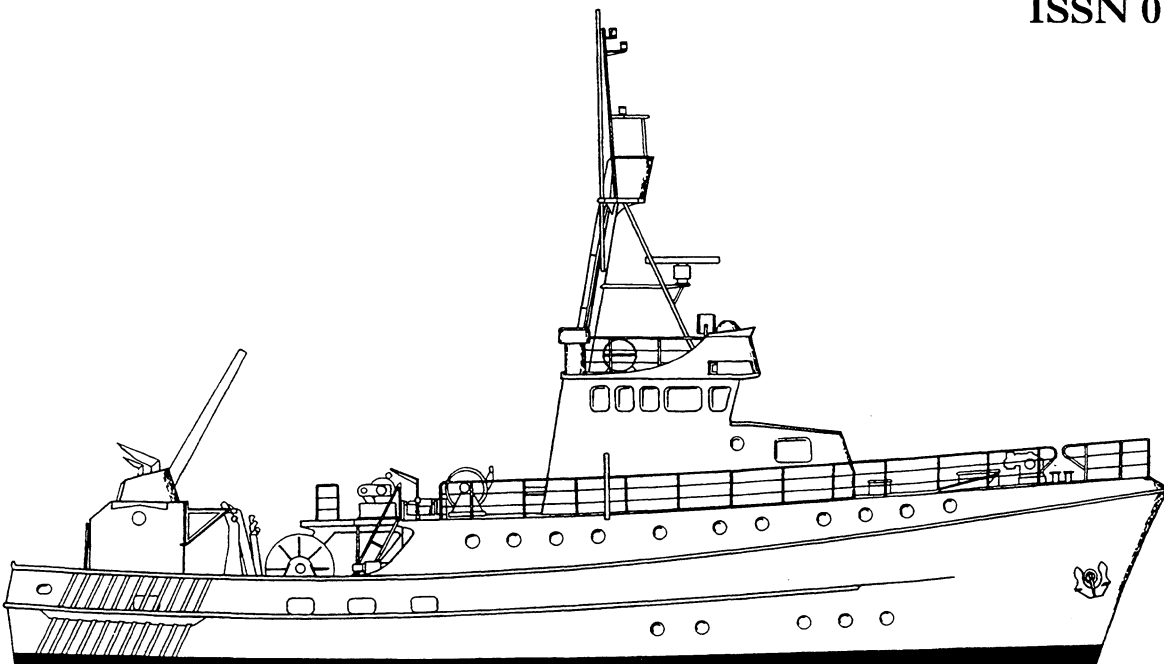


**Inshore trawl survey of the Canterbury Bight
and Pegasus Bay, May-June 1993
(KAH9306)**

Michael P. Beentjes

**New Zealand Fisheries
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Inquiries to:
The Editor, MAF Fisheries Greta Point,
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Introduction

This report presents results from the third in a series of inshore trawl surveys of red cod and associated shelf, edge, and slope species on the southeast coast of the South Island. The first two surveys in the time series were conducted in May and June 1991 (Beentjes & Wass 1994) and 1992 (Beentjes 1995). This time series of trawl surveys complements inshore surveys on the west coast of the South Island and southeast coast of the North Island.

This report details the survey design and methods, and provides relevant stock assessment data for commercially important Individual Transferable Quota (ITQ) and non-ITQ species. The survey was conducted during May and June 1993 between Shag Point and the Waiau River and distribution, length frequency, biological, and biomass data were collected for red cod and associated species in the depth range 30–400 m. The survey was aimed primarily at providing stock assessment information for red cod, and consequently more effort was put into optimising the survey design for this species. This multispecies survey also provided stock assessment data for barracouta, stargazer, tarakihi, red gurnard, sea perch, spiny dogfish, elephantfish, and other associated commercial species.

Beentjes & Wass (1994) provided fisheries background information, a detailed net plan, and a detailed description of gonad staging.

Project objectives

1. To develop a time series of relative abundance indices for red cod and other major commercial species using bottom trawl surveys along the east coast of the South Island between Kaikoura and Oamaru in the depth range 30–400 m. (Other important species include stargazer, barracouta, spiny dogfish, tarakihi, sea perch, ling, elephantfish, rig, ghost shark, and red gurnard.)
2. To determine the distribution and develop a time series of recruitment indices of juveniles, prerecruits, and adults of red cod and the other commercial species.
3. To develop a population age-structure database for red cod to monitor population dynamics.

Survey objectives

1. To estimate the relative biomass of recruited red cod and of the other commercially important species mentioned above.
2. To collect biological data and samples (length frequencies, sex ratios, gonad state, feeding condition, otoliths) for determination of recruited biomass, growth rates, productivity, and age structure of red cod and associated species.
3. To determine the distribution patterns of red cod and associated species.

Project and voyage personnel

The survey was divided into two parts (7–23 May, 23 May–6 June) with a changeover of scientific staff at the halfway stage. M. Beentjes was voyage leader for the first half and M. Coakley for the second half. A. Aberdein was skipper. M. Beentjes was responsible for final database editing.

Methods

Survey area and design

The survey used a two-phase stratified random trawl design (*after* Francis 1984). Strata areas and boundaries were identical to those used in the 1991 and 1992 surveys, but in this and the 1992 surveys all nine strata were surveyed compared to seven in 1991. The surveyed area was 20 876 km² in 1992 and 1993.

The survey area extended from the Waiiau River (south of Kaikoura) to Shag Point (north of Otago Peninsula) and was divided into nine strata on the basis of depth and area (Figure 1). The depth range of 30–400 m was chosen to include shallow water species such as elephantfish, rig, and red gurnard as well as the continental shelf edge and slope species such as barracouta, stargazer, dark ghost shark, ling, sea perch, and red cod. The three depth ranges (30–100, 100–200, and 200–400 m) represent inshore, shelf edge, and continental slope areas. The strata were digitised from bathymetric charts using natural depth contours as strata borders. The division of each of the three depth ranges into nine strata was determined on the basis of area and the presence of bathymetric and land features. Foul ground was not excluded from the survey area as it tends to be sporadic, is not easily defined, and remains constant between surveys. The bathymetry of the survey area is updated with each survey. This information is recorded on the survey charts and provides an aid to avoiding foul and ensuring that tows are in the assigned depth range.

Stations were randomly generated with a minimum of three per stratum at least 5 km apart. The number of phase 1 stations was related to the area of the individual strata; phase 2 stations were allocated to strata with the highest variation in red cod catches. Phase 2 stations were aimed at improving the precision of biomass estimates for red cod and were allocated both during and at the end of phase 1 to make the best use of the available time.

Vessel and gear specifications

GRV *Kaharoa*, a 28 m stern trawler with a power rating of 522 kW and a displacement of 302 t, is capable of trawling to depths of 500 m. The two-panel net was specially designed and built for the South Island inshore *Kaharoa* trawl surveys. It is based on the 'Alfredo' design, fishes hard down, and achieves a headline height of about 4–5 m. A 60 mm codend was used (*see* Beentjes & Wass (1994) for a detailed net plan).

Trawling procedure

All tows were conducted in daylight between 0730 and 1730 hours (NZST): 4–5 tows a day were planned. If the station was in an area of foul or the depth was out of range, an area within 5 km of the station in the same stratum was searched. If suitable ground was not found, the station was abandoned and the next station on the list was selected. Standard tows were over a distance of 3 n. miles (measured by GPS) at a speed over the ground of 3 kn. If 3 n. miles was not achieved in 1 h, the net was hauled.

Kaharoa was not equipped with Scanmar gear, so doorspread could not be accurately determined for each tow. During gear trials in 1991 the Koyama (1974) method indicated a door spread of 79.0 m averaged over a range of depths and this was taken as the default doorspread for the survey.

Headline height was recorded using a net sonde and averaged over the length of the tow:

about 5 m was obtained on all tows. Warp to depth ratios ranged from 3:1 to 9:1 with higher ratios in shallower depths. Surface temperatures were recorded.

Catch and biological sampling

The catch from each tow was sorted, boxed, and weighed by species on motion-compensating 100 kg Seaway scales to the nearest 0.1 kg. For large catches, the weight of the dominant species was estimated by multiplying the number of boxes by the average box weight.

Length, to the nearest centimetre below actual length, and sex were recorded for all ITQ species, either for the whole catch or, for larger catches, on a subsample of up to 200 randomly selected fish. The following biological information was obtained from a random sample of up to 20 fish for red cod, red gurnard, and stargazer: length to the nearest millimetre, individual fish weight, otoliths (removed for ageing), gonads (weighed and staged), and stomach fullness, digestive state, and percentage composition of prey items. The following non-ITQ species were also measured and sexed: spiny dogfish, sea perch, jack mackerel, kahawai, squid, and dark ghost shark.

A gonadosomatic index (*GSI*) was calculated for red cod, red gurnard, and stargazer from:

$$GSI = \text{gonad weight} \times 100 / \text{body weight}$$

School shark were individually weighed, measured, sexed, tagged using internal tags, and released within minutes of landing on deck.

Data analysis

Doorspread biomass estimates were based on the area-swept method described by Francis (1981, 1989) using the Trawlsurvey Analysis Program (Vignaux 1994) (version as at May 1994).

The following assumptions were made.

1. The area swept on each tow equals the distance between the doors multiplied by the distance towed (doorspread was taken as 79.0 m and distance towed was usually 3 n. miles).
2. The vulnerability is 1.0. This assumes that all fish within the volume swept are caught and there is no escapement.
3. Vertical availability is 1.0. This assumes that all fish in the water column are below the headline height and available to the net.
4. Areal availability is 1.0. This assumes that there are no fish from the southeast coast South Island stocks outside the survey area.

Although these assumptions are unlikely to be correct, they have been adopted to provide a relative biomass estimate that can be compared between trawl surveys in the time series.

All 74 tows were used in the biomass calculations, including numbers 20, 71, and 72 which were not 3 n. miles long (Appendix 1). All length frequencies were scaled by the percentage of catch sampled, area swept (function of doorspread and distance towed), and stratum area using the Trawlsurvey Analysis Program. Length weight coefficients used in scaling length frequencies are given in Appendix 2. They were determined in this survey for red cod, stargazer, red gurnard, and sea perch. Default coefficients were used for other species.

Results

Survey area

Sixty-six phase 1 and 8 phase 2 stations were completed (Figure 1, Table 1, Appendix 1). All nine strata were surveyed in an area of 23 347 km²; overall station density was 1:315 km². The number of strata and the area surveyed were the same as for the 1992 trawl survey (Beentjes 1995).

Catch composition

Ninety-six tonnes of fish (73 species) were caught during the survey (mean catch rate = 1297 kg per tow, *s.d.* = 1122, range 71–4615 kg). Spiny dogfish and barracouta made up 50% of the total catch by weight (Table 2, Appendix 3) and 80% of the total catch was made up of only six species. Spiny dogfish, barracouta, red cod, witch, arrow squid, and stargazer were caught in over 80% of the tows.

Catch rates and biomass estimates

Mean catch rates and biomass estimates by stratum for the 10 most abundant commercial species are given in Tables 3 and 4, respectively. Total biomass and coefficients of variation (*c.v.s*) were estimated for 22 commercially important species (Table 5). For red cod, strata 5 and 6 had the highest catch rates and biomass.

Recruited biomass has been calculated only for red cod as this is the only species for which size at recruitment into the fishery is known (40 cm). The analysis indicates that 79% of the biomass was recruited fish (over 40 cm). Coefficients of variation for total biomass and recruited biomass of red cod were 30% and 27%, respectively.

Species distribution

Distribution and catch rates of all species by station are shown in Figure 2. Catches varied widely between strata. Distribution and catch rates of the 16 most abundant commercial species are given in Figures 3–18. The percentage of stations at which each species was caught is shown in Table 2.

Water temperatures

Surface water temperatures are shown in Figure 19. Problems with the net sonde prevented the recording of bottom temperatures.

School shark tagging

Sixty-one school shark were tagged and released.

Biology

Scaled length frequency distributions are presented for barracouta, spiny dogfish, sea perch, arrow squid, stargazer, tarakihi, red gurnard, red cod, dark ghost shark, ling, silver warehou, hoki, lemon sole, elephantfish, and jack mackerels (*Trachurus declivis* and *T. murphyi*) for the total area (Figures 20–28), and by depth for barracouta, spiny dogfish, sea perch, arrow squid, stargazer, tarakihi, red gurnard, and red cod (Figures 20–26). Only species of which 100 or more fish were measured have been included.

Length weight relationships were calculated for males, females, and both sexes combined for red cod, stargazer, and red gurnard (Table 6).

Biological data on reproductive state and feeding are given for red cod (Tables 7–11), stargazer (Tables 12–16), and red gurnard (Tables 17–21).

The length frequency and biological data collected for each species are summarised in Appendix 4.

Gonad stages were defined by Beentjes & Wass (1994).

Discussion

A major objective of the survey was to provide a time series of relative biomass indices for red cod. Coefficients of variation for red cod were 30% for all fish and 27% for recruited biomass. This was a slight improvement on the results from the 1991 and 1992 trawl surveys (1991, 33% and 36%; 1992, 40% and 34% for total and recruited biomass, respectively). These *c.v.s* are a result of the patchy and unpredictable distribution of red cod. In 1993 nearly all red cod were caught between 100 and 200 m, mainly in strata 5 and 6, whereas in 1992 red cod were more evenly distributed over all three depth ranges and particularly in strata 8, 9, and 5. the *c.v.s* for red cod may be reduced by lengthening the survey to accommodate more phase 2 stations and/or by re-stratifying to more accurately reflect the distribution of red cod.

Less than a quarter of the estimated biomass of red cod was prerecruited fish of less than 40 cm TL, compared with about a half in both 1991 and 1992. The length frequency distribution for red cod has a range of lengths with no single cohort dominating, in contrast to 1991 and 1992 when the 1+ cohort was clearly the most abundant (*see* Beentjes (1992) for red cod ageing). If these data are a true indication of prerecruit abundance, then recruitment in 1993 has not been as successful as in 1991 and 1992.

The mean catch per tow of all species combined and the number of species caught was about 30% higher than in 1991 and 1992. The reasons for this have not yet been investigated.

Acknowledgments

Thanks to Alan Aberdein and the crew of *Kaharoa* for their help and cooperation on a well run survey. Thanks also to the scientific crew for their enthusiasm and efforts and the science team at MAF Fisheries South for their support and contributions to the southeast trawl survey programme. Jonathan Alsop and Frank Webster contributed to the production of figures and tables. Rosie Hurst reviewed this report and made helpful comments and suggestions.

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Table 1: Stratum depth ranges, area, number of phase 1 and phase 2 stations, and station density

Stratum	Depth (m)	Area (km ²)	<u>Number of stations</u>		Station density (per km ²)
			Phase 1	Phase 2	
1	30–100	2 230	6	0	1:372
2	30–100	5 712	15	0	1:381
3	30–100	4 862	10	0	1:486
4	30–100	2 084	4	0	1:521
5	100–200	2 999	6	3	1:333
6	100–200	2 244	6	5	1:204
7	100–200	992	4	0	1:248
8	200–400	745	7	0	1:106
9	200–400	1 479	8	0	1:185
Total		23 347	66	8	Mean = 1:315

