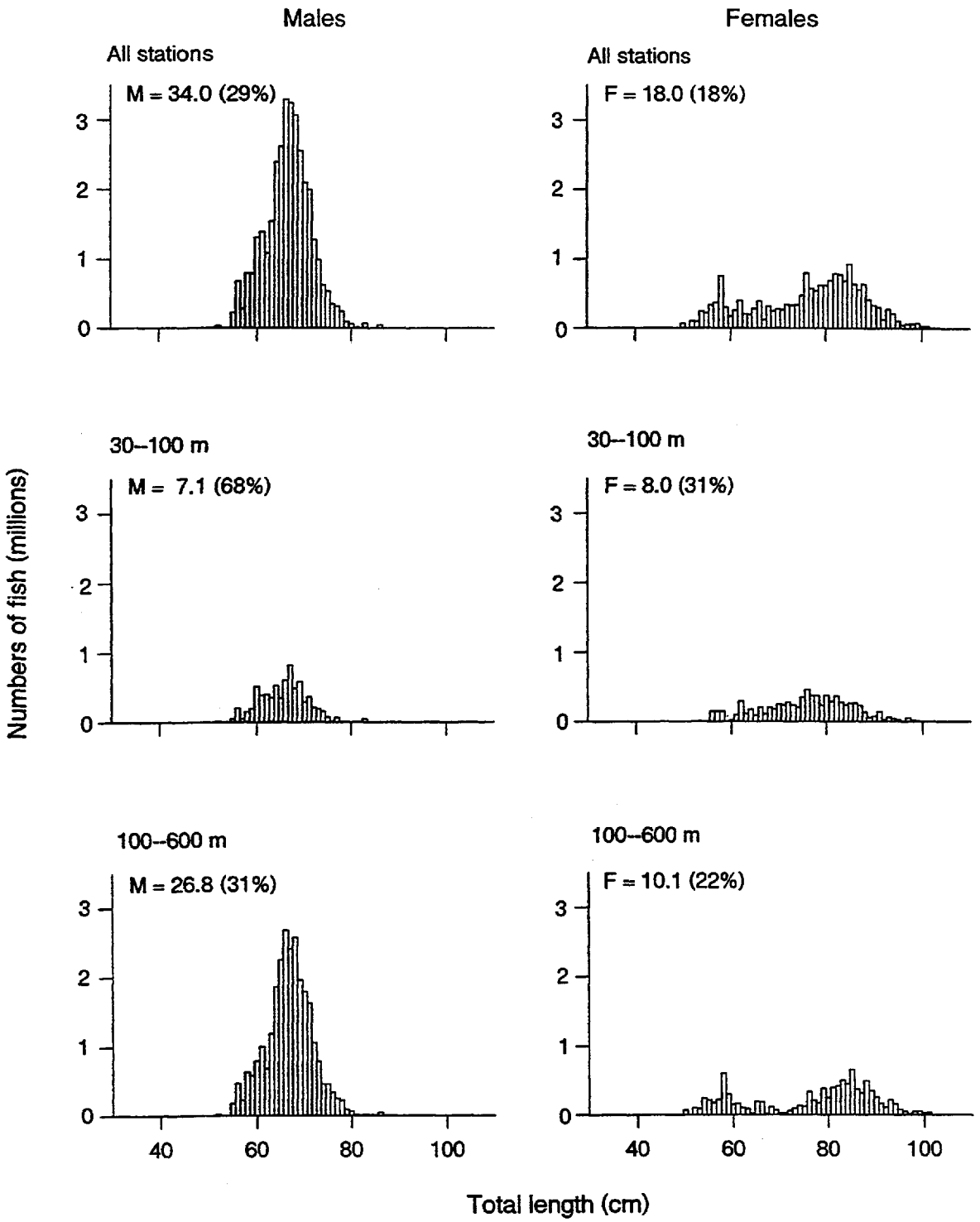


Figure 4—*continued*: Southern spiny dogfish

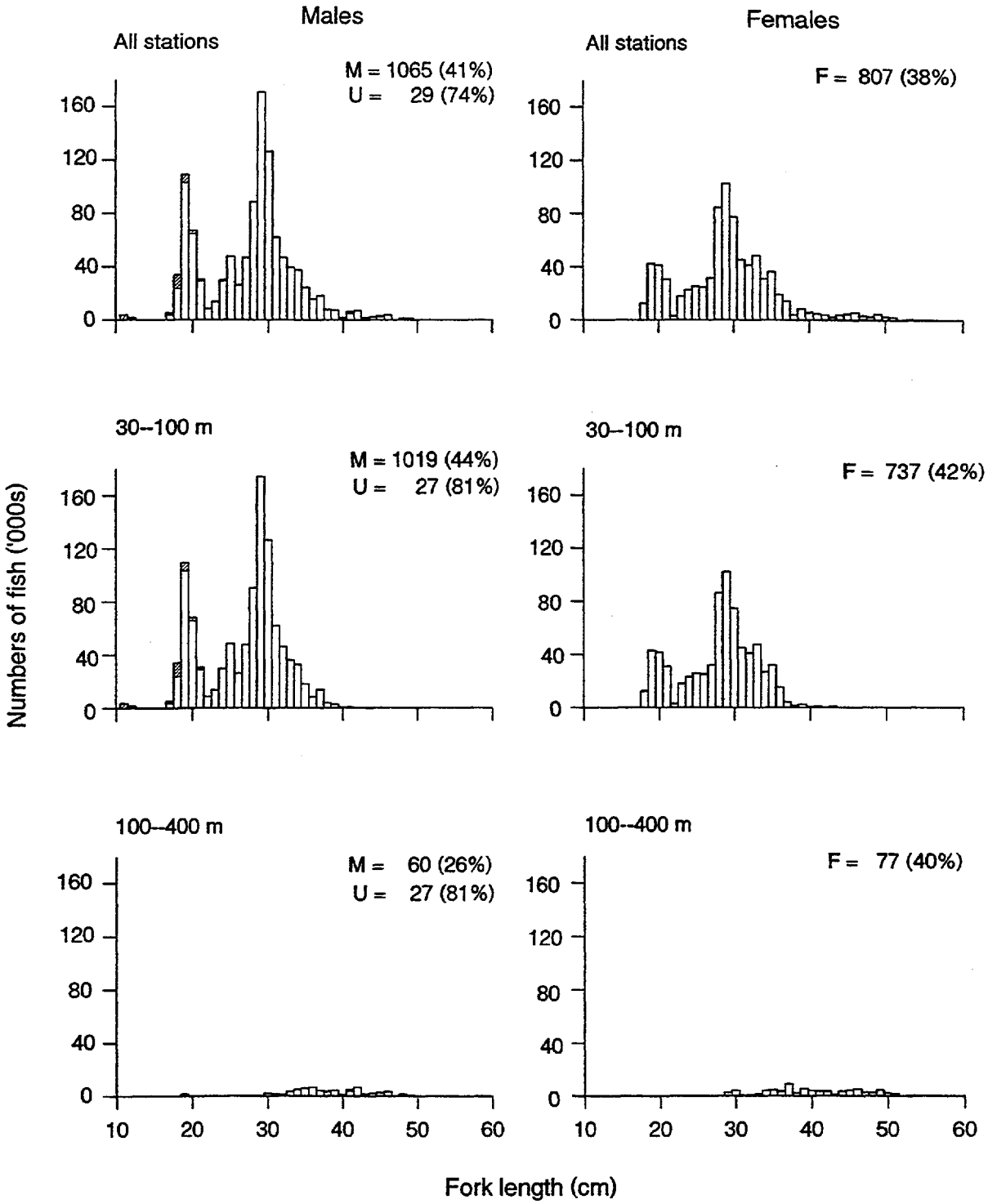


Figure 4—*continued*: Tarakihi