Table 2: Species caught, total weight, and percentage occurrence at 74 stations

Common name	Species code	Scientific name	Total catch (kg)	% of catch by weight	Occurrence
Barracouta	BAR	<i>Thyrsites atun</i>	26 017.3	27.1	87.8
Spiny dogfish	SPD	<i>Squalus acanthias</i>	21 605.4	22.5	98.6
Red cod	RCO	<i>Pseudophycis bachus</i>	12 353.8	12.9	81.1
Dark ghost shark	GSH	<i>Hydrolagus novaezealandiae</i>	8 646.6	9.0	37.8
Tarakihi	TAR	<i>Nemadactylus macropterus</i>	4 898.7	5.1	62.2
Sea perch	SPE	<i>Helicolenus papillosus</i>	4 127.5	4.3	70.3
Arrow squid	SQU	<i>Nototodarus sloanii</i>	2 603.2	2.7	95.9
Rattails	RAT	Macrouridae	2 245.8	2.3	45.9
Ling	LIN	<i>Genypterus blacodes</i>	1 736.7	1.8	73.0
Hoki	HOK	<i>Macruronus novaezealandiae</i>	1 399.5	1.5	21.6
Witch	WIT	<i>Arnoglossus scapha</i>	1 123.3	1.2	93.2
Stargazer	STA	<i>Kathetostoma giganteum</i>	1 034.5	1.1	91.9
Silver warehou	SWA	<i>Seriolella punctata</i>	997.0	1.0	67.6
Smooth skate	SSK	<i>Raja innominata</i>	992.7	1.0	59.5
Carpet shark	CAR	<i>Cephaloscyllium isabella</i>	877.0	0.9	48.6
Southern spider crab	SSC	<i>Leptomithrax australis</i>	680.7	0.7	1.4
Red gurnard	GUR	<i>Chelidonichthys kumu</i>	626.9	0.7	24.3
Pigfish	PIG	<i>Congiopodus leucopaecilus</i>	596.0	0.6	43.2
Elephantfish	ELE	<i>Callorhynchus milii</i>	540.3	0.6	31.1
School shark	SCH	<i>Galeorhinus galeus</i>	472.9	0.4	39.2
Jack mackerel	JMD	<i>Trachurus declivis</i>	404.2	0.4	36.5
Rough skate	RSK	<i>Raja nasuta</i>	387.4	0.4	32.4
Peruvian jack mackerel	JMM	<i>Trachurus murphyi</i>	355.0	0.4	41.9
Hapuku	HAP	<i>Polyprion oxygeneios</i>	255.4	0.3	37.8
Lemon sole	LSO	<i>Pelotretis flavilatus</i>	158.5	0.2	55.4
Javelinfish	JAV	<i>Lepidorhynchus denticulatus</i>	93.4	0.1	10.8
Rig	SPO	<i>Mustelus lenticulatus</i>	78.7	<0.1	23.0
Blue cod	BCO	<i>Parapercis colias</i>	66.2	<0.1	16.2
Crested bellowsfish	CBE	<i>Notopogon lilliei</i>	61.4	<0.1	29.7
Jack mackerel	JMN	<i>Trachurus novaezealandiae</i>	58.1	<0.1	10.8
Common warehou	WAR	<i>Seriolella brama</i>	56.0	<0.1	18.9
Blue moki	MOK	<i>Latridopsis ciliaris</i>	53.2	<0.1	4.1
Deepsea flathead	FHD	<i>Hoplichthys haswelli</i>	47.3	<0.1	14.9
Electric ray	ERA	<i>Torpedo fairchildi</i>	45.3	<0.1	6.8
Shark	SHA	Unidentified	42.0	<0.1	1.4
Octopus	OCT	<i>Octopus maorum</i>	41.3	<0.1	17.6
Scaly gurnard	SCG	<i>Lepidotrigla brachyoptera</i>	38.8	<0.1	55.4
White warehou	WWA	<i>Seriolella caerulea</i>	35.8	<0.1	6.8
Conger eel	CON	<i>Conger verreauxi</i>	18.9	<0.1	2.7
Pale toadfish	TOA	<i>Neophrynichthys angustus</i>	17.9	<0.1	43.2
Lookdown dory	LDO	<i>Cyttus traversi</i>	14.9	<0.1	4.1
Gemfish	SKI	<i>Rexea solandri</i>	12.0	<0.1	2.7
Silverside	SSI	<i>Argentina elongata</i>	8.5	<0.1	28.4
Leatherjacket	LEA	<i>Parika scaber</i>	8.0	<0.1	6.8
Sand flounder	SFL	<i>Rhombosolea plebeia</i>	6.8	<0.1	5.4
English mackerel	EMA	<i>Scomber australasicus</i>	6.7	<0.1	5.4
N.Z. sole	ESO	<i>Peltorhamphus novaezeelandiae</i>	6.2	<0.1	5.4
Warty squid	MIQ	<i>Moroteuthis ingens</i>	4.9	<0.1	1.4
Spotty	STY	<i>Notolabrus celidotus</i>	4.9	<0.1	4.1
Hake	HAK	<i>Merluccius australis</i>	4.5	<0.1	4.1
Silver dory	SDO	<i>Cyttus novaezealandiae</i>	4.1	<0.1	5.4
Skate	BTA	<i>Pavoraja asperula</i>	4.0	<0.1	1.4
Trumpeter	TRU	<i>Latris lineata</i>	3.9	<0.1	1.4
Rudderfish	RUD	<i>Centrolophus niger</i>	3.5	<0.1	1.4
Bluenose	BNS	<i>Hyperoglyphe antarctica</i>	3.2	<0.1	1.4
Girdled wrasse	GPF	<i>Pseudolabrus cinctus</i>	3.0	<0.1	1.4
Scampi	SCI	<i>Metanephrops challengeri</i>	3.0	<0.1	4.1
Spiny sea dragon	SDR	<i>Solegnathus spinosissimus</i>	1.6	<0.1	5.4
Sand eel	GON	<i>Gonorynchus gonorynchus</i>	1.2	<0.1	4.1
Lucifer dogfish	ETL	<i>Etmopterus lucifer</i>	1.0	<0.1	1.4
Pavoraja spinifera	BTS	<i>Pavoraja spinifera</i>	0.8	<0.1	1.4
Southern blue whiting	SBW	<i>Micromesistius australis</i>	0.7	<0.1	2.7
Sprat	SPM	<i>Sprattus muelleri</i>	0.7	<0.1	1.4
Brill	BRI	<i>Colistium guntheri</i>	0.6	<0.1	1.4
Alert pigfish	API	<i>Alertichthys blacki</i>	0.5	<0.1	1.4
Opalfish	OPA	<i>Hemerocoetes sp.</i>	0.4	<0.1	5.4
Ruby fish	RBY	<i>Plagiogeneion rubiginosus</i>	0.4	<0.1	1.4
Broad squid	BSQ	<i>Sepioteuthis australis</i>	0.1	<0.1	1.4
Dawson's catshark	DCS	<i>Halaelurus dawsoni</i>	0.1	<0.1	1.4
Frostfish	FRO	<i>Lepidopus caudatus</i>	0.1	<0.1	1.4
Ahuru	PCO	<i>Auchenoceros punctatus</i>	0.1	<0.1	1.4

Total 96 001.0

Table 3: Mean catch rate (kg.km⁻²) and standard deviation of the 10 most abundant commercial species by stratum*

Stratum		BAR	SPD	RCO	GSH	TAR	SPE	SQU	LIN	HOK	STA
1	Catch rate	1 282.8	954.7	35.6	0.0	75.4	105.0	21.6	30.3	0.0	20.2
	s.d.	1 860.0	1 139.1	61.2	0.0	150.5	201.3	26.4	33.1	0.0	16.8
2	Catch rate	1 306.9	304.9	81.5	0.0	509.5	11.2	50.4	10.0	0.0	35.3
	s.d.	2 419.7	369.9	242.6	0.0	1 566.1	28.5	77.6	18.9	0.0	35.5
3	Catch rate	601.2	1 026.9	20.2	0.0	68.4	57.9	23.8	6.4	0.0	20.2
	s.d.	689.5	1 114.7	53.1	0.1	94.3	125.7	43.6	10.8	0.0	17.9
4	Catch rate	164.8	720.2	119.3	0.0	250.9	593.8	43.6	11.1	0.1	19.9
	s.d.	115.9	958.3	87.0	0.0	237.8	880.0	31.0	17.2	0.2	36.5
5	Catch rate	1 538.6	653.4	574.7	668.3	5.3	304.5	16.5	49.6	0.2	21.2
	s.d.	1 194.1	557.9	813.0	1 309.6	9.0	242.1	13.8	57.3	0.5	12.7
6	Catch rate	895.7	617.1	1 448.6	20.5	1.9	202.7	65.7	8.7	0.0	62.9
	s.d.	1 551.8	650.5	2 535.7	37.6	4.6	326.4	137.1	8.3	0.0	86.5
7	Catch rate	76.6	1 572.9	262.4	0.0	324.1	127.8	43.3	1.5	0.0	80.8
	s.d.	94.9	2 564.7	287.0	0.0	578.2	93.4	41.8	3.0	0.0	58.4
8	Catch rate	34.4	840.6	441.7	1 759.6	0.0	1.7	415.2	168.2	83.8	15.9
	s.d.	34.4	1 033.2	451.6	2 180.6	0.0	3.7	372.9	213.6	137.3	22.9
9	Catch rate	131.9	121.1	92.3	137.2	1.4	23.4	104.1	224.6	325.0	15.8
	s.d.	284.5	88.3	192.0	130.4	4.0	60.9	119.6	393.5	327.3	17.4

* Species codes are given in Table 2.

Table 4: Biomass (t) and c.v.(%) of the top 10 most abundant commercial species by stratum*

Stratum		BAR	SPD	RCO	GSH	TAR	SPE	SQU	LIN	HOK	STA
1	Biomass	2 861	2 129	79	0	168	234	48	68	0	45
	c.v.	59	49	70	-	81	78	50	45	0	34
2	Biomass	7 465	1 742	466	0	2 911	64	288	57	0	202
	c.v.	48	31	77	-	79	66	40	49	0	26
3	Biomass	2 923	4 993	98	0	333	281	116	31	0	98
	c.v.	36	34	83	100	44	69	58	54	0	28
4	Biomass	344	1 501	249	0	523	1 237	91	23	0	41
	c.v.	35	67	36	-	47	74	36	78	100	92
5	Biomass	4 614	1 960	1 724	2 004	16	913	50	149	0	63
	c.v.	26	28	47	65	56	27	28	38	0	20
6	Biomass	2 010	1 385	3 251	46	4	455	147	20	0	141
	c.v.	52	32	53	55	71	49	63	29	0	41
7	Biomass	76	1 560	260	0	322	127	43	1	0	80
	c.v.	62	82	55	-	89	37	48	100	0	36
8	Biomass	26	626	329	1 311	0	1	309	125	62	12
	c.v.	38	46	39	47	-	81	34	48	62	55
9	Biomass	195	179	136	203	2	35	154	332	481	23
	c.v.	76	26	74	34	100	92	41	62	36	39

* Species codes are given in Table 2.

Table 5: Estimated biomass and c.v. (%) for commercially important species. Population numbers are given for species in which length frequency histograms have been presented.

Common name	Estimated biomass (t)	c.v. (%)	Scaled numbers (000's)		
			Males	Females	Unsexed
Barracouta	20 513	21	8 990	10 720	127
Spiny dogfish	16 074	17	8 626	4 257	39
Red cod (total)	6 592	30	3 507	3 605	269
Red cod (recruited)	5 233	27			
Tarakihi	4 278	55	2 571	1 927	16 577
Dark ghost shark	3 564	41	2 563	2 646	0
Sea perch	3 348	30	6 564	5 377	849
Arrow squid	1 246	17	597	545	1 608
Ling	806	28	244	295	14
Stargazer	706	14	244	267	20
Red gurnard	614	31	504	516	6
Hoki	544	32	460	422	15
Elephantfish	537	34	146	106	0
School shark	429	42			
Jack mackerel (<i>T. declivis</i>)	422	79	209	140	5
Silver warehou	327	44	354	261	35
Peruvian jack mackerel (<i>T. murphyi</i>)	262	28	131	67	17
Hapuku	204	32			
Lemon sole	135	19	69	412	4
Rig	77	30			
Blue cod	61	42			
Common warehou	54	38			
Jack mackerel (<i>T. novaezelandiae</i>)	54	59			

Table 6: Length weight coefficients for red cod, stargazer and red gurnard*

		n	Length (cm)			a	b	r
			Range	Mean	s.d.			
Red cod	Male	163	11.5–64.1	44.621	11.494	0.004593	3.20022	97.3
	Female	241	11.4–73.0	50.205	16.126	0.005241	3.16745	98.8
	Combined	405	11.4–73.0	47.876	14.742	0.004791	3.19008	98.5
Stargazer	Male	88	12.3–57.8	38.509	8.929	0.022115	2.91877	96.8
	Female	94	16.2–78.0	41.770	10.778	0.009950	3.14029	98.9
	Combined	183	11.9–78.0	40.039	10.223	0.013745	3.05125	97.9
Red gurnard	Male	80	24.0–46.8	35.400	5.191	0.077430	2.52341	31.4
	Female	100	19.0–52.6	37.488	6.983	0.019894	2.84485	26.8
	Combined	180	19.0–52.6	36.577	6.317	0.036684	2.70510	29.9

* $W = aL^b$, where W = weight (g) and L = length (cm); n = sample size.

Table 7: Reproductive state of red cod

Stage	Gonadosomatic index			
	Males		Females	
	No.	Mean	No.	Mean
1	103	0.30	172	0.52
2	1	0.49	0	–
3	1	0.57	0	–
Total	105		172	

Table 8: Mean gonad stages and weights by sex and length for red cod*

Length range (cm)	Males			Females		
	No.	Mean gonad stage	Mean gonad weight (g)	No.	Mean gonad stage	Mean gonad weight (g)
0.0–15	3	1	0.3	12	1	0.2
15.1–20	7	1	1.0	10	1	0.1
20.1–25	0			4	1	1.0
25.1–30	15	1	0.3	12	1	0.7
30.1–35	4	1	0.3	13	1	1.3
35.1–40	11	1	0.9	8	1	1.3
40.1–45	26	1	1.3	14	1	0.9
45.1–50	34	1	2.0	18	1	3.6
50.1–55	44	1	2.4	18	1	6.2
55.1–60	13	1	2.7	53	1	7.3
60.1–65	6	1	2.7	49	1	7.8
65.1–70	0			26	1	11.7
70.1–75	0			5	1	14.2

* Males and females: stage 1 – immature/resting
 2 – maturing
 3 – ripening
 4 – running ripe
 5 – spent

Table 9: Stomach fullness of red cod by time of day

Time	No. of stomachs	Empty (%)	Trace (%)	Part full (%)	Full (%)	Everted (%)
0500–0830	139	5	8	38	26	9
0830–1200	120	20	9	33	14	8
1200–1530	146	14	14	43	18	10
1530–1900	0	0	0	0	0	0
Mean	405	13	11	38	20	9

Table 10: Digestion state of red cod stomachs by time of day

Time	No. of food items	Fresh (%)	Part digested (%)	Digested (%)	Mixed (%)
0500–0830	128	43	28	16	10
0830–1200	75	5	64	27	4
1200–1530	128	19	41	32	7
1530–1900	0	0	0	0	0
Mean	331	25	41	25	8

Table 11: Occurrence of red cod food items by stratum

Stratum	No. of food items	<i>Munida</i> (%)	Crustacea (%)	Squid (%)	Red cod (%)	Fish (%)	Other (%)
1	35	91	3	0	3	3	0
2	53	0	17	2	8	21	53
4	17	0	18	0	12	41	29
5	101	81	4	0	4	7	4
6	55	71	0	0	0	25	4
7	7	0	0	0	0	100	0
8	44	75	7	0	0	11	7
9	19	68	11	0	0	16	5
Mean	331	60	7	0	3	17	13

Table 12: Reproductive state of stargazer

Stage	Gonadosomatic index			
	Males		Females	
	No.	Mean	No.	Mean
1	71	0.17	89	0.30
2	8	0.44	0	–
3	2	0.57	4	5.18
Total	81		93	

Table 13: Mean gonad stages and weights by sex and length for stargazer (see Table 8 for gonad staging)

Length range (cm)	Males			Females		
	No.	Mean gonad stage	Mean gonad weight (g)	No.	Mean gonad stage	Mean gonad weight (g)
0.0–15	3	1	1.0	1	1	1.0
15.1–20	0			1	1	1.0
20.1–25	3	1	0.3	1	1	1.0
25.1–30	7	1	1.0	10	1	1.6
30.1–35	14	1	1.2	12	1	2.1
35.1–40	23	1	1.3	19	1	2.8
40.1–45	21	1	2.5	22	1	3.1
45.1–50	9	1	4.8	12	1	4.0
50.1–55	6	1	6.5	6	1	4.5
55.1–60	2	2	10.0	3	1	8.0
60.1–65	0			3	1	8.0
65.1–70	0			4	2	205.8
70.1–75	0			0		
75.1–80	0			1	3	400.0

Table 14: Stomach fullness of stargazer by time of day

Time	No. of stomachs	Empty (%)	Trace (%)	Part full (%)	Full (%)	Everted (%)
0500–0830	38	18	16	53	13	0
0830–1200	71	15	21	45	17	1
1200–1530	74	14	11	64	11	1
1530–1900	0	0	0	0	0	0
Mean	183	15	16	54	14	1

Table 15: Digestion state of stargazer stomachs by time of day

Time	No. of food items	Fresh (%)	Part digested (%)	Digested (%)	Mixed (%)
0500–0830	36	0	11	67	22
0830–1200	66	5	11	67	18
1200–1530	70	1	16	69	11
1530–1900	0	0	0	0	0
Mean	172	2	13	67	16

Table 16: Occurrence of stargazer food items by stratum

Stratum	No. of food items	<i>Munida</i> (%)	Crustacea (%)	Squid (%)	Red cod (%)	Fish (%)	Other (%)
1	13	0	8	8	15	69	0
2	93	0	0	0	2	65	33
4	18	0	0	6	6	72	17
5	15	7	7	13	7	53	13
7	18	0	0	11	0	67	22
8	15	0	0	13	0	67	20
Mean	172	1	1	5	3	65	25

Table 17: Reproductive state of red gurnard

Stage	Gonadosomatic index			
	Males		Females	
	No.	Mean	No.	Mean
1	69	0.64	51	0.87
2	2	0.71	19	1.03
3	1	0.79	12	1.45
4	2	0.78	2	2.04
5	0	-	1	2.40
Total	74		85	

Table 18: Mean gonad stages and weights by sex and length for red gurnard (see Table 8 for gonad staging)

Length range (cm)	Males			Females		
	No.	Mean gonad stage	Mean gonad weight (g)	No.	Mean gonad stage	Mean gonad weight (g)
15.1–20	0			1	1	0
20.1–25	4	1	1.3	4	1	1.3
25.1–30	7	1	1.4	4	1	1.5
30.1–35	28	1	2.1	32	1	2.3
35.1–40	24	1	3.0	22	1	3.4
40.1–45	15	1	3.4	23	2	9.2
45.1–50	2	1	3.0	10	2	14.1
50.1–55	0			4	3	21.8

Table 19: Stomach fullness of red gurnard by time of day

Time	No. of stomachs	Empty (%)	Trace (%)	Part full (%)	Full (%)	Everted (%)
0500–0830	80	39	6	18	6	6
0830–1200	80	34	14	26	11	15
1200–1530	20	20	15	45	5	15
1530–1900	0	0	0	0	0	0
Mean	180	34	11	24	8	11

Table 20: Digestion state of red gurnard stomachs by time of day

Time	No. of food items	Fresh (%)	Part digested (%)	Digested (%)	Mixed (%)
0500–0830	25	0	36	64	0
0830–1200	46	13	41	39	7
1200–1530	14	43	21	36	0
1530–1900	0	0	0	0	0
Mean	85	14	36	46	4

Table 21: Occurrence of red gurnard food items by stratum

Stratum	No. of food items	<i>Munida</i> (%)	Crustacea (%)	Squid (%)	Red cod (%)	Fish (%)	Other (%)
1	22	5	41	0	0	18	36
2	45	4	2	0	4	38	51
3	3	0	0	0	0	33	67
4	15	20	0	0	0	0	80
Mean	85	7	12	0	2	26	53