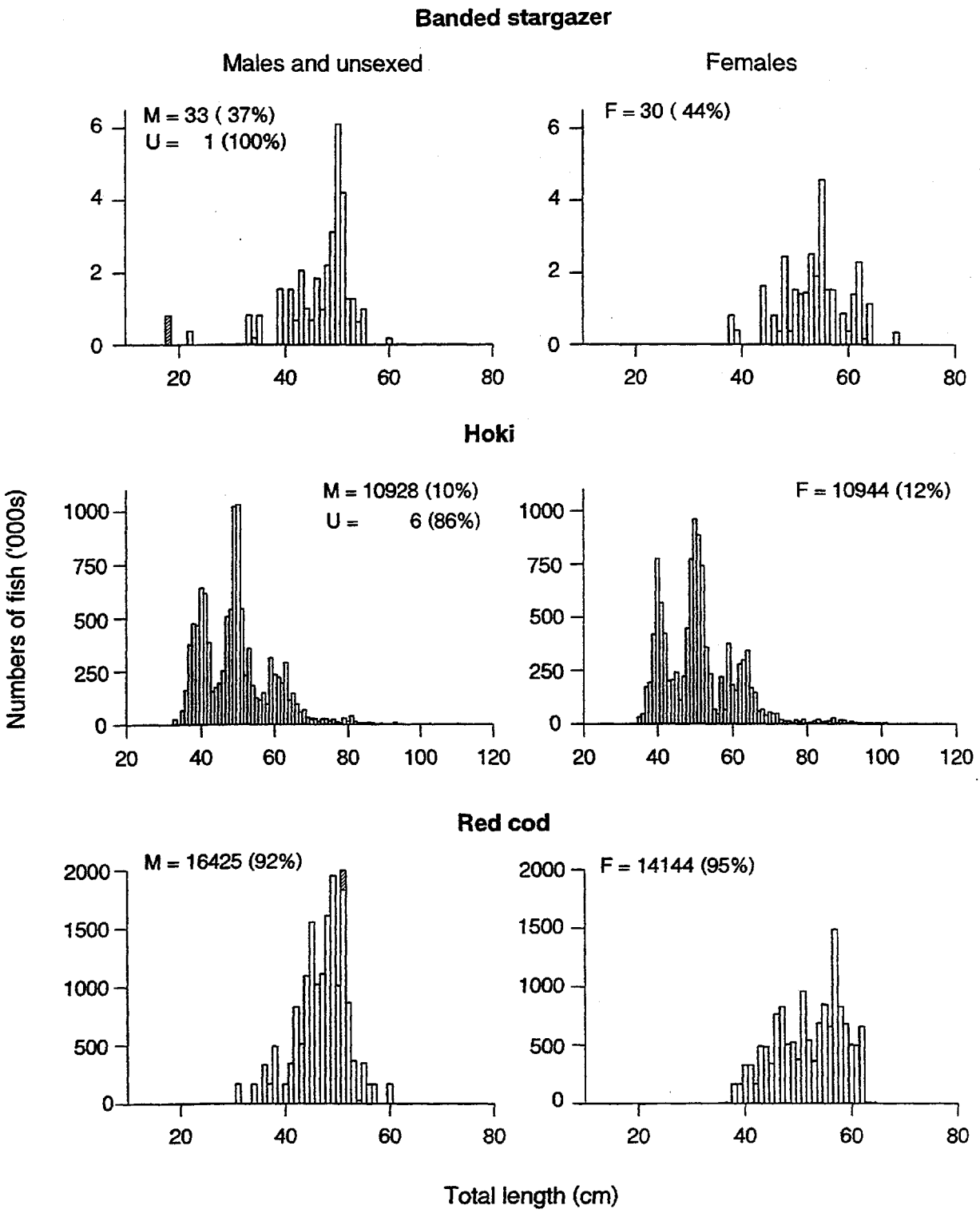


Figure 4—*continued*: Other species

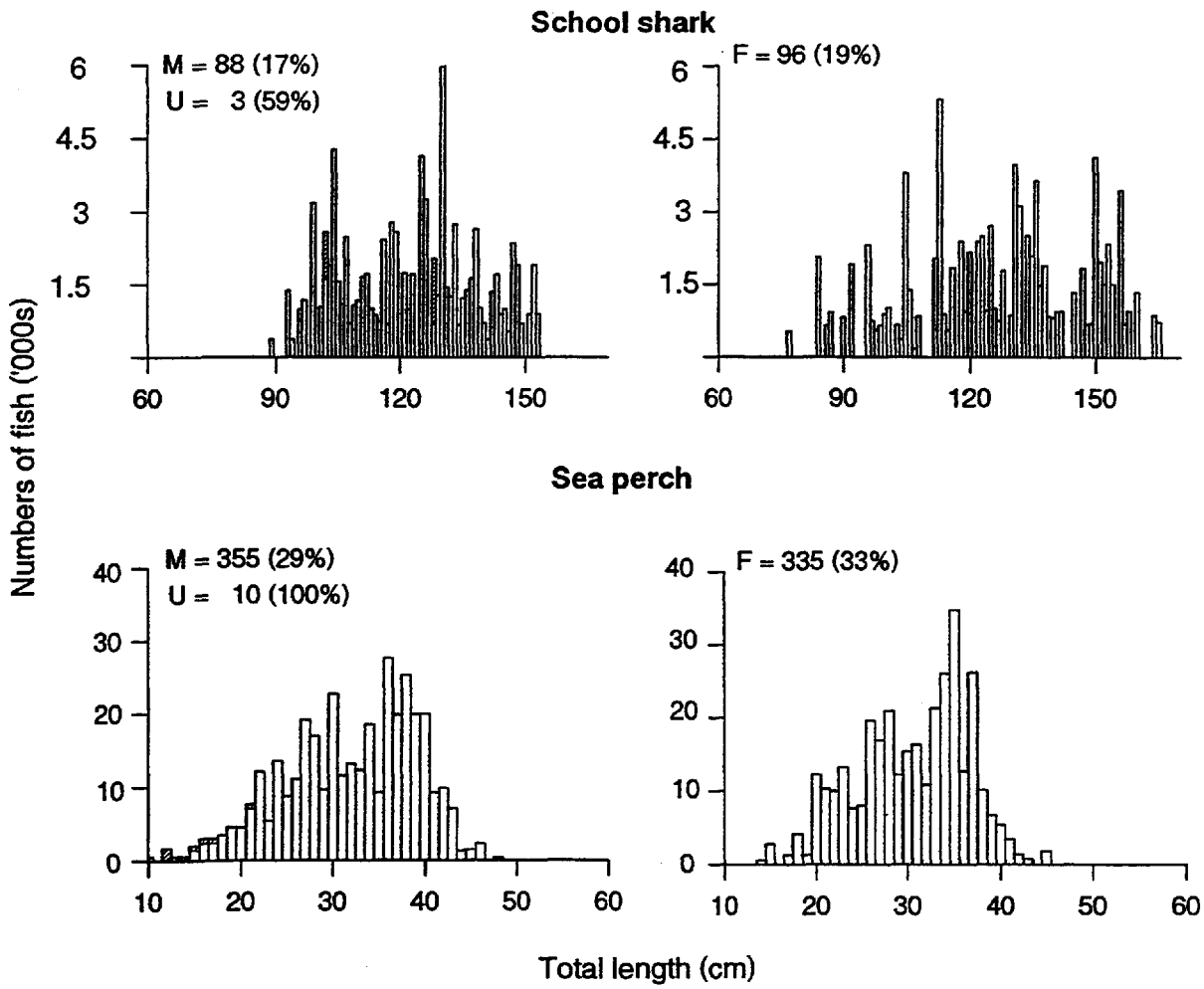


Figure 4—*continued*: Other species

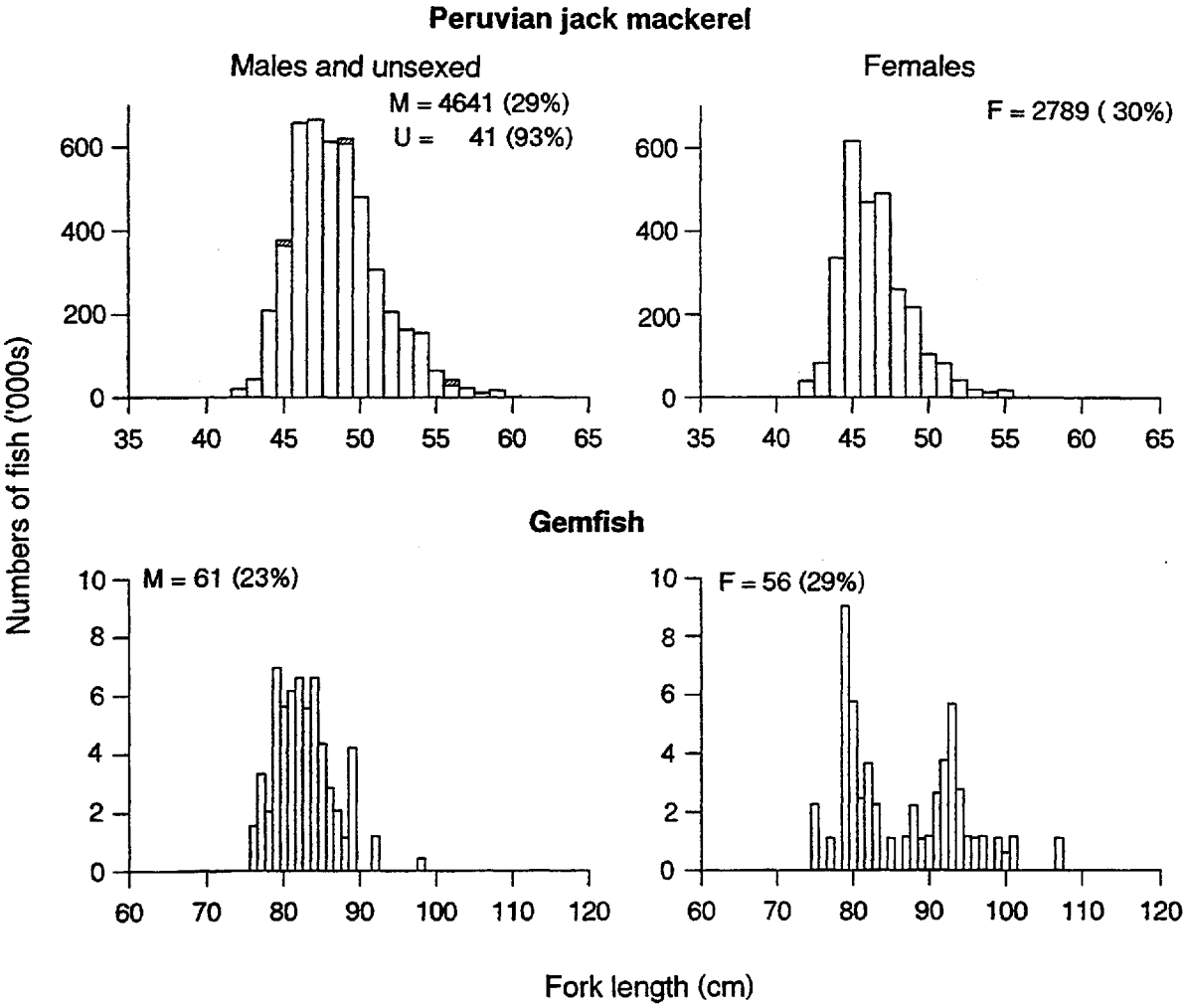


Figure 4—*continued*: Other species

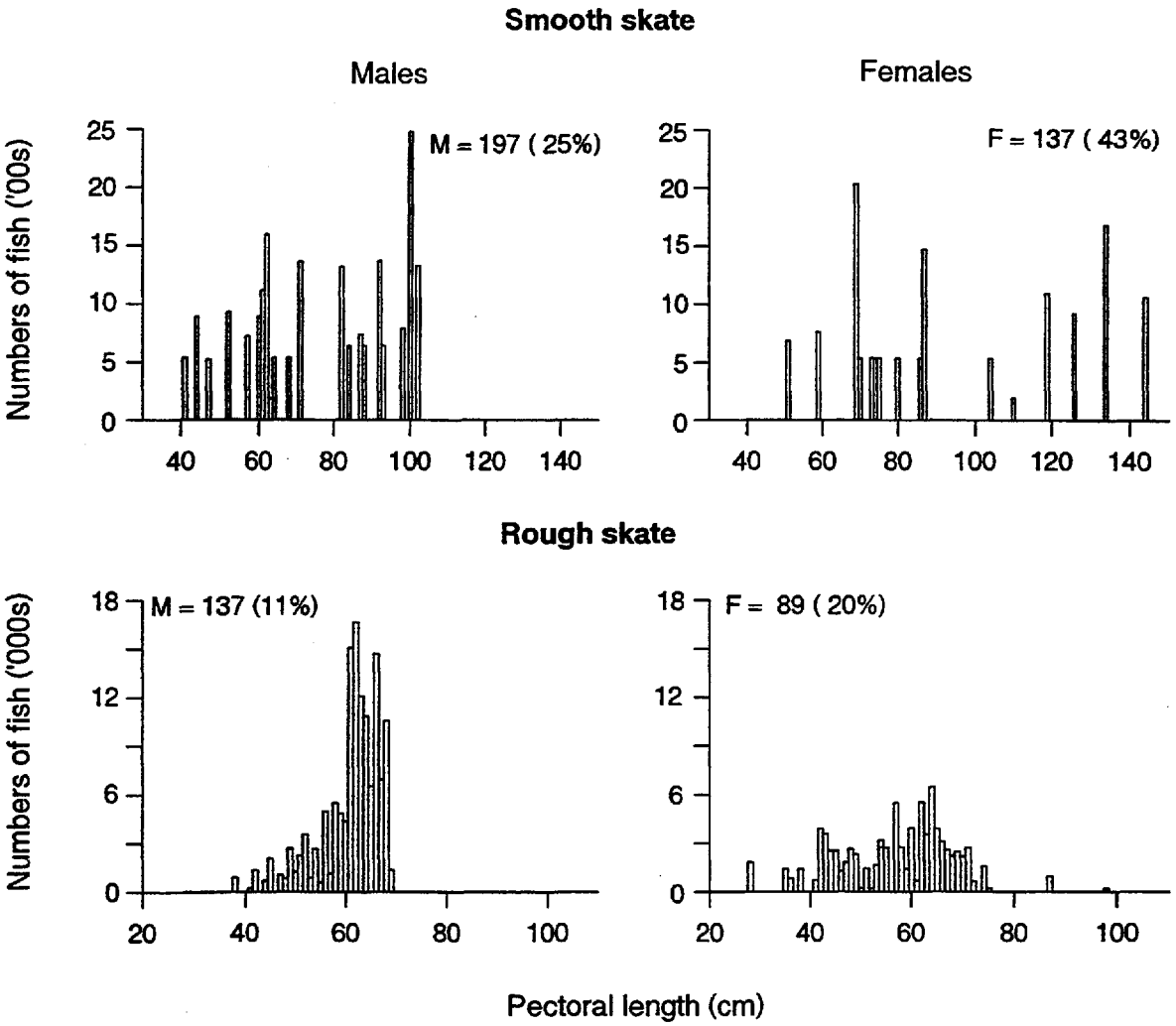