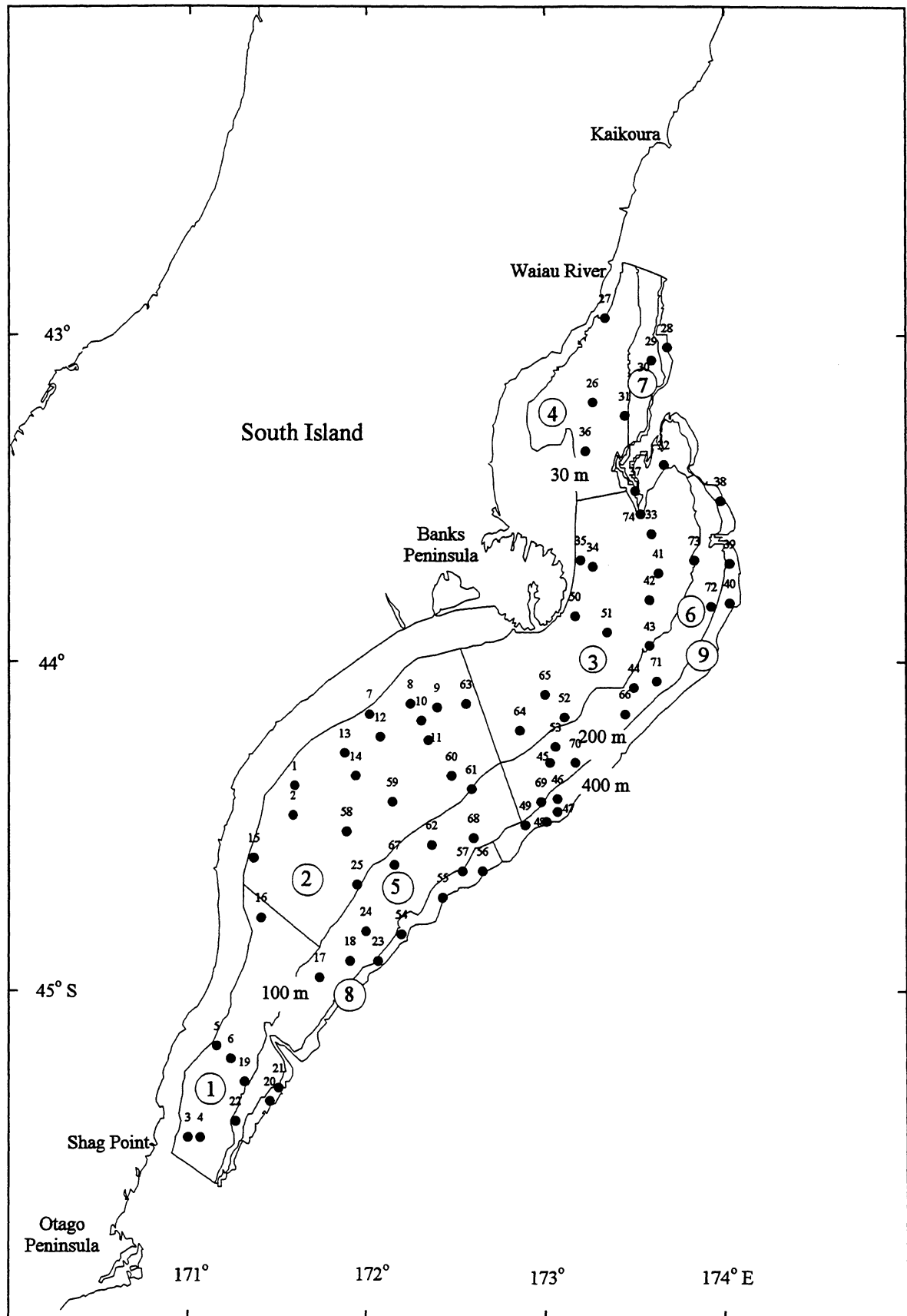


Figure 1: Survey area showing strata and trawl station positions and numbers.

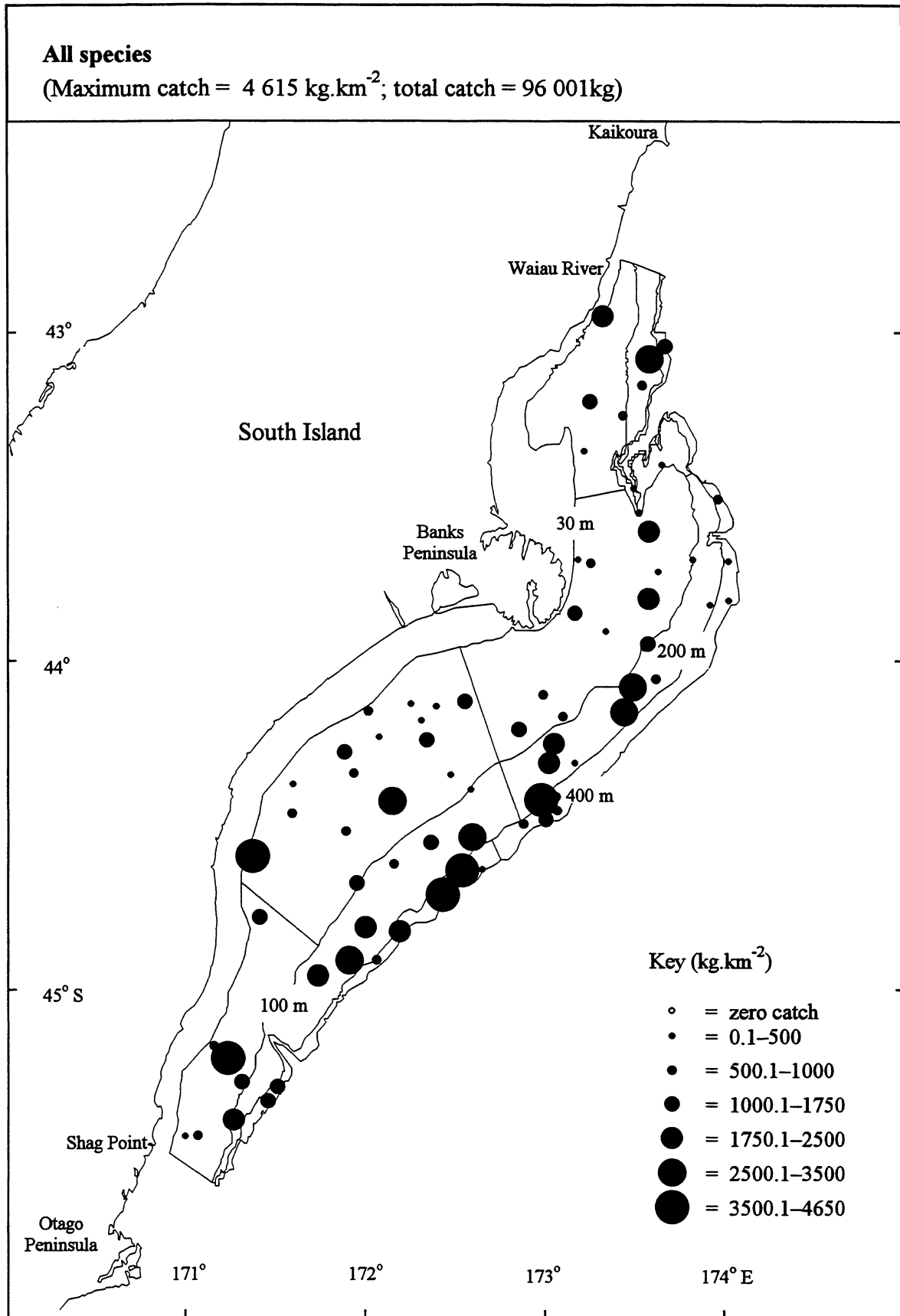


Figure 2: Catch rates for all species combined.

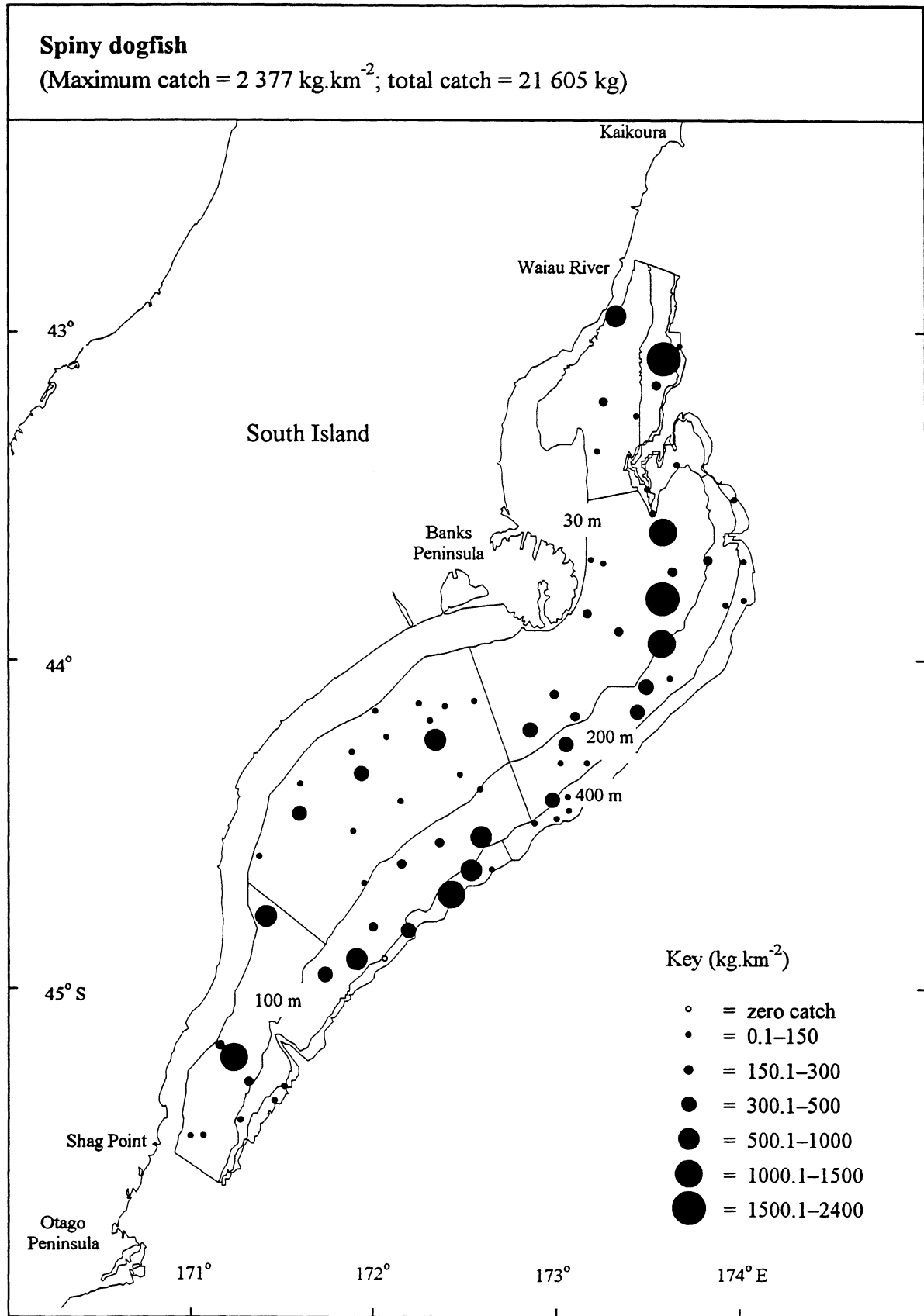


Figure 3: Catch rates of spiny dogfish.

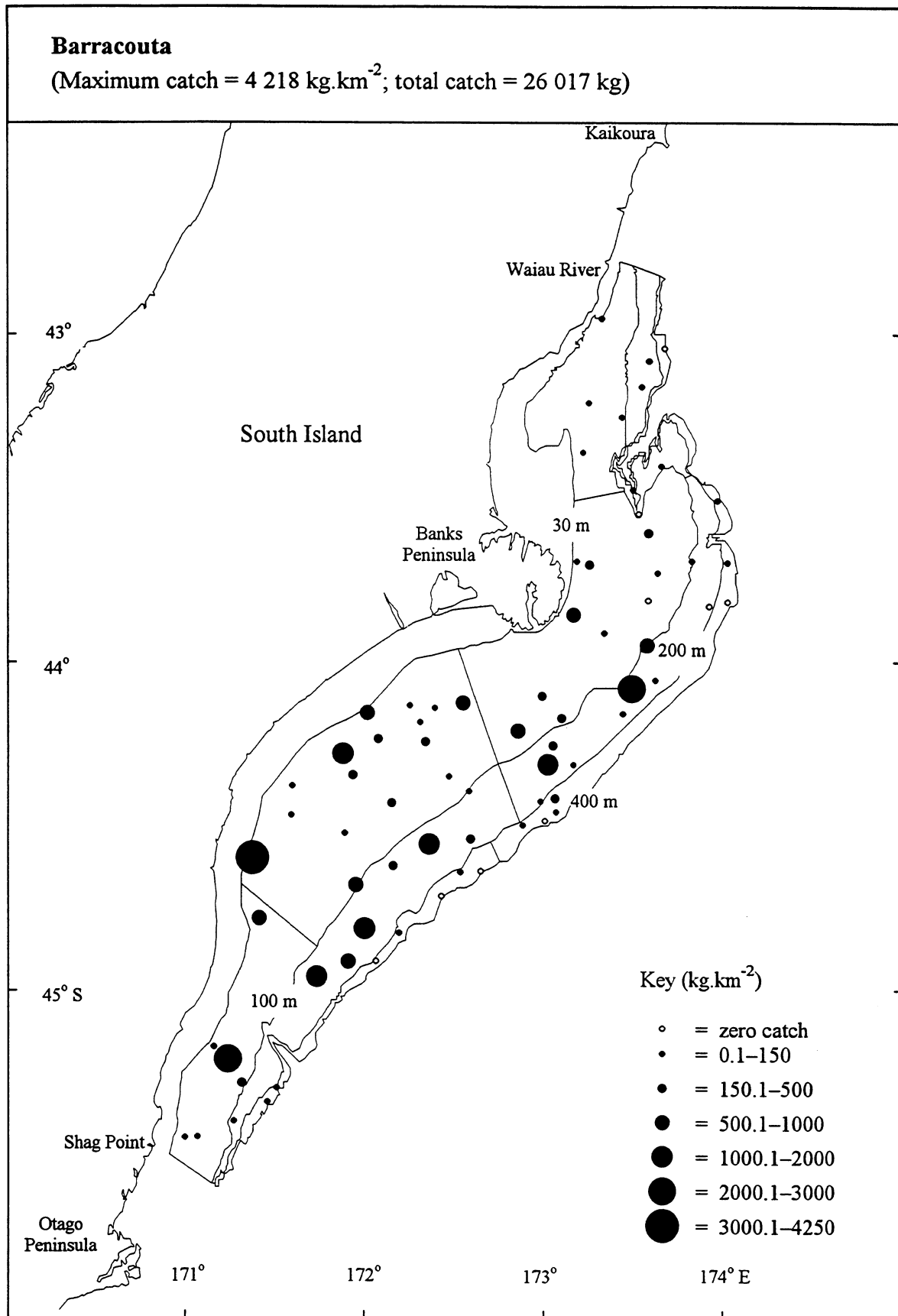


Figure 4: Catch rates of barracouta.

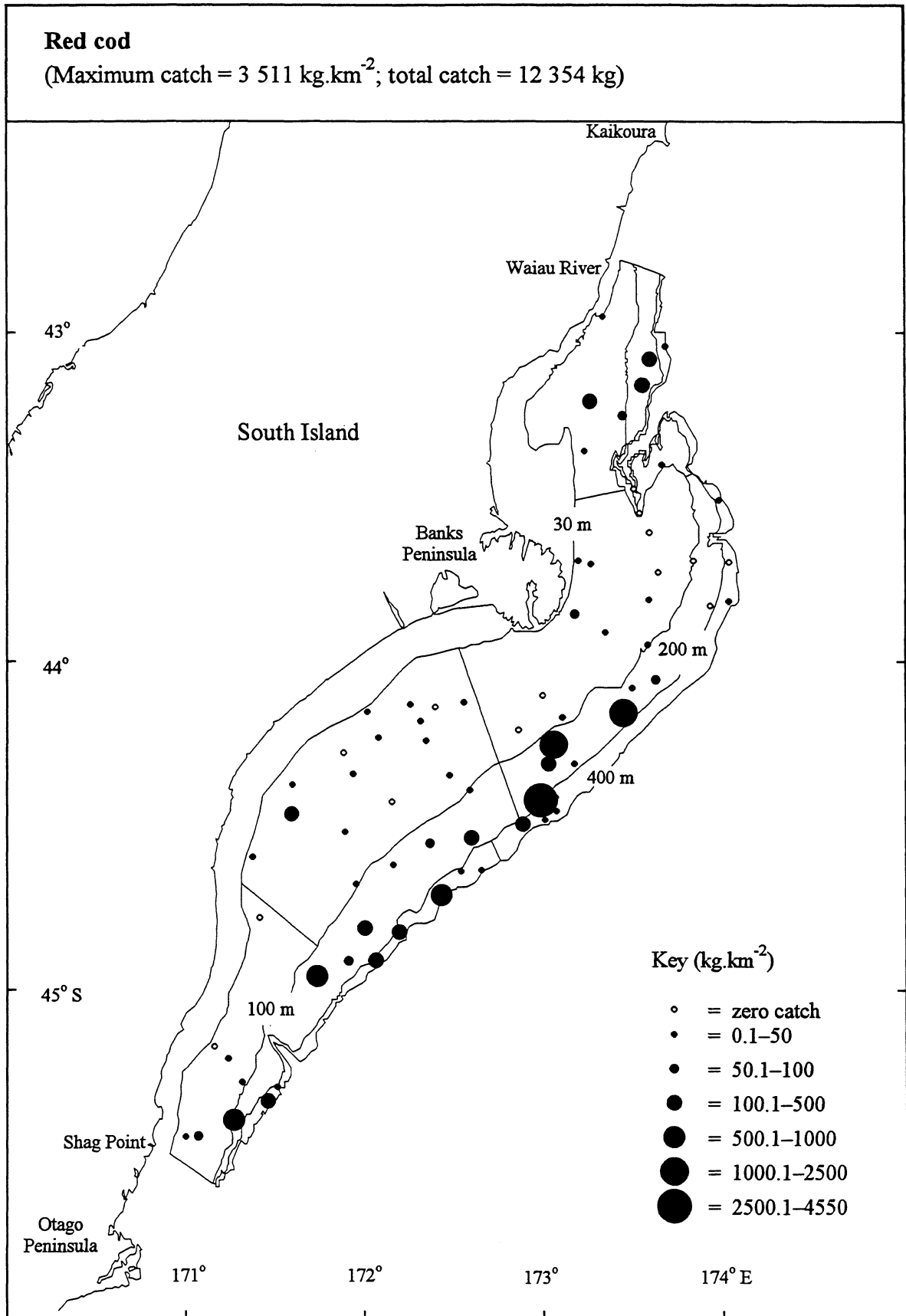


Figure 5: Catch rates of red cod.

Tarakihi

(Maximum catch = 2 702 kg.km⁻²; total catch = 4 899 kg)

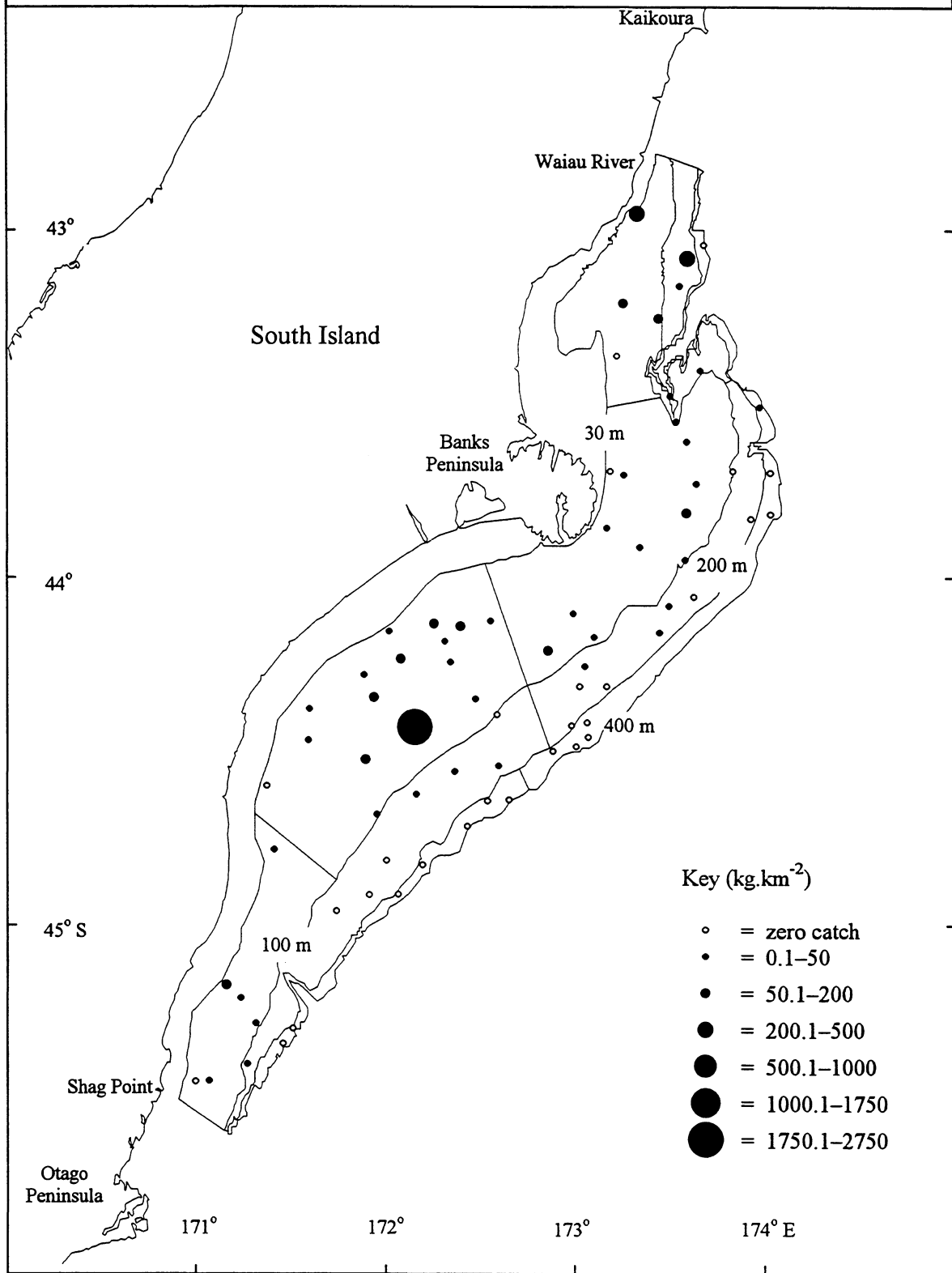


Figure 6: Catch rates of tarakihi.

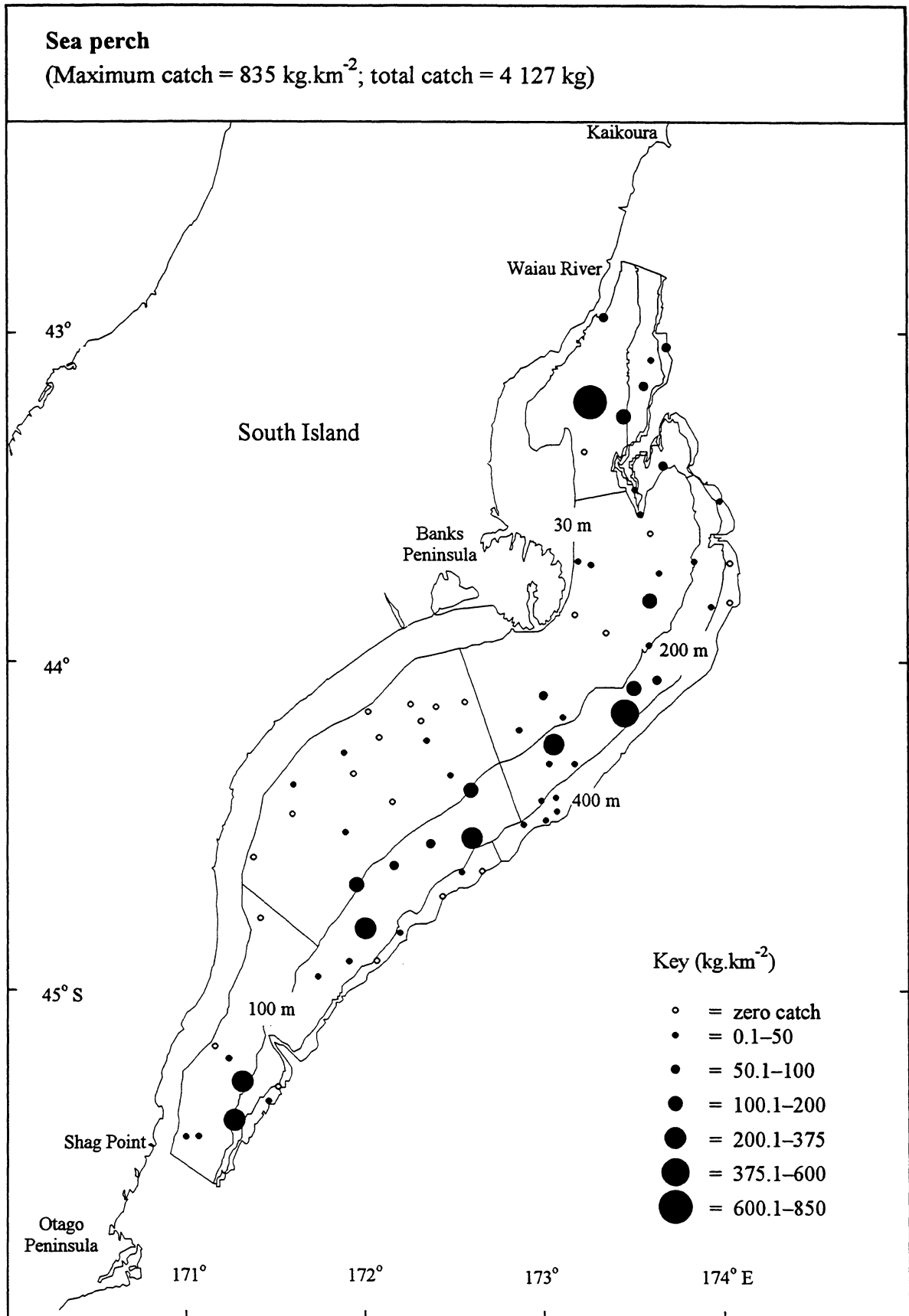


Figure 7: Catch rates of sea perch.

Ling

(Maximum catch = 510 kg.km^{-2} ; total catch = 1 737 kg)

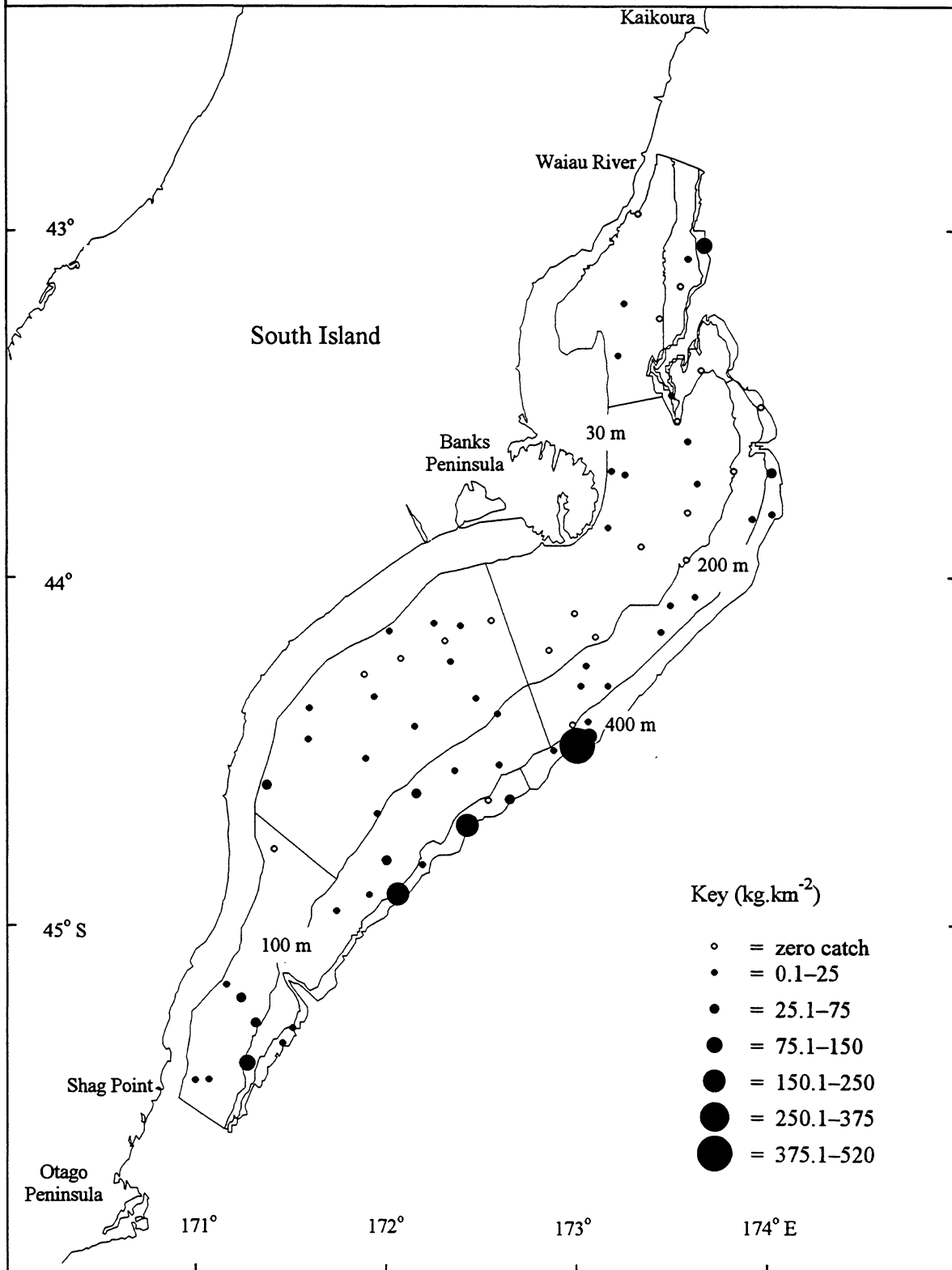


Figure 8: Catch rates of ling.

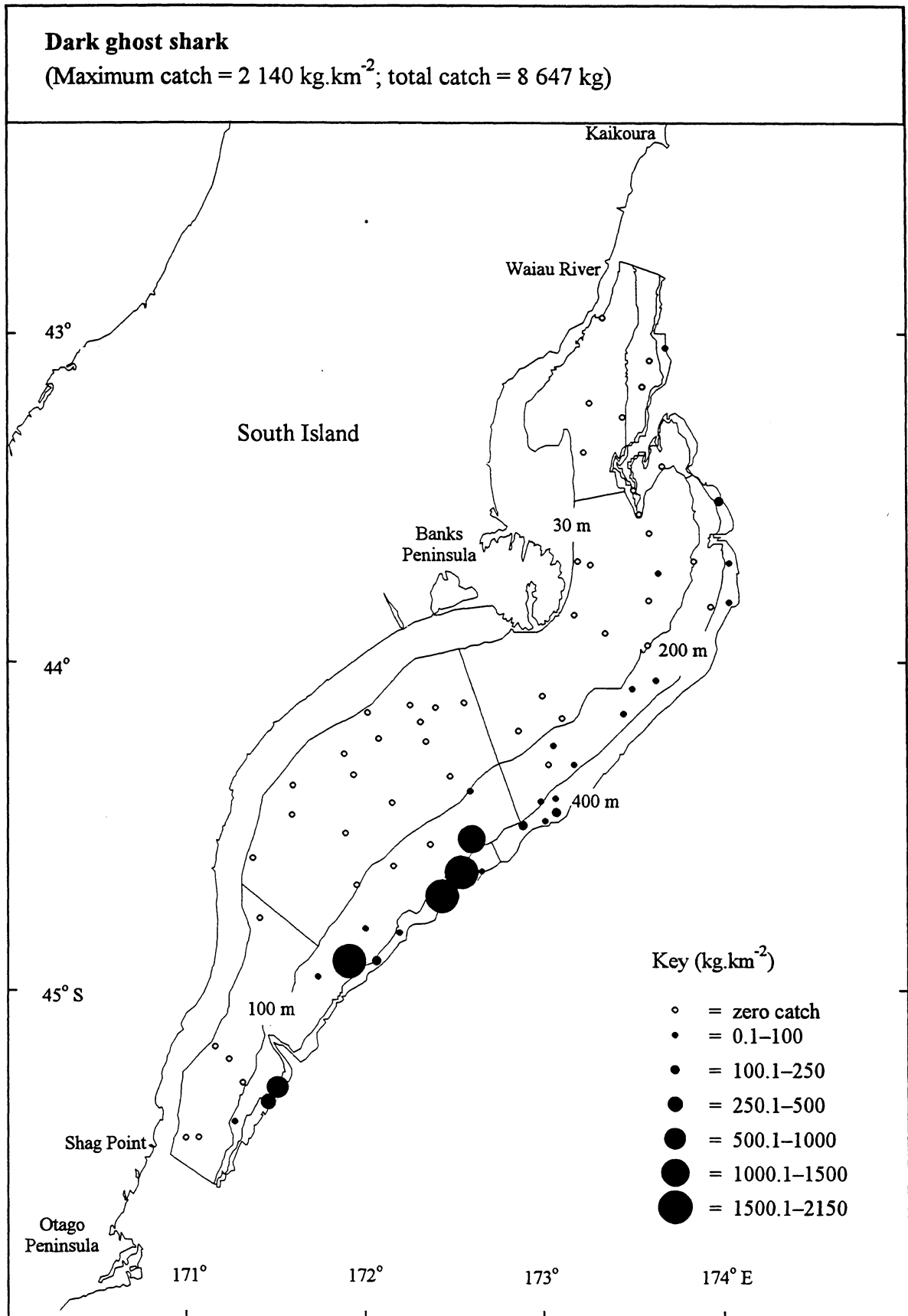


Figure 9: Catch rates of dark ghost shark.