Figure 4—*continued*: Other species

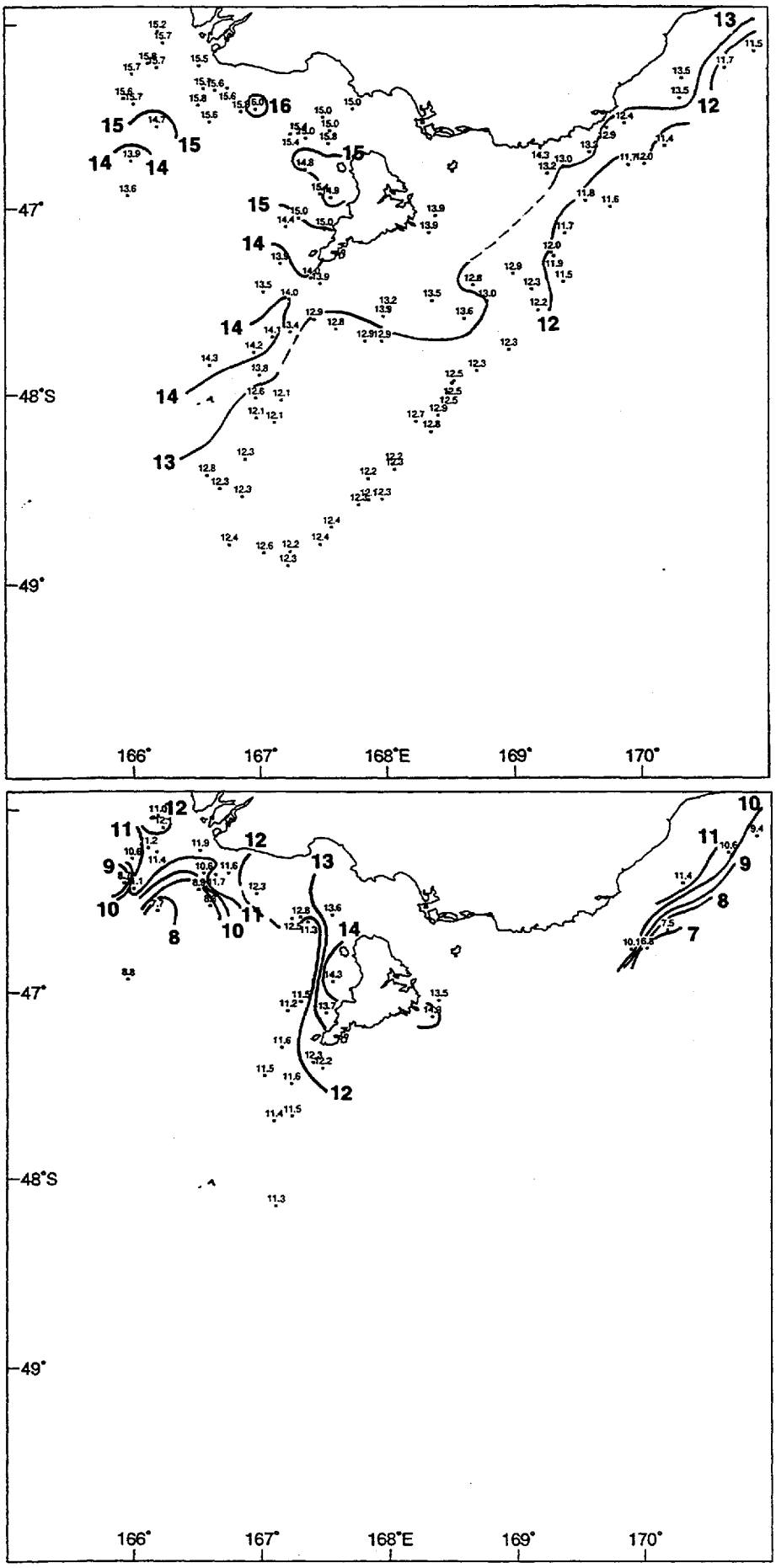


Figure 5: Surface (above) and bottom (below) water temperatures.

Appendix 1: Individual station data: phase 1, stations 1–113; phase 2, 114–134

Station	Stratum	Date	Time	Start of tow Latitude ° 'S	Start of tow Longitude ° 'E	Start of tow Depth (m)	Tow distance (n. mile)	Doo spread (m
1	13	25-Feb-96	0638	46 08.39	170 53.26	226	3.00	110.6
2	4B	25-Feb-96	0840	46 13.91	170 39.82	132	2.98	97.3
3	4A	25-Feb-96	1121	46 24.09	170 18.27	105	2.99	97.3
4	17	25-Feb-96	1357	46 39.78	170 11.17	454	3.01	116.0
5	17	25-Feb-96	1556	46 45.78	170 01.61	489	3.01	116.0
6	4B	25-Feb-96	1736	46 45.98	169 53.93	112	3.07	97.3
7	3	26-Feb-96	0626	46 27.50	167 43.48	39	3.03	77.9
8	3	26-Feb-96	0822	46 30.25	167 29.36	67	3.04	87.4
9	11	26-Feb-96	1025	46 37.00	167 21.26	118	3.01	97.3
10	3	26-Feb-96	1243	46 38.75	167 31.92	70	3.00	87.4
11	11	26-Feb-96	1454	46 47.29	167 20.97	138	3.03	97.3
12	11	26-Feb-96	1736	46 55.25	167 27.95	108	3.03	97.3
F 13	20	27-Feb-96	0648	46 55.80	165 56.78	438	2.26	116.0
14	12	27-Feb-96	0906	46 44.44	165 58.44	173	3.00	105.7
15	20	27-Feb-96	1122	46 33.25	166 10.23	545	3.01	115.7
16	12	27-Feb-96	1416	46 25.88	165 59.50	139	3.03	97.3
17	20	27-Feb-96	1631	46 24.06	165 54.76	520	2.99	115.7
18	16	27-Feb-96	1900	46 16.08	165 58.53	200	2.00	110.6
F 19	12	28-Feb-96	0634	46 02.06	166 10.51	124	2.81	97.3
20	12	28-Feb-96	1202	46 13.98	166 10.03	147	3.01	97.3
21	12	28-Feb-96	1338	46 12.53	166 06.10	144	3.01	97.3
22	12	28-Feb-96	1523	46 05.82	166 12.99	109	2.66	97.3
23	11	28-Feb-96	1806	46 13.31	166 30.32	131	2.01	97.3
24	11	29-Feb-96	0619	46 20.79	166 43.84	129	2.17	97.3
25	16	29-Feb-96	0752	46 21.37	166 37.95	211	3.00	110.6
26	16	29-Feb-96	0933	46 20.82	166 32.19	351	3.01	113.4
27	20	29-Feb-96	1153	46 26.23	166 29.82	448	3.00	116.0
28	20	29-Feb-96	1346	46 31.61	166 35.22	482	3.00	116.0
29	16	29-Feb-96	1642	46 28.29	166 50.39	198	2.87	110.6
30	11	29-Feb-96	1808	46 27.54	166 57.13	144	2.99	97.3
F 31	11	1-Mar-96	0616	46 35.88	167 14.14	136	1.38	97.3
32	11	1-Mar-96	0715	46 35.38	167 17.77	120	2.01	97.3
33	3	1-Mar-96	0954	46 34.57	167 32.66	61	3.00	87.4
34	2	1-Mar-96	1648	47 02.46	168 23.15	77	3.05	91.5
35	2	1-Mar-96	1822	47 07.89	168 20.19	90	2.99	91.5
36	3	2-Mar-96	0634	46 56.47	167 32.94	83	2.97	91.5
37	3	2-Mar-96	0836	47 06.69	167 30.11	79	3.00	91.5
38	11	2-Mar-96	1038	47 02.94	167 18.00	133	3.00	97.3
39	11	2-Mar-96	1214	47 05.89	167 11.82	147	3.00	97.3
40	10A	2-Mar-96	1645	47 22.62	167 23.82	151	3.02	97.3
41	10A	2-Mar-96	1817	47 24.54	167 28.12	142	2.95	97.3
42	10A	3-Mar-96	0645	47 17.83	167 09.04	151	2.69	97.3
43	10A	3-Mar-96	0832	47 27.08	167 01.09	159	2.95	105.7
44	10A	3-Mar-96	1036	47 29.56	167 13.53	149	3.00	97.3
45	10A	3-Mar-96	1245	47 36.00	167 25.20	142	2.12	97.3
46	10A	3-Mar-96	1449	47 40.07	167 13.86	142	2.23	97.3
47	10B	3-Mar-96	1634	47 41.60	167 05.31	141	2.95	97.3

Station	Stratum	Date	Time	Start of tow Latitude ° ‘S	Longitude ° ‘E	Depth (m)	Tow distance (n. mile)	Door spread (m)
48	10B	3-Mar-96	1849	47 46.55	166 56.67	154	1.98	105.7
49	9	4-Mar-96	0629	48 08.80	167 06.48	142	2.99	97.3
50	9	4-Mar-96	0802	48 07.43	166 57.70	144	3.00	97.3
51	9	4-Mar-96	0954	48 01.71	167 09.88	144	3.00	97.3
52	9	4-Mar-96	1143	48 01.11	166 57.31	143	3.00	97.3
53	10B	4-Mar-96	1323	47 53.77	166 59.18	144	3.00	97.3
54	10B	4-Mar-96	1621	47 50.62	166 35.40	167	3.05	105.7
55	9	5-Mar-96	0631	48 20.49	166 52.66	145	3.00	97.3
56	9	5-Mar-96	0842	48 25.56	166 34.41	141	3.02	97.3
57	8A	5-Mar-96	1006	48 29.77	166 40.54	136	3.00	97.3
58	8A	5-Mar-96	1134	48 32.31	166 51.27	134	2.99	97.3
59	8B	5-Mar-96	1431	48 47.63	166 44.90	158	3.12	105.7
60	8B	5-Mar-96	1717	48 50.13	167 01.65	174	2.94	105.7
61	18	6-Mar-96	0630	48 54.16	167 13.06	454	3.00	115.4
62	8B	6-Mar-96	0832	48 49.69	167 14.12	182	3.00	105.7
63	18	6-Mar-96	1027	48 47.46	167 28.14	400	2.99	113.4
F 64	8A	6-Mar-96	1214	48 42.03	167 33.62	129	2.99	97.3
65	18	6-Mar-96	1619	48 33.10	167 57.83	555	2.90	115.7
F 66	8A	6-Mar-96	1801	48 34.88	167 46.53	131	0.60	97.3
67	8A	7-Mar-96	0623	48 33.43	167 51.36	137	2.09	97.3
68	7	7-Mar-96	0812	48 26.65	167 51.02	130	2.08	97.3
69	7	7-Mar-96	1011	48 21.88	168 03.26	135	2.00	97.3
70	7	7-Mar-96	1126	48 23.68	168 03.85	140	2.97	97.3
71	7	7-Mar-96	1439	48 08.59	168 13.89	134	2.10	97.3
72	7	7-Mar-96	1615	48 11.85	168 21.01	138	2.76	97.3
73	7	7-Mar-96	1824	48 06.71	168 24.26	135	2.66	97.3
74	6B	8-Mar-96	0626	47 59.45	168 28.95	134	3.01	97.3
75	6B	8-Mar-96	0747	47 56.56	168 30.70	133	3.00	97.3
76	6B	8-Mar-96	0919	47 55.76	168 31.41	133	3.00	97.3
77	6B	8-Mar-96	1102	47 52.58	168 42.05	136	3.00	97.3
78	18	8-Mar-96	1331	47 45.86	168 57.17	553	3.01	115.7
79	18	8-Mar-96	1556	47 33.13	169 11.27	542	2.99	115.7
80	13	8-Mar-96	1830	47 26.50	169 08.37	237	2.08	110.6
81	6A	9-Mar-96	0624	47 39.05	167 35.46	110	2.00	97.3
82	6A	9-Mar-96	0810	47 42.92	167 49.60	136	3.00	97.3
83	6A	9-Mar-96	0932	47 43.07	167 57.66	135	2.99	97.3
84	6A	9-Mar-96	1205	47 35.04	167 58.20	141	3.00	97.3
85	6A	9-Mar-96	1343	47 32.20	168 00.50	113	3.00	97.3
86	6A	9-Mar-96	1536	47 30.13	168 21.45	118	3.00	97.3
87	6A	9-Mar-96	1736	47 35.80	168 36.30	126	3.02	97.3
88	6A	10-Mar-96	0632	47 25.21	168 40.25	120	2.99	97.3
89	6B	10-Mar-96	0812	47 30.20	168 46.81	121	3.03	97.3
90	5B	10-Mar-96	1031	47 21.38	168 59.21	117	3.00	97.3
91	13	10-Mar-96	1334	47 15.88	169 18.89	333	3.00	113.4
F 92	17	10-Mar-96	1550	47 24.20	169 23.40	481	2.99	116.0
93	5B	10-Mar-96	1833	47 14.64	169 17.75	122	2.07	97.3
94	1	11-Mar-96	0623	46 17.57	170 19.16	68	2.99	87.4