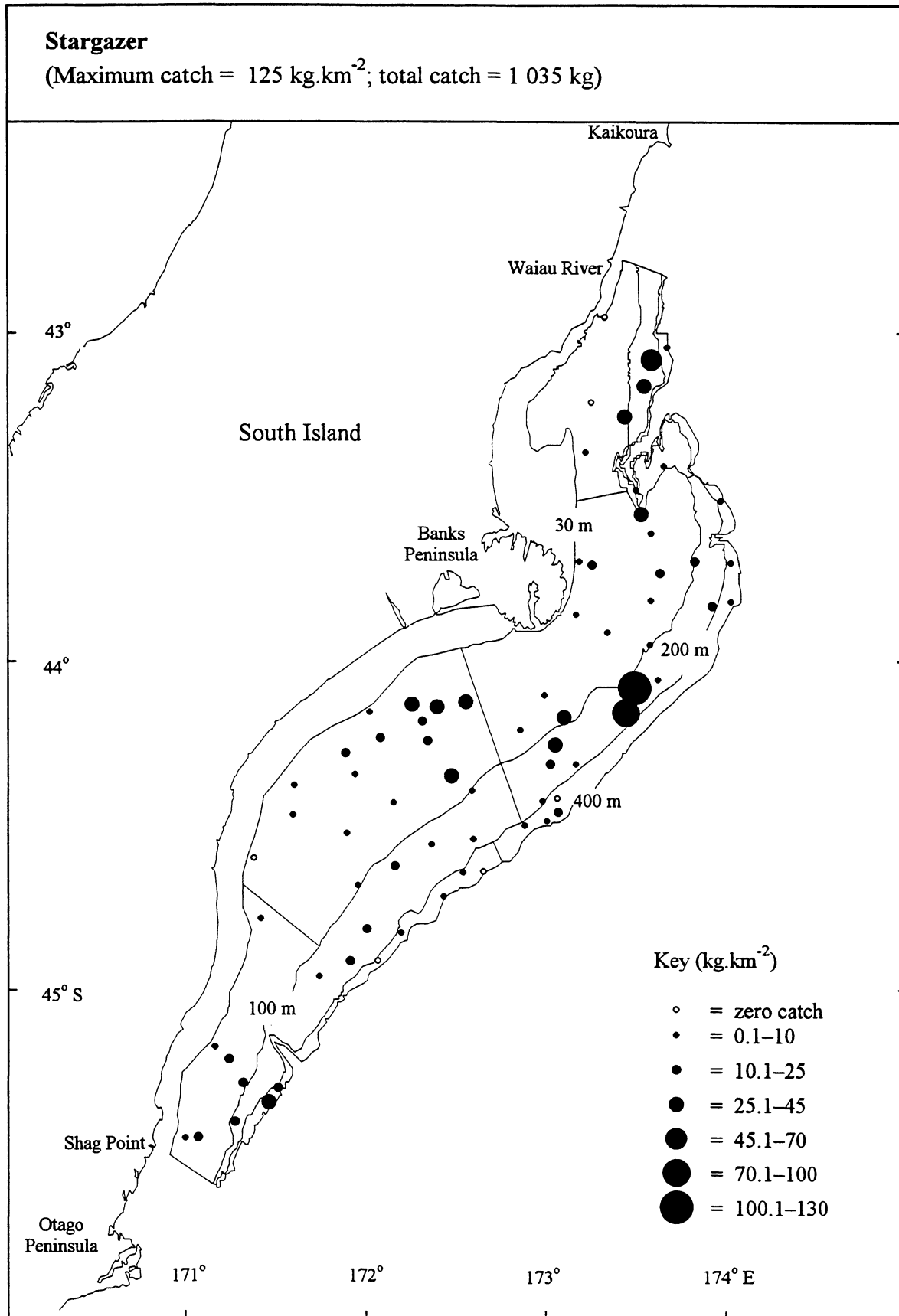


Figure 10: Catch rates of stargazer.

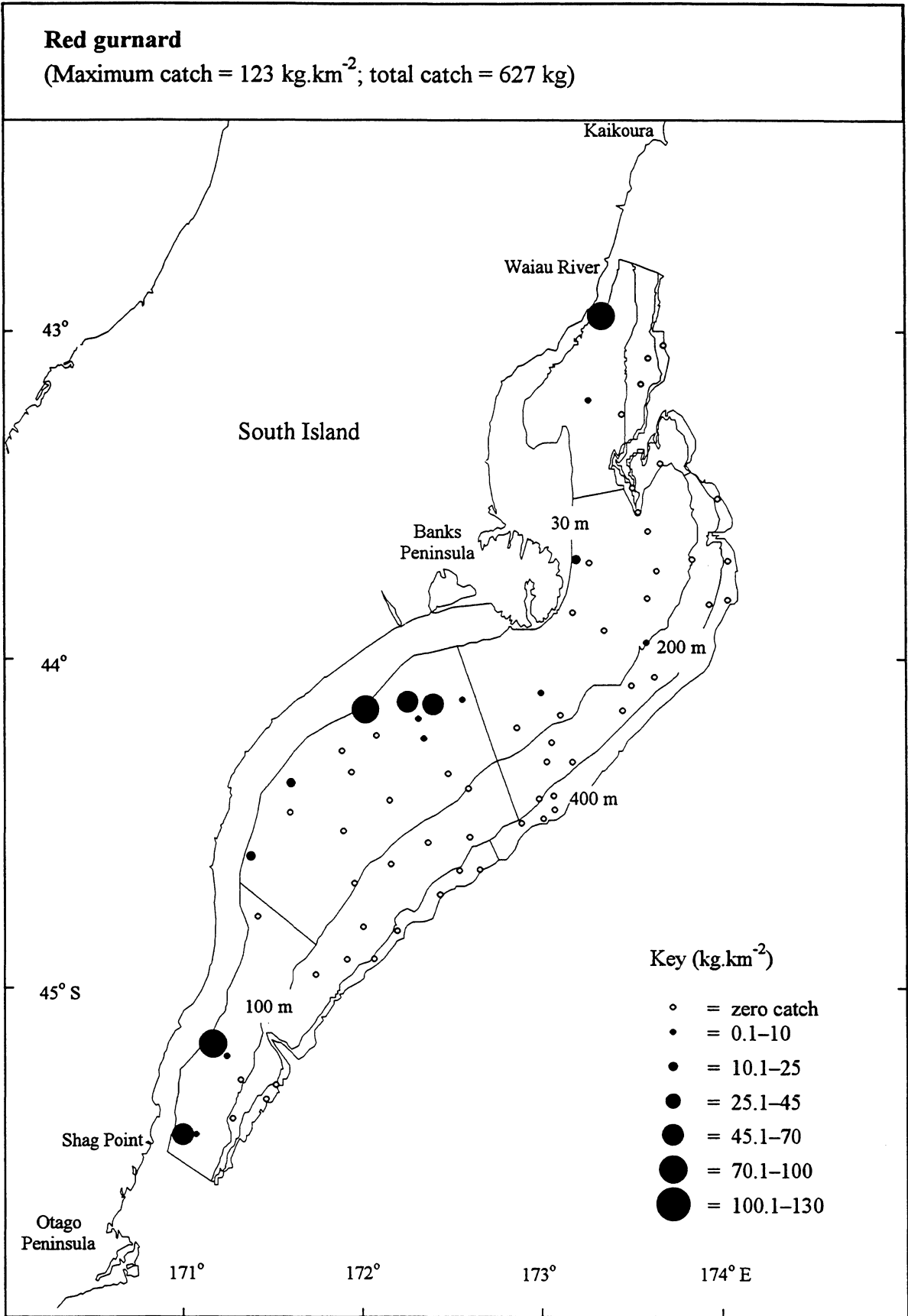


Figure 11: Catch rates of red gurnard.

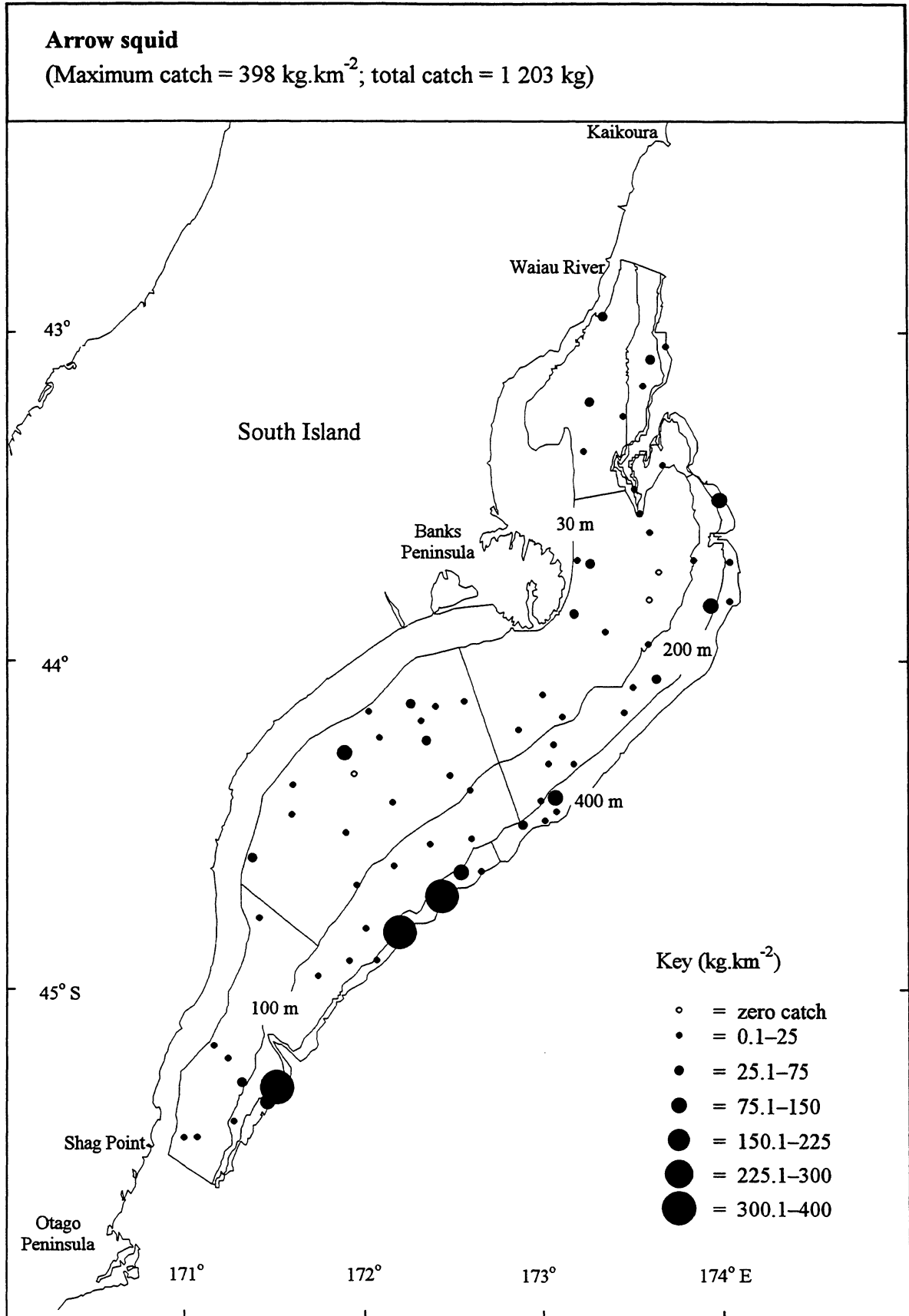


Figure 12: Catch rates of arrow squid.

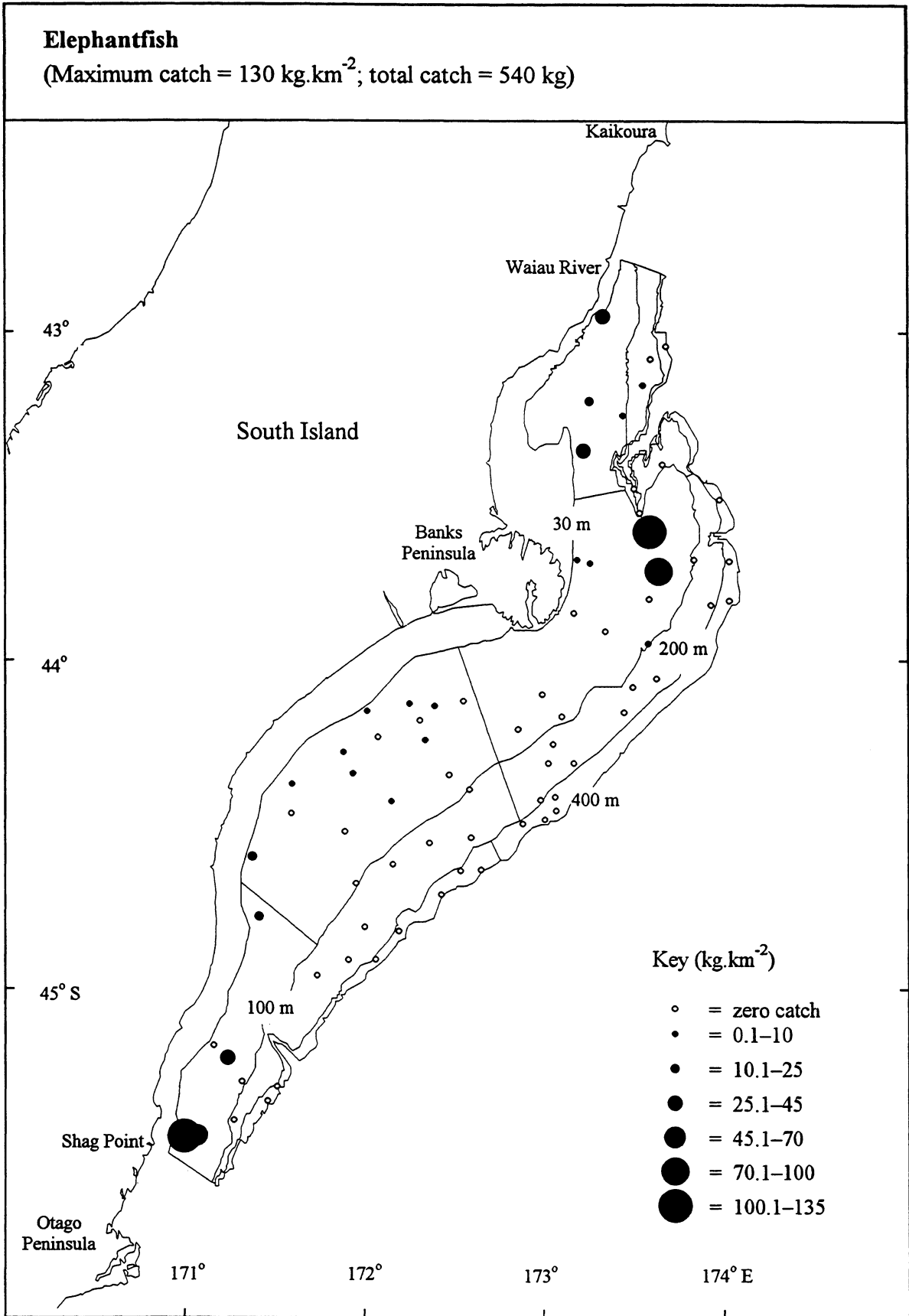


Figure 13: Catch rates of elephantfish.

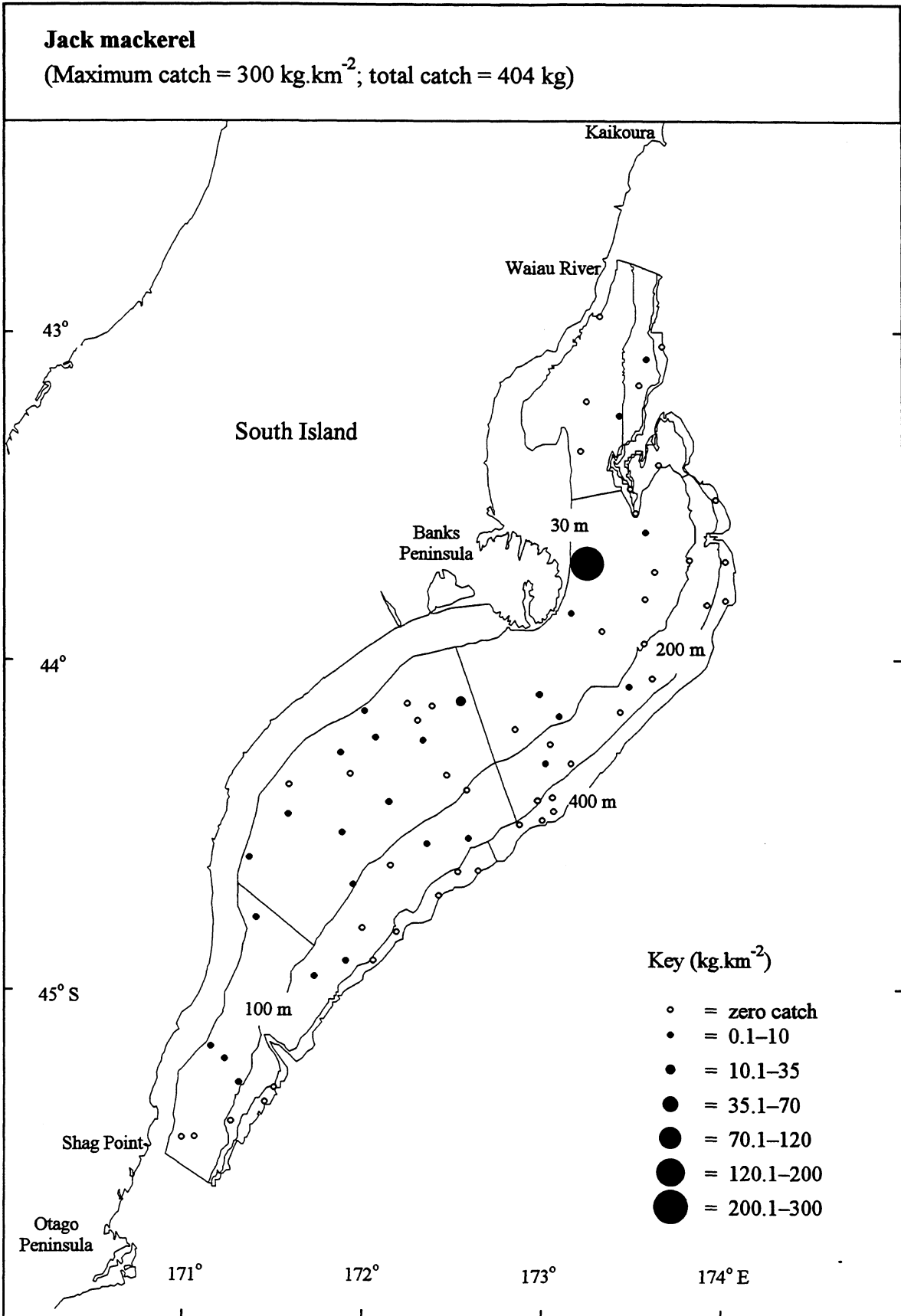


Figure 14: Catch rates of jack mackerel (*Trachurus declivis*).

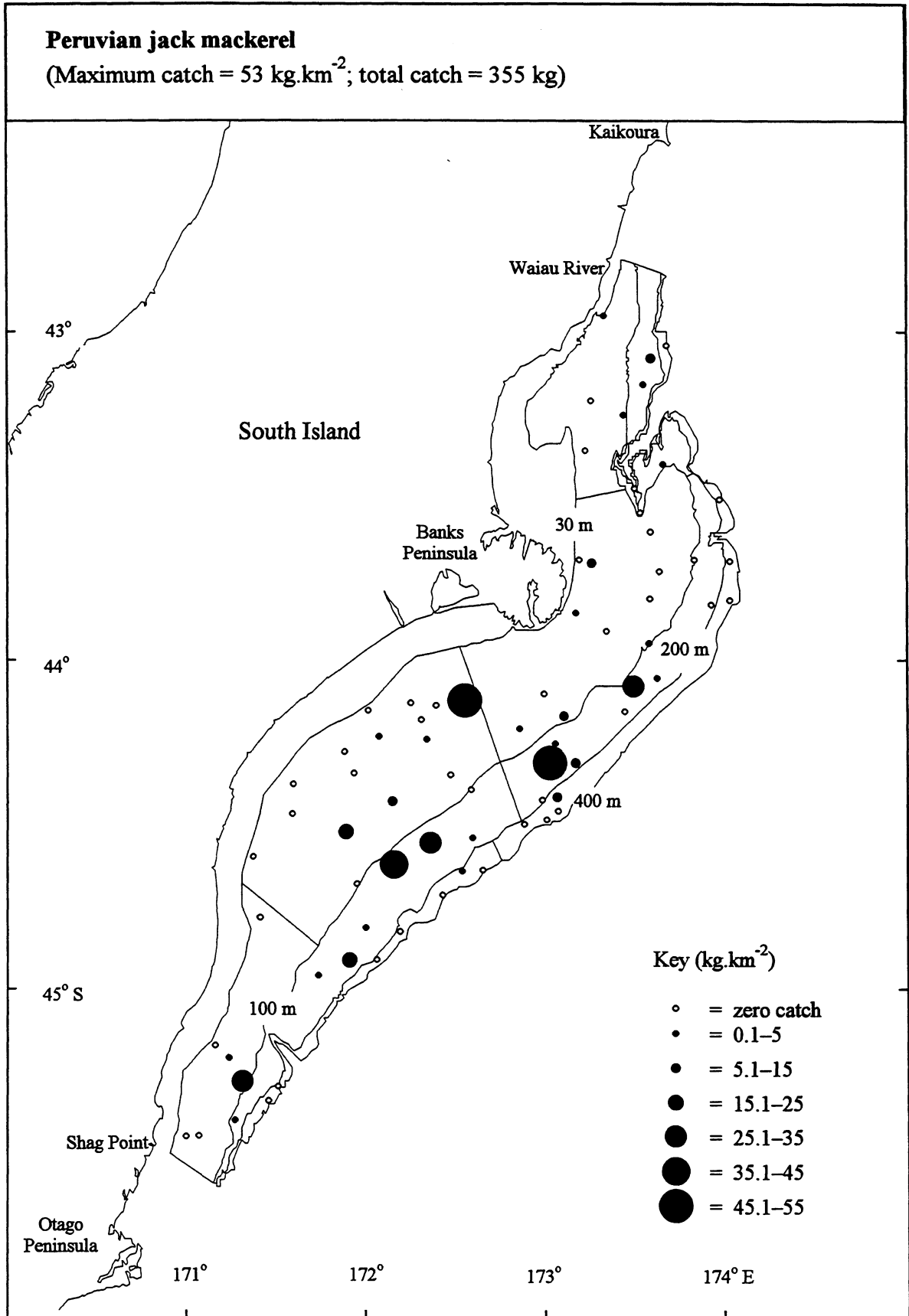


Figure 15: Catch rates of Peruvian jack mackerel (*Trachurus murphyi*).

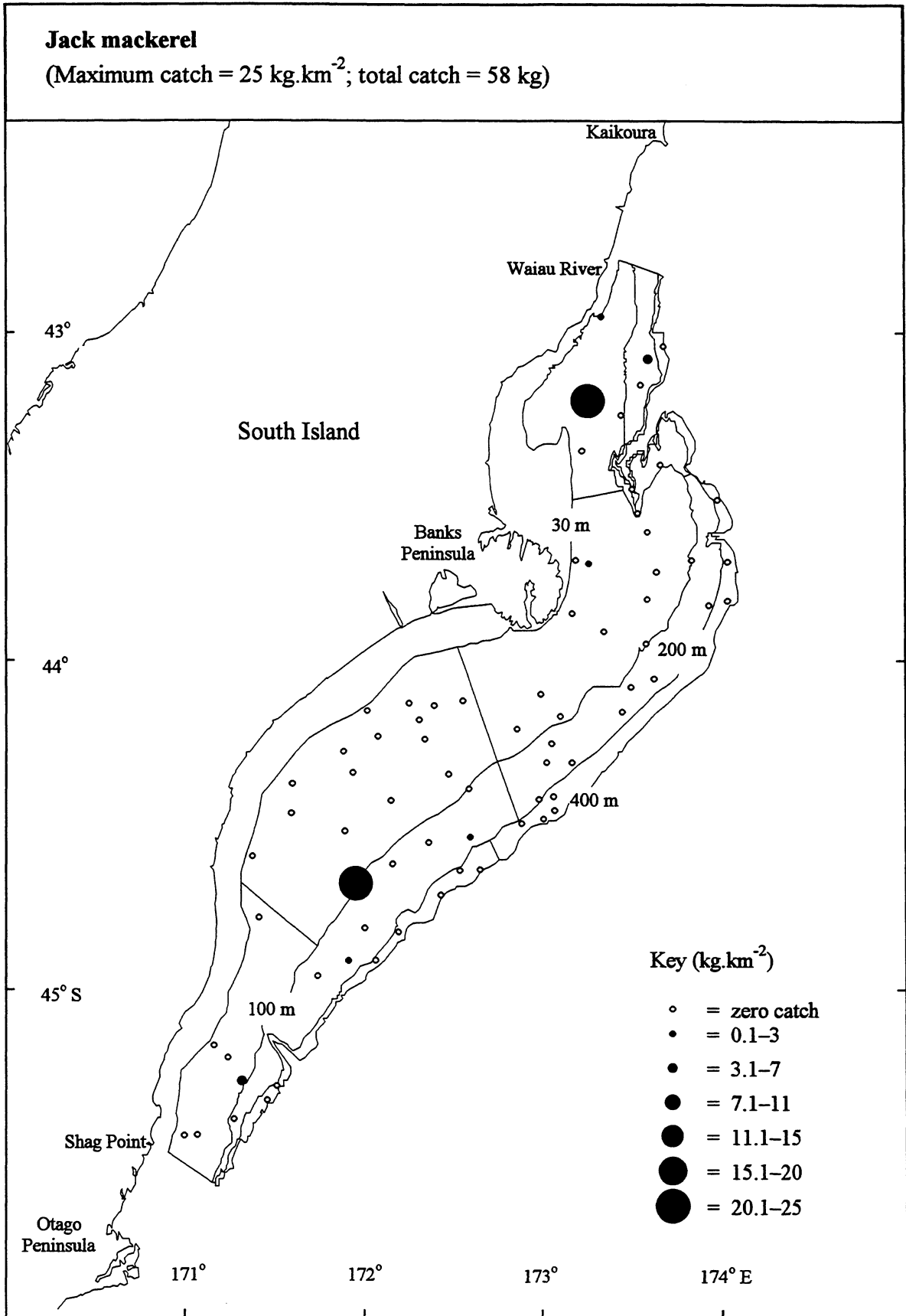


Figure 16: Catch rates of jack mackerel (*Trachurus novaezelandiae*).

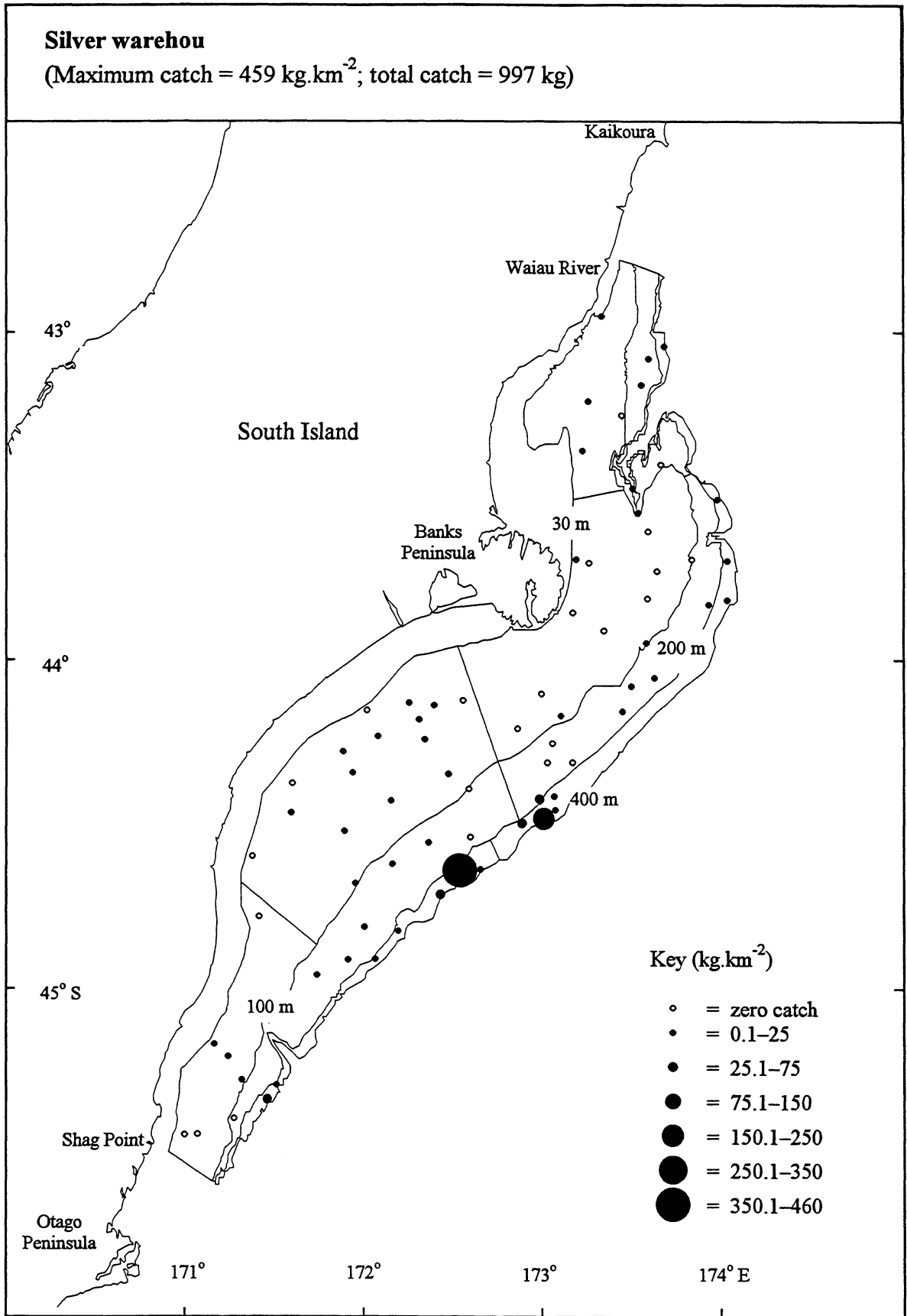


Figure 17: Catch rates of silver warehou.

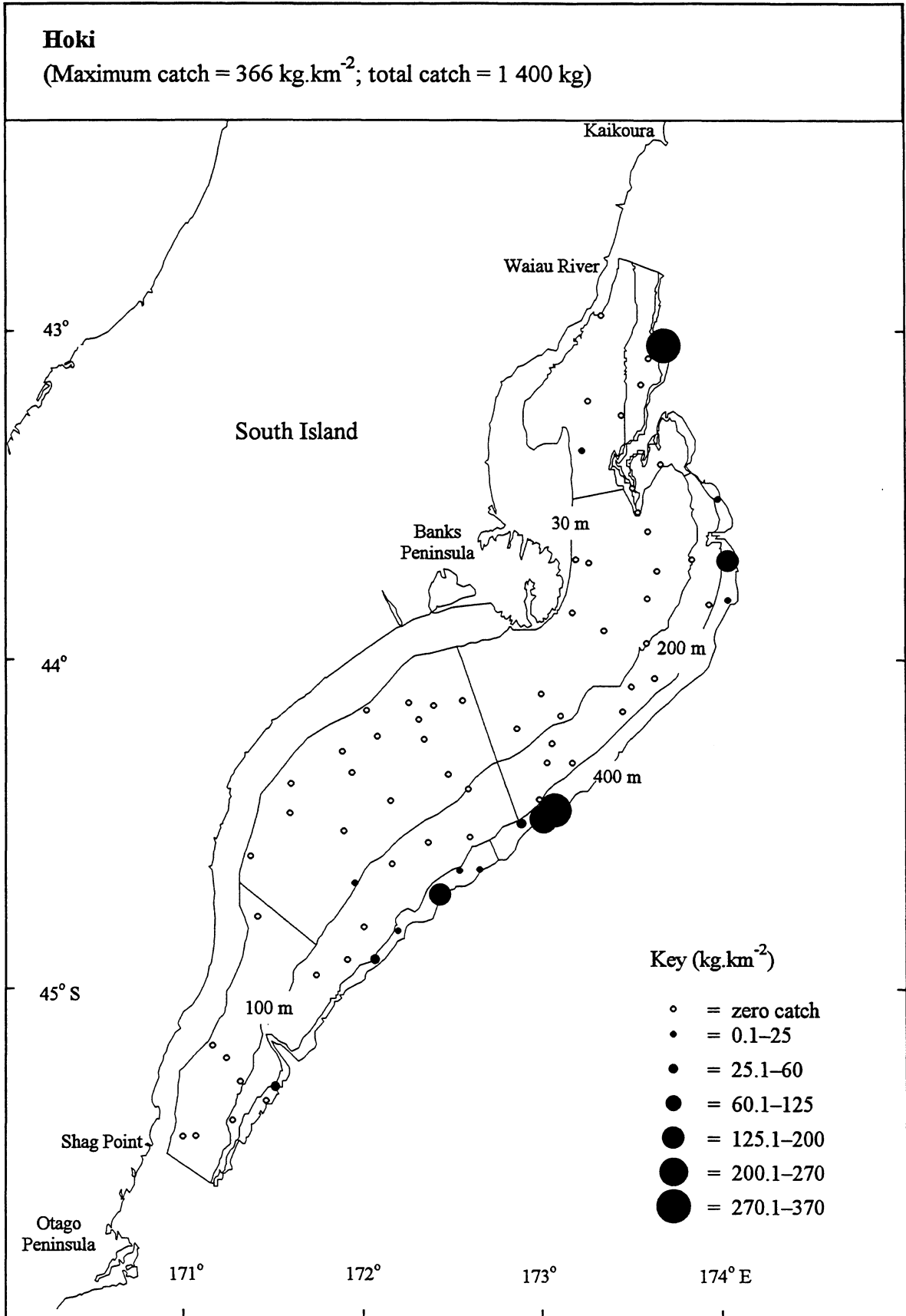


Figure 18: Catch rates of hoki.