Station	Stratum	Date	Start of tow Time	Latitude ° 'S	Longitude ° 'E	Depth (m)	Tow distance (n. mile)	Door spread (m)
95	1	11-Mar-96	0901	46 02.18	170 38.20	56	3.00	87.4
96	1	11-Mar-96	1058	46 00.22	170 42.77	68	3.00	87.4
97	4A	12-Mar-96	0628	46 32.43	169 52.11	100	2.99	97.3
98	1	12-Mar-96	0804	46 33.89	169 43.71	79	3.00	96.1
99	4B	12-Mar-96	1035	46 45.41	169 38.13	112	3.00	98.3
100	5B	12-Mar-96	1253	46 57.74	169 33.80	119	3.01	97.8
101	17	12-Mar-96	1518	46 59.72	169 45.31	568	3.00	121.0
102	5B	12-Mar-96	1806	47 08.35	169 24.17	125	3.00	100.7
103	4A	13-Mar-96	0654	46 41.90	169 35.36	104	2.99	99.3
104	1	13-Mar-96	0843	46 46.52	169 23.36	87	2.01	90.5
105	1	13-Mar-96	1002	46 48.75	169 15.81	84	2.67	92.0
106	1	13-Mar-96	1231	46 40.49	169 12.43	35	3.00	71.4
107	1	20-Mar-96	1744	45 59.36	170 34.27	54	3.04	78.9
108	2	21-Mar-96	0641	46 42.16	169 09.57	46	2.05	78.3
109	2	21-Mar-96	0853	46 50.82	168 48.38	70	3.03	91.7
110	5A	21-Mar-96	1111	47 05.57	168 51.08	107	2.96	87.5
111	5A	21-Mar-96	1346	47 18.68	168 33.88	112	3.00	88.0
112	5A	21-Mar-96	1610	47 19.78	168 14.59	105	3.03	97.7
113	5A	21-Mar-96	1808	47 22.06	168 20.50	108	2.17	93.0
114	6B	22-Mar-96	0647	47 50.96	168 36.12	132	3.03	99.1
115	6B	22-Mar-96	0827	47 47.39	168 41.49	130	3.00	98.2
116	6B	22-Mar-96	0948	47 44.43	168 37.47	130	3.01	97.8
117	6B	22-Mar-96	1136	47 43.93	168 43.95	133	2.99	97.6
118	6B	22-Mar-96	1334	47 36.26	168 47.20	127	3.00	94.0
119	6B	22-Mar-96	1520	47 34.61	168 53.96	129	3.00	89.0
120	6B	22-Mar-96	1655	47 27.68	168 55.36	124	2.99	100.0
121	9	23-Mar-96	0647	48 14.45	166 59.38	146	3.00	103.2
122	9	23-Mar-96	0853	48 02.01	166 50.81	138	3.01	106.3
123	10B	23-Mar-96	1121	47 47.02	166 46.19	165	3.00	111.2
124	10B	23-Mar-96	1350	47 42.74	166 56.26	159	3.01	119.0
125	10A	23-Mar-96	1650	47 34.82	167 16.08	144	2.99	105.9
126	5A	24-Mar-96	0646	47 17.20	168 49.02	116	3.04	96.7
127	5A	24-Mar-96	0834	47 10.85	168 48.16	111	3.00	95.8
F128	2	24-Mar-96	1053	46 59.86	168 40.54	87	1.15	93.0
129	2	24-Mar-96	1158	46 58.40	168 38.93	79	2.00	95.0
130	2	24-Mar-96	1330	46 58.36	168 52.80	84	2.00	89.0
131	4A	24-Mar-96	1623	46 49.72	169 26.06	109	2.04	95.4
F132	6B	25-Mar-96	0644	47 47.82	168 33.99	132	2.66	104.5
133	6B	25-Mar-96	1400	47 39.80	168 41.36	129	3.00	94.7
134	6B	25-Mar-96	1700	47 30.01	168 59.53	126	3.04	102.0

F Foul trawl shot.

Appendix 2: Total catch, number of stations at which caught (Occ.), species code, and depth range of all species caught.

Species code	Common name	Scientific name	Catch (kg)	Occ.	Depth (m) Min.	Max.
ACO	Tam O'Shanter urchin	*Araeosoma coriaceum*	1.1	1	401	442
ANT	anemones	Anthozoa	12.3	22	100	585
API	alert pigfish	*Alertichthys blacki*	0.4	1	135	138
AST	snaggletooths	Atronesthidae	0.9	2	119	125
ATC	antlered crab	*Paramola petterdi*	0.3	1	401	442
BAR	barracouta	*Thyrsites atun*	10 013.7	90	29	539
BBE	banded bellowsfish	*Centriscopus humerosus*	9.4	5	112	512
BCO	blue cod	*Parapercis colias*	496.8	36	47	150
BER	numbfish	*Typhlonarke* spp.	1.9	2	100	115
BGZ	banded giant stargazer	*Kathetostoma* spp.	398.3	28	109	442
BPE	butterfly perch	*Caesioperca lepidoptera*	66.3	3	110	138
BSH	seal shark	*Scymnorhinus licha*	21.7	2	482	585
BTS		*Pavoraja spinifera*	2.2	1	169	173
CAR	carpet shark	*Cephaloscyllium isabella*	888.1	53	47	182
CAS	oblique banded rattail	*Caelorinchus aspercephalus*	172.2	23	105	585
CBE	crested bellowsfish	*Notopogon lilliei*	501.3	6	57	138
CBO	Bollons's rattail	*Caelorinchus bollonsi*	319.7	13	112	585
CCX	small banded rattail	*C. parvifasciatus*	2.4	1	448	452
CFA	banded rattail	*C. fasciatus*	34.5	6	400	574
CID	cidarid urchin	Cidaridae	0.2	2	137	150
COL	Oliver's rattail	*Caelorinchus oliverianus*	56.2	9	448	585
COR	red coral	Stylasterina (Order)	10.9	2	65	139
COU	coral (unspecified)		71.8	2	57	138
CRB	crab		103.2	44	65	568
CSQ	leafscaled gulper shark	*Centrophorus squamosus*	97.2	2	482	585
DCO	dwarf cod	*Austrophycis marginata*	0.3	2	133	555
DCS	Dawsons catshark	*Halaelurus dawsoni*	5.6	2	47	87
DEA	dealfish	*Trachipterus trachypterus*	14.1	1	448	452
ECH	echinoid (sea urchin)	Echinoidea	1.3	3	54	68
ELE	elephantfish	*Callorhynchus milii*	168.4	10	37	87
EPR	cardinalfish	*Epigonus robustus*	1.4	3	401	585
ESO	N.Z. sole	*Peltorhamphus novaezeelandiae*	0.9	1	29	35
ETB	Baxter's dogfish	*Etmopterus baxteri*	209.3	5	400	574
ETL	Lucifer dogfish	*E. lucifer*	5.9	7	432	585
FHD	deepsea flathead	*Hoplichthys haswelli*	0.4	1	178	182
FRO	frostfish	*Lepidopus caudatus*	5.4	2	344	442
GFL	greenback flounder	*Rhombosolea tapirina*	27.7	3	47	68
GON	sand eel	*Gonorynchus gonorynchus*	0.9	1	37	46
GPF	girdled wrasse	*Notolabrus cinctus*	5.2	6	110	158
GSC	giant spider crab	*Jacquinotia edwardsii*	1 295.4	25	79	565
GSH	dark ghost shark	*Hydrolagus novaezealandiae*	3 203.3	10	105	565
GSP	pale ghost shark	*Hydrolagus* sp.	242.9	10	400	574
GUR	red gurnard	*Chelidonichthys kumu*	293.2	21	29	115
HAG	hagfish	*Eptatretus cirrhatus*	1.4	1	149	150
HAK	hake	*Merluccius australis*	437.6	12	400	585
HAP	hapuku	*Polyprion oxygeneios*	1 208.2	79	54	351
HCO	hairy conger	*Bassanago hirsutus*	66.7	5	448	568
HOK	hoki	*Macruronus novaezelandiae*	12 806.4	18	112	585
HOR	horse mussel	*Atrina zelandica*	0.7	1	119	120
JAV	javelinfish	*Lepidorhynchus denticulatus*	298.2	16	79	585
JDO	John dory	*Zeus faber*	2.2	1	58	63
JFI	jellyfish		22.9	7	54	141

Species code	Common name	Scientific name	Catch (kg)	Occ.	Depth (m) Min.	Max.
JMD	jack mackerel	*Trachurus declivis*	357.4	30	40	155
JMM	Peruvian jack mackerel	*T. murphyi*	10 317.9	73	37	565
LCH	longnosed chimaera	*Harriotta raleighana*	11.1	3	508	574
LDO	lookdown dory	*Cyttus traversi*	114.8	15	122	585
LEA	leatherjacket	*Parika scaber*	57.6	4	29	67
LIN	ling	*Genypterus blacodes*	3 423.3	76	40	585
LSO	lemon sole	*Pelotretis flavilatus*	41.6	16	29	135
MIQ	warty squid	*Moroteuthis ingens*	10.2	4	401	585
MOL	molluscs		1.1	5	65	573
NOS	arrow squid	*Nototodarus sloanii*	7 293.7	115	29	585
OCT	octopus	*Octopus maorum*	76.7	15	57	565
ONG	sponges	Porifera	516.3	47	65	573
OPA	opalfish	*Hemerocoetes* spp.	0.5	3	54	155
OPE	orange perch	*Lepidoperca aurantia*	13.1	5	110	285
OPH	ophiuroid (brittle star)		0.3	1	63	67
OPI	umbrella octopus	*Opisthoteuthis* sp.	1.1	3	54	68
OSQ		Octopoteuthiidae	13.0	1	47	54
PAD	paddle crab	*Ovalipes catharus*	3.5	7	133	144
PGD	prickly dogfish	*Oxynotus bruniensis*	18.6	3	400	573
PHO	lighthouse fish	*Photichthys argenteus*	0.1	1	448	452
PHY	phyllosoma		0.1	1	198	212
PIG	pigfish	*Congiopodus leucopaecilus*	10.2	15	57	158
PLI	starfish	*Peribolaster lictor*	1.9	6	109	573
PMU	heart urchin	*Paramaretia multituberculata*	0.4	2	400	565
QSC	queen scallop	*Chlamys delicatula*	0.8	4	37	135
RBM	Ray's bream	*Brama brama*	75.5	15	112	574
RBT	redbait	*Emmelichthys nitidus*	602.6	66	47	182
RCO	red cod	*Pseudophycis bachus*	14 074.6	31	37	539
RHY	common roughy	*Paratrachichthys trailli*	60.2	2	120	452
RIB	ribaldo	*Mora moro*	36.2	4	482	574
RSK	rough skate	*Raja nasuta*	1 464.4	84	47	477
RUD	rudderfish	*Centrolophus niger*	85.5	3	474	574
SAL	salps		138.1	18	81	477
SBK	spineback	*Notacanthus sexspinis*	17.6	5	223	574
SBO	southern boarfish	*Pseudopentaceros richardsoni*	3.4	1	130	132
SBR	southern bastard cod	*Pseudophycis barbata*	1.4	1	158	158
SBW	southern blue whiting	*Micromesistius australis*	1.2	2	474	512
SCC	sea cucumber	*Stichopus mollis*	19.3	23	57	222
SCG	scaly gurnard	*Lepidotrigla brachyoptera*	82.5	28	40	171
SCH	school shark	*Galeorhinus galeus*	2 441.7	66	37	351
SCO	swollenhead conger	*Bassanago bulbiceps*	6.3	1	482	539
SDO	silver dory	*Cyttus novaezealandiae*	963.0	49	57	442
SFI	starfish		11.4	35	54	574
SKI	gemfish	*Rexea solandri*	568.0	33	100	351
SND	shovelnosed spiny dogfish	*Deania calcea*	84.4	4	448	585
SPD	southern spiny dogfish	*Squalus acanthias*	106 360.3	109	37	574
SPE	sea perch	*Helicolenus* sp.	892.1	41	58	568
SPF	scarlet wrasse	*Pseudolabrus miles*	11.6	10	57	149
SPO	rig	*Mustelus lenticulatus*	81.9	9	37	170
SPP	splendid perch	*Callanthias allporti*	3.8	1	120	124
SRH	silver roughy	*Hoplostetus mediterraneus*	0.2	1	545	585
SSC	giant masking crab	*Leptomithrax australis*	1.3	1	165	170
SSH	slender smoothhound	*Gollum attenuatus*	7.1	2	129	285
SSI	silverside	*Argentina elongata*	20.9	32	63	565
SSK	smooth skate	*Raja innominata*	744.1	30	63	568
STA	giant stargazer	*Kathetostoma giganteum*	2 450.9	103	29	585

Species code	Common name	Scientific name	Catch (kg)	Occ.	Depth (m) Min.	Max.
SWA	silver warehou	*Seriolella punctata*	4287.8	66	47	565
TAR	tarakihi	*Nemadactylus macropterus*	1 293.9	42	37	351
THR	thresher shark	*Alopias vulpinus*	130.0	1	37	46
TOD	dark toadfish	*Neophrynichthys latus*	1.8	4	29	144
TOP	pale toadfish	*N. angustus*	13.0	3	474	568
TRU	trumpeter	*Latris lineata*	14.2	5	65	141
TUR	turbot	*Colistium nudipinnis*	3.1	1	63	67
WAR	common warehou	*Seriolella brama*	5 716.7	24	58	285
WIT	witch	*Arnoglossus scapha*	32.5	52	37	574
WLP	wavy line perch	*Lepidoperca* sp. B	0.1	1	200	285
WWA	white warehou	*Seriolella caerulea*	175.0	5	400	565
YCO	yellow cod	*Parapercis gilliesi*	0.6	2	136	285
ZFM	rubbish: fishing metals		5.0	1	211	222
ZFO	rubbish: fishing other		2.1	1	128	135

Appendix 3: Length-weight relationships used to scale length frequencies (derived from TAN9604 data unless indicated)*