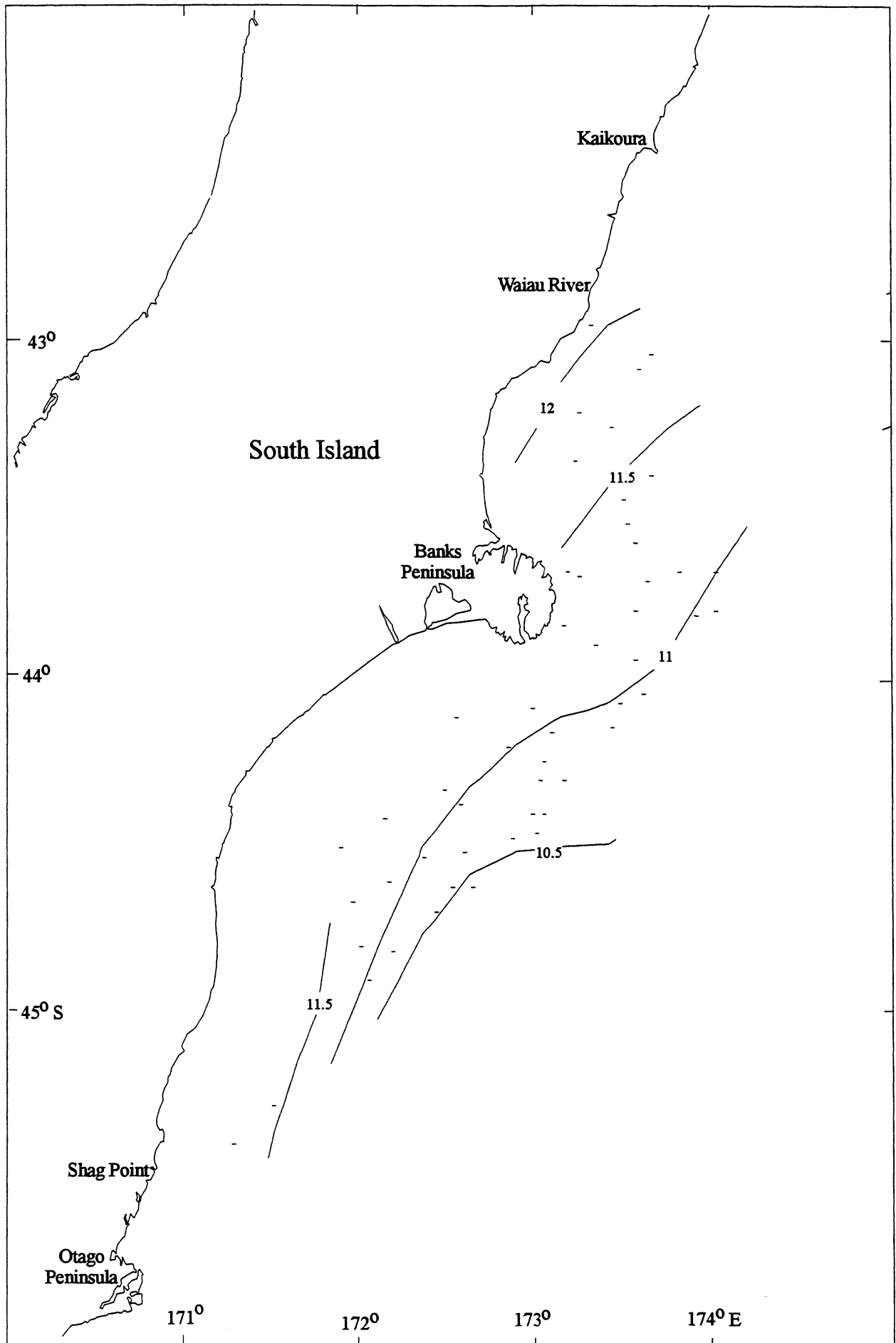


Figure 19 : Sea surface temperatures (°C) .

Barracouta

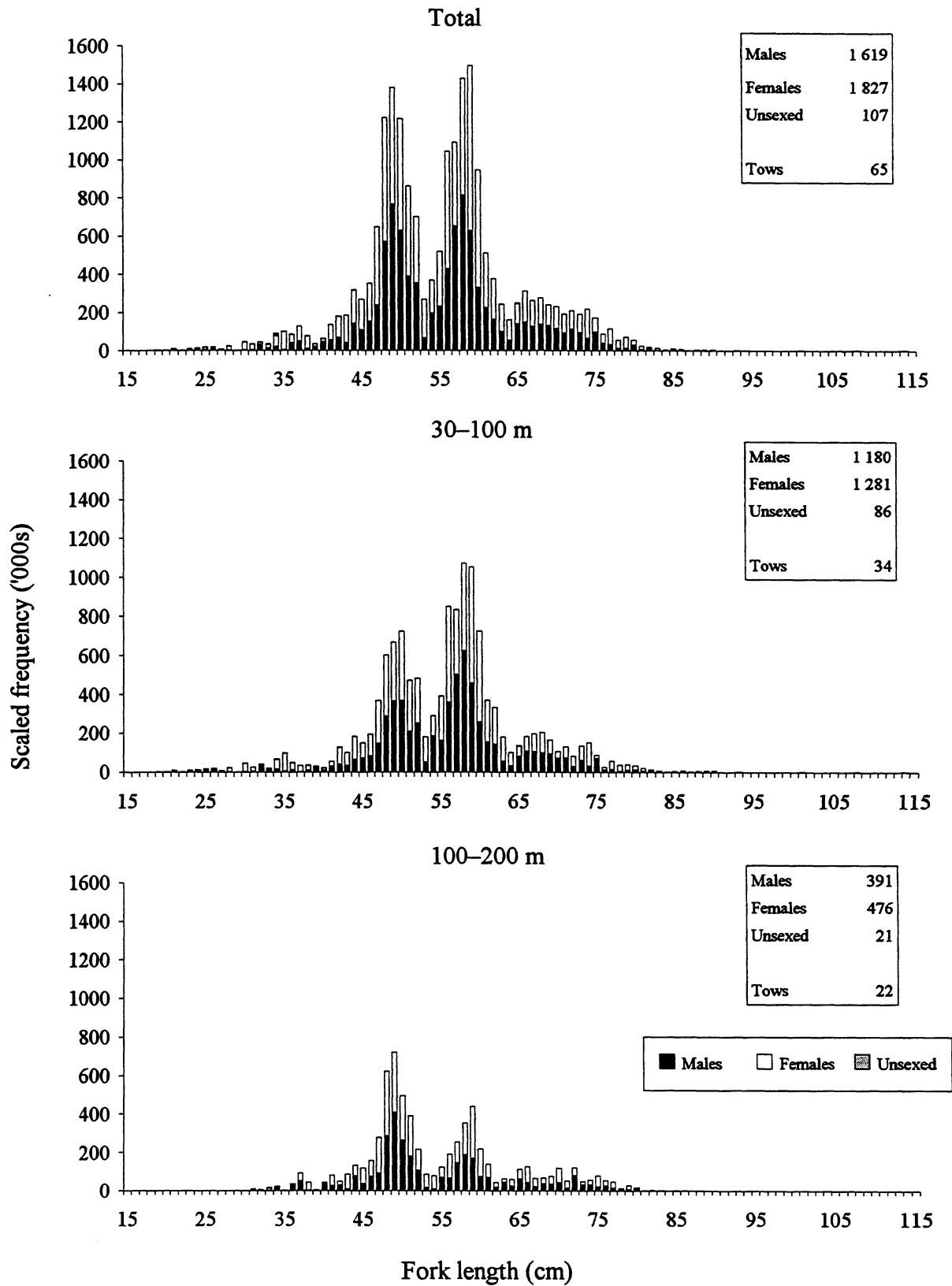


Figure 20: Scaled length frequency distributions for barracouta for total survey area and by depth (numbers of males, females, and unsexed are actual numbers measured).

Spiny dogfish

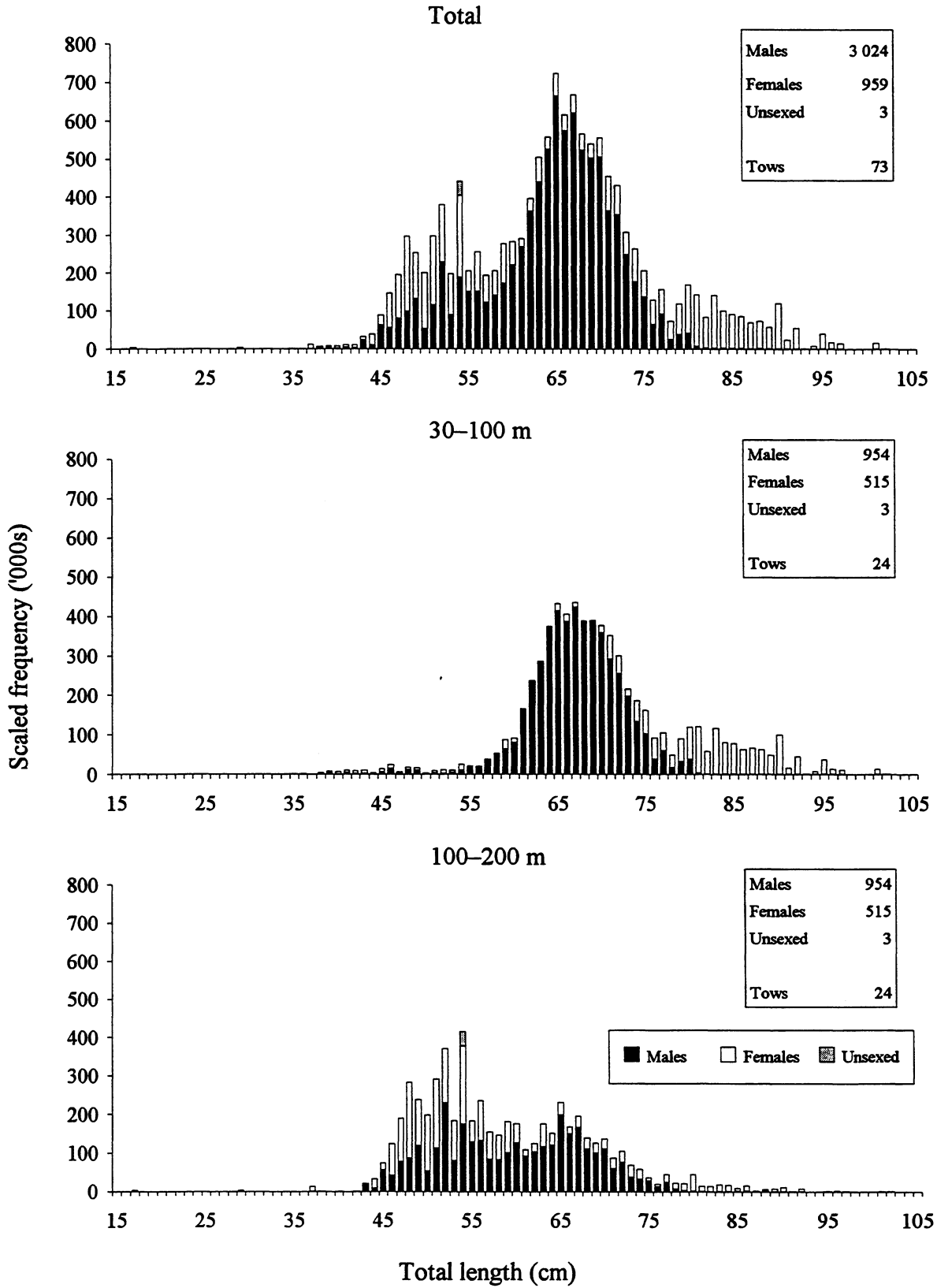


Figure 21: Scaled length frequency distributions for spiny dogfish for total survey area and by depth (numbers of males, females, and unsexed are actual numbers measured).

Sea perch

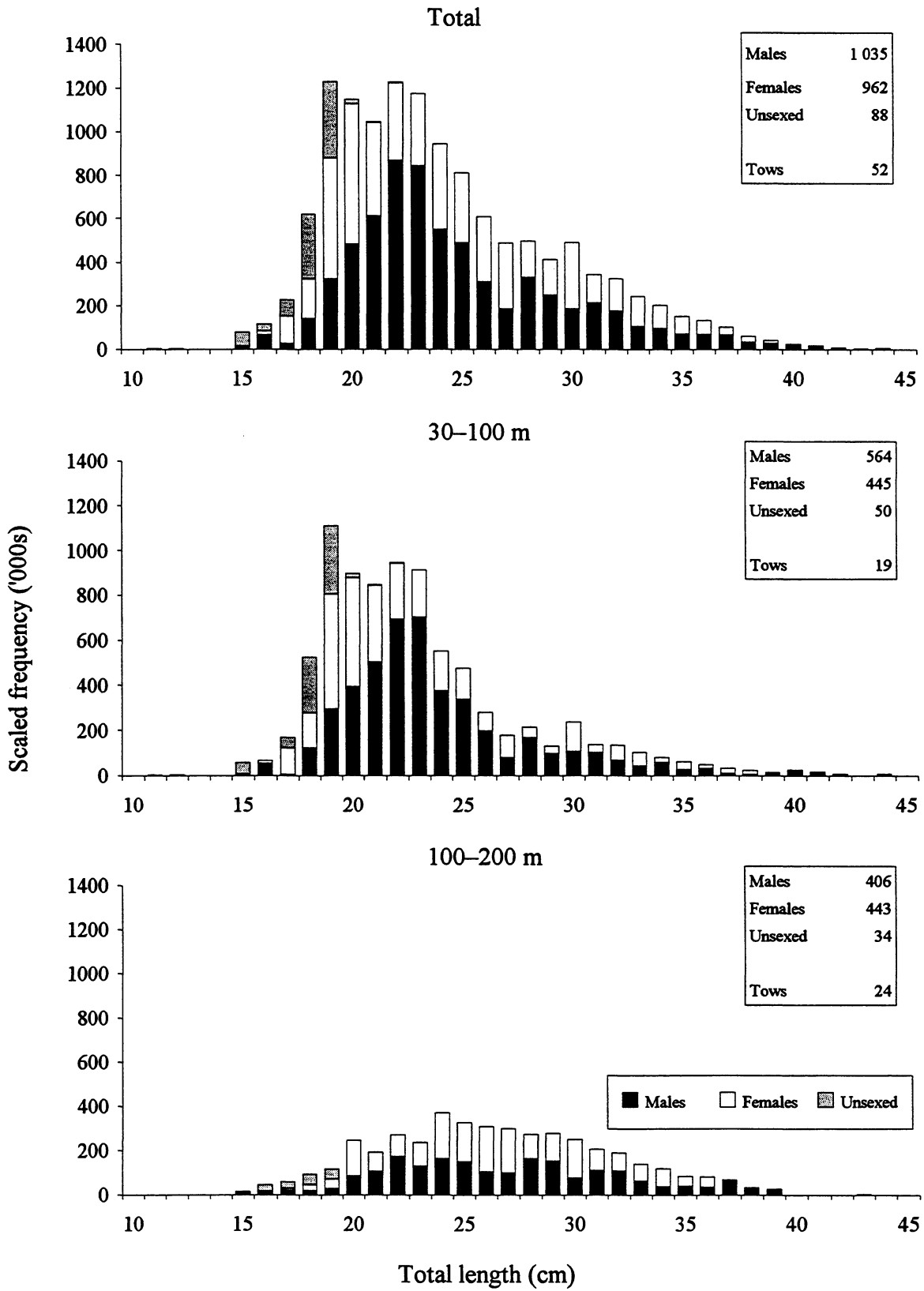


Figure 22: Scaled length frequency distributions for sea perch for total survey area and by depth (numbers of males, females, and unsexed are actual numbers measured).

Arrow squid

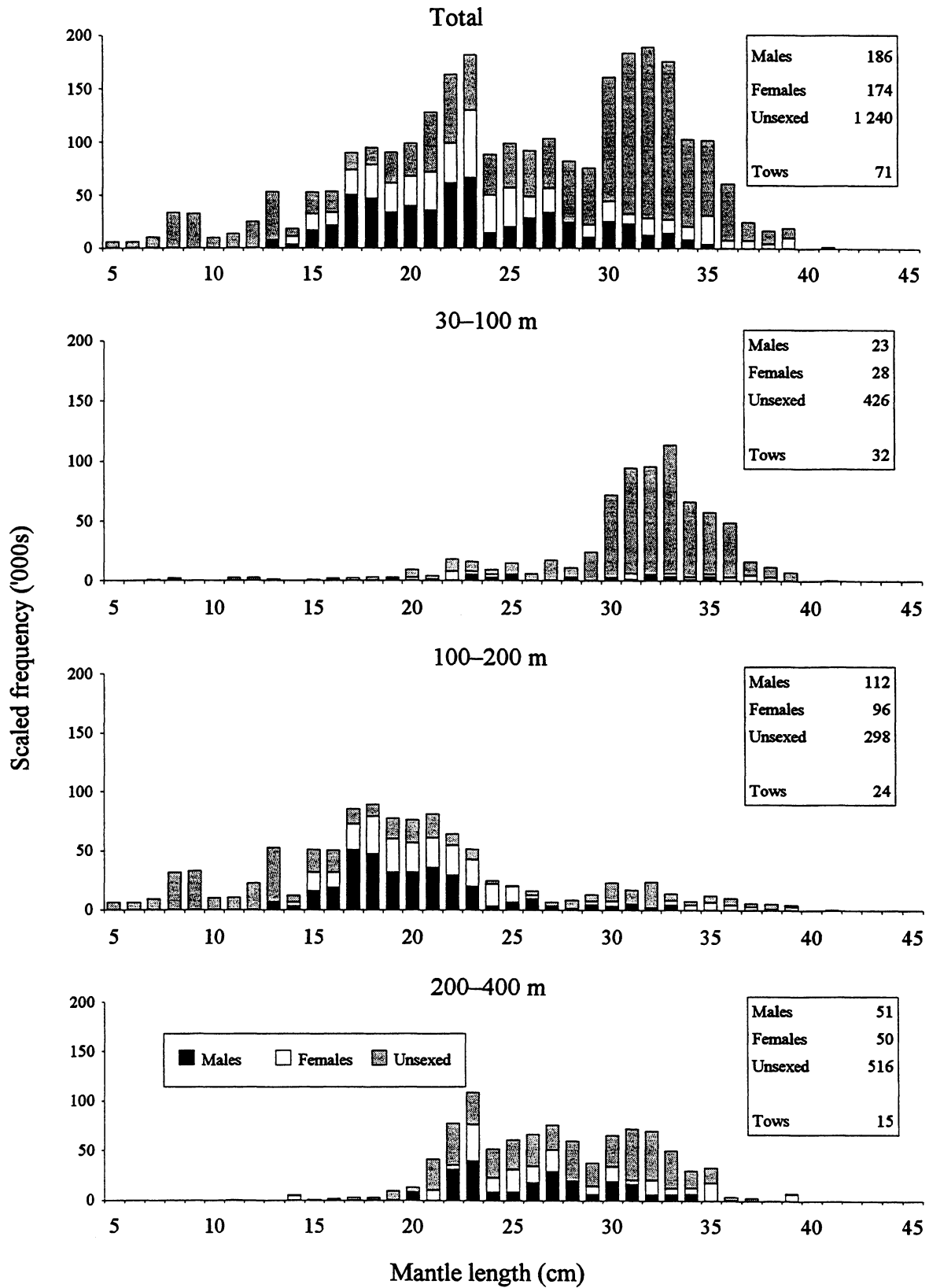


Figure 23: Scaled length frequency distributions for arrow squid for total survey area and by depth (numbers of males, females, and unsexed are actual numbers measured).