Species code	Sex	*a*	*b*	*r*(%)	Number of fish	Length (cm) Min.	Max.
BAR	All	0.0060	2.94	98.0	1 075	10.8	94.1
	M	0.0080	2.87	98.0	537	31.3	84.4
	F	0.0067	2.91	97.5	533	34.0	94.1
BCO	All	0.0090	3.16	98.5	333	19.9	60.6
	M	0.0068	3.23	98.8	206	22.8	60.6
	F	0.0117	3.10	98.5	126	19.9	55.3
BGZ	All	0.0057	3.40	97.8	81	22.7	69.3
	M	0.0080	3.30	98.1	43	22.7	60.0
	F	0.0094	3.28	96.1	38	39.4	69.3
GSH	All	0.0025	3.24	96.0	189	31.3	73.2
GSP	All	0.0343	2.58	83.8	135	51.5	80.3
GUR	All	0.0065	3.11	95.1	310	33.3	55.0
	M	0.0260	2.73	91.8	138	33.3	50.1
	F	0.0080	3.06	94.4	172	36.3	55.0
HAK	All	0.0022	3.27	96.6	71	62.8	124.8
	M	0.0046	3.09	96.6	18	69.2	99.7
	F	0.0025	3.25	96.6	53	62.8	124.8
HAP	All	0.0054	3.22	96.3	233	49.8	106.1
	M	0.0055	3.22	95.7	117	52.1	99.1
	F	0.0053	3.22	96.7	114	49.8	106.1
JMM	All	0.0362	2.68	79.9	184	43.7	61.6
	M	0.0239	2.78	84.3	124	44.4	61.6
	F	0.0205	2.83	74.2	60	43.7	55.5
LIN	All	0.0017	3.24	96.2	597	41.0	127.7
	M	0.0017	3.24	95.5	310	50.6	105.3
	F	0.0015	3.25	96.5	286	52.9	127.7
NOS	All	0.0127	3.16	94.9	532	13.3	39.4
	M	0.0089	3.28	94.4	204	15.0	33.6
	F	0.0147	3.10	95.5	328	13.3	39.4
RCO	All	0.0156	2.85	94.0	335	15.7	65.4
	M	0.0339	2.64	86.8	196	31.0	60.1
	F	0.0166	2.85	90.7	133	36.1	65.4
RSK	All	0.0444	2.82	96.1	285	28.9	87.0
	M	0.0939	2.63	94.4	169	38.0	69.8
	F	0.0249	2.98	98.5	115	28.9	87.0
SCH	All	0.0039	3.05	95.9	240	74.1	165.0
	M	0.0061	2.95	95.0	119	89.0	153.0
	F	0.0030	3.11	96.8	118	74.1	165.0

Species code	Sex	*a*	*b*	*r*(%)	Number of fish	Length (cm) Min.	Max.
SKI	All	0.0003	3.72	86.6	106	75.1	107.8
	M	0.0007	3.55	71.6	58	76.3	98.1
	F	0.0001	3.94	91.9	48	75.1	107.8
SPD	All	0.0002	3.74	94.1	845	49.0	107.0
	M	0.0042	2.99	85.9	372	54.0	85.3
	F	0.0006	3.48	92.9	473	49.0	107.0
SPE	All	0.0118	3.15	97.7	448	15.0	48.0
SSK	All	0.2173	2.98	98.6	34	44.4	144.0
STA	All	0.0113	3.10	97.4	576	23.8	79.3
	M	0.0206	2.94	96.1	309	23.8	65.7
	F	0.0106	3.12	97.6	267	28.3	79.3
SWA	All	0.0049	3.37	99.5	632	13.6	60.1
	M	0.0046	3.39	99.0	258	20.3	56.1
	F	0.0054	3.34	99.2	323	19.3	60.1
TAR	All	0.0096	3.19	99.2	485	17.7	54.8
	M	0.0087	3.21	99.0	245	17.7	45.0
	F	0.0105	3.16	99.2	240	18.3	54.8
WAR	All	0.0186	3.04	95.6	338	27.4	69.6
	M	0.0173	3.06	97.2	135	27.4	66.5
	F	0.0219	3.04	94.2	203	31.3	69.6
WWA	All	0.0219	3.01	97.2	58	32.8	59.1
Other sources:							
TAN9301							
HOK	All	0.0057	2.85	99.6	180	36	86

* Species codes are given in Appendix 2.
$w = aL^b$ where w is weight (g) and L is length (cm).

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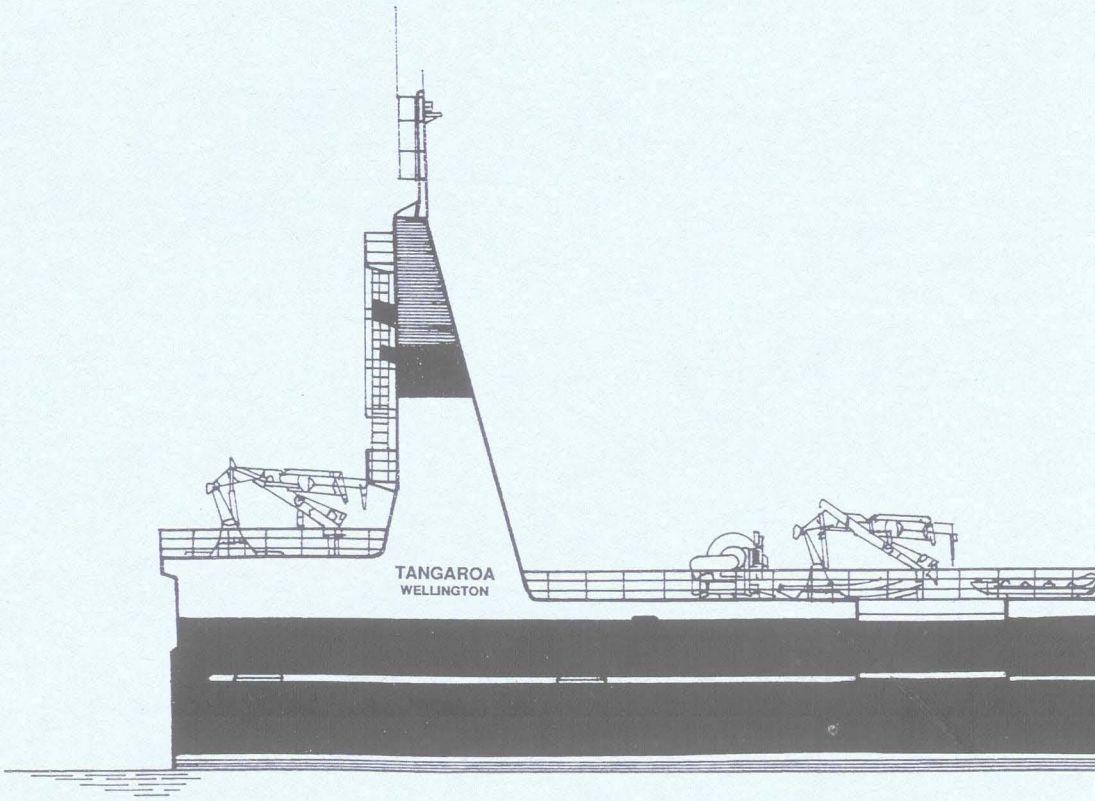
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