Stargazer

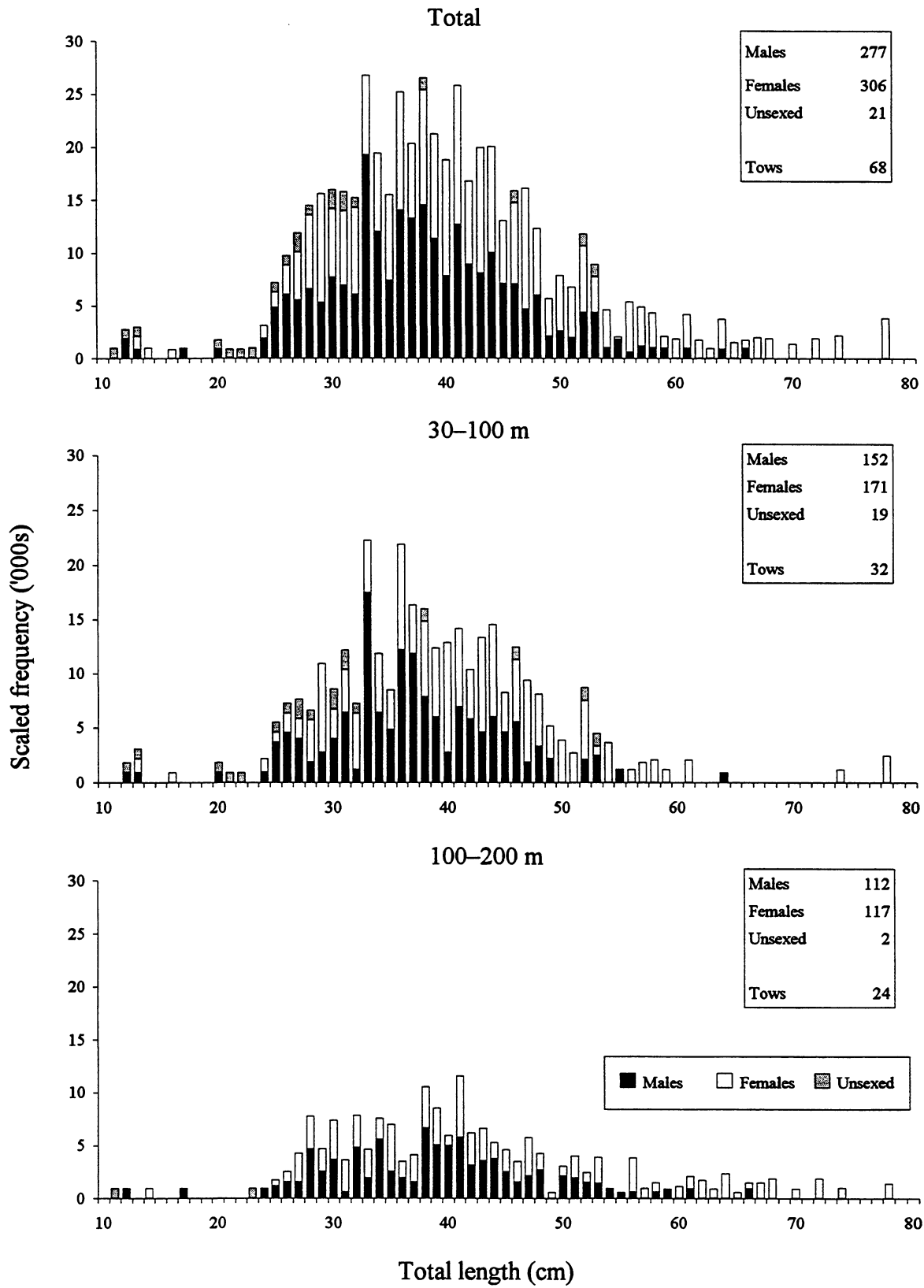
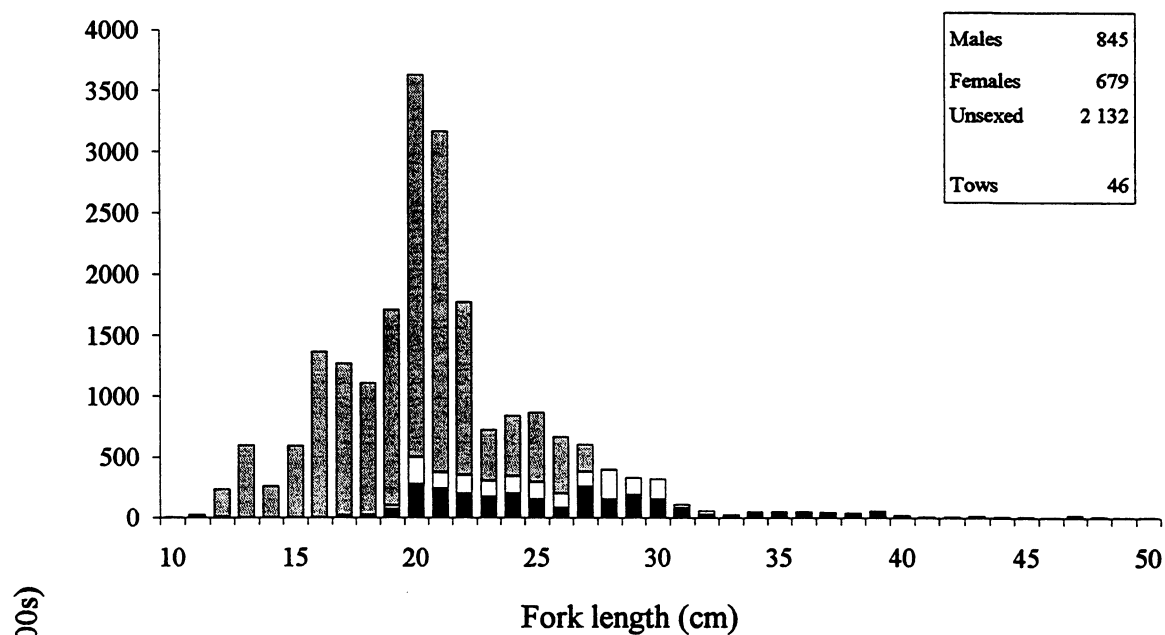


Figure 24: Scaled length frequency distributions for stargazer for total survey area and by depth (numbers of males, females, and unsexed are actual numbers measured).

Tarakihi

Total



Red gurnard

Total

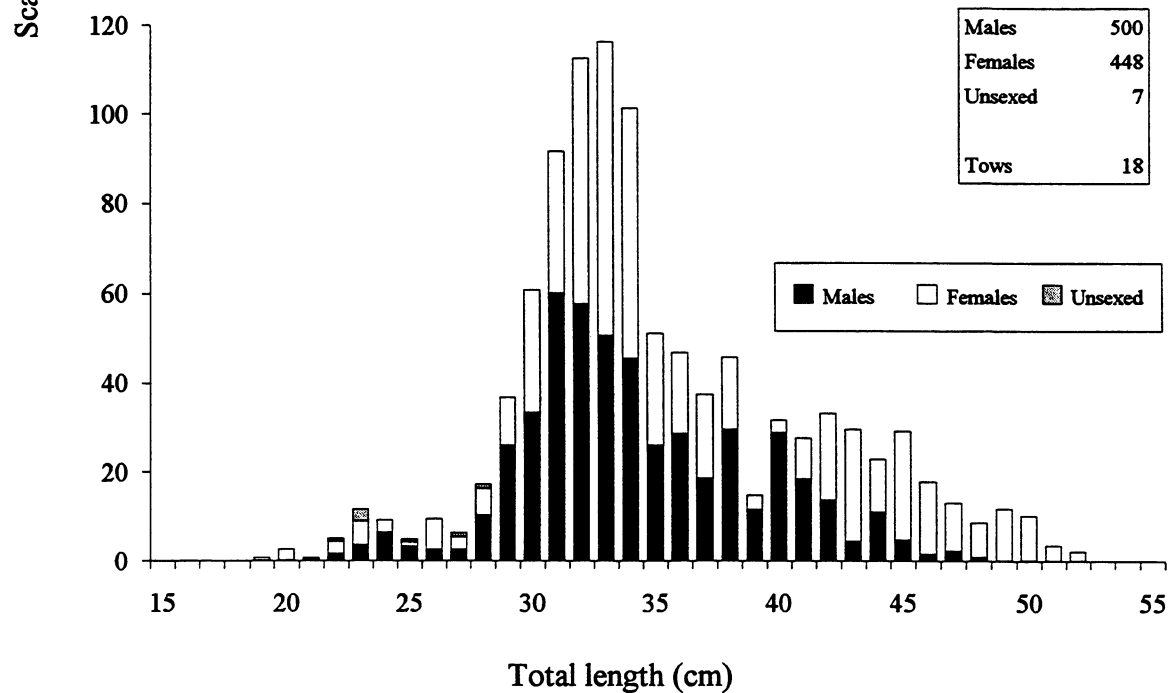


Figure 25: Scaled length frequency distributions for tarakihi and red gurnard for total survey area (numbers of males, females, and unsexed are actual numbers measured). Almost all fish were caught in the 30–100 m range.

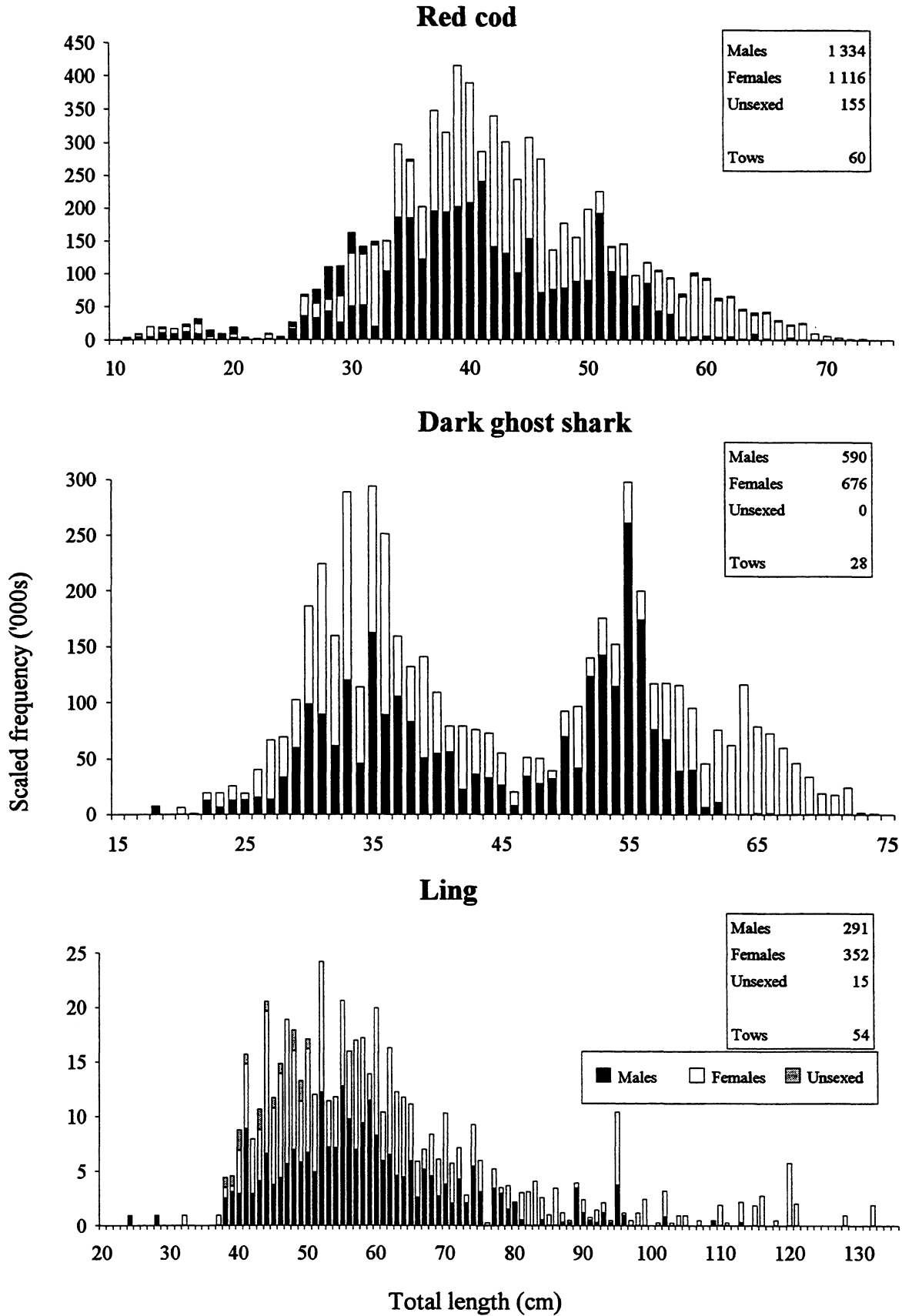


Figure 26: Scaled length frequency distributions for red cod, dark ghost shark, and ling (numbers of males, females, and unsexed are actual numbers measured). Almost all red cod were caught in the 100–200 m range.

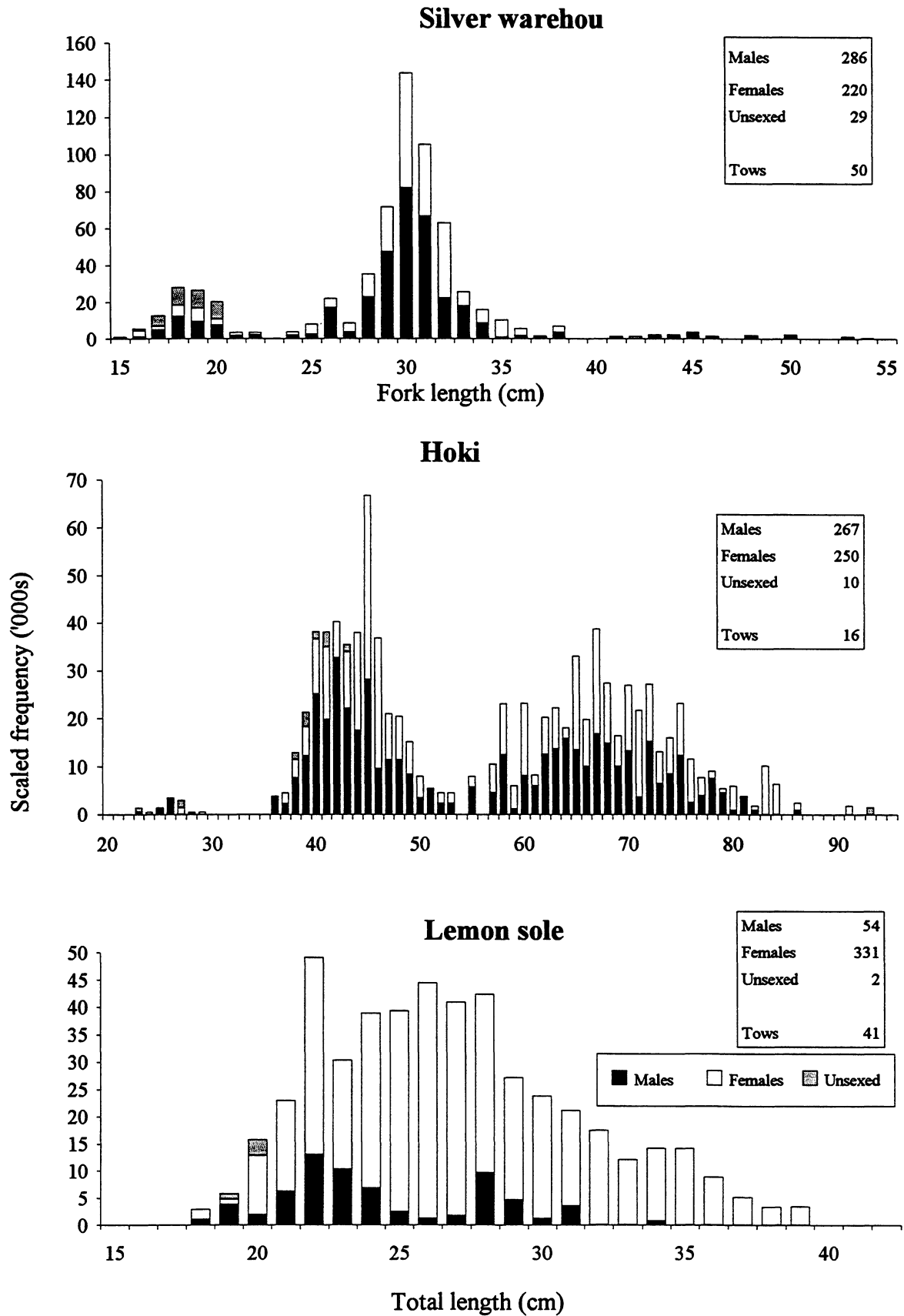


Figure 27: Scaled length frequency distributions for silver warehou, hoki, and lemon sole (numbers of males, females, and unsexed are actual numbers measured).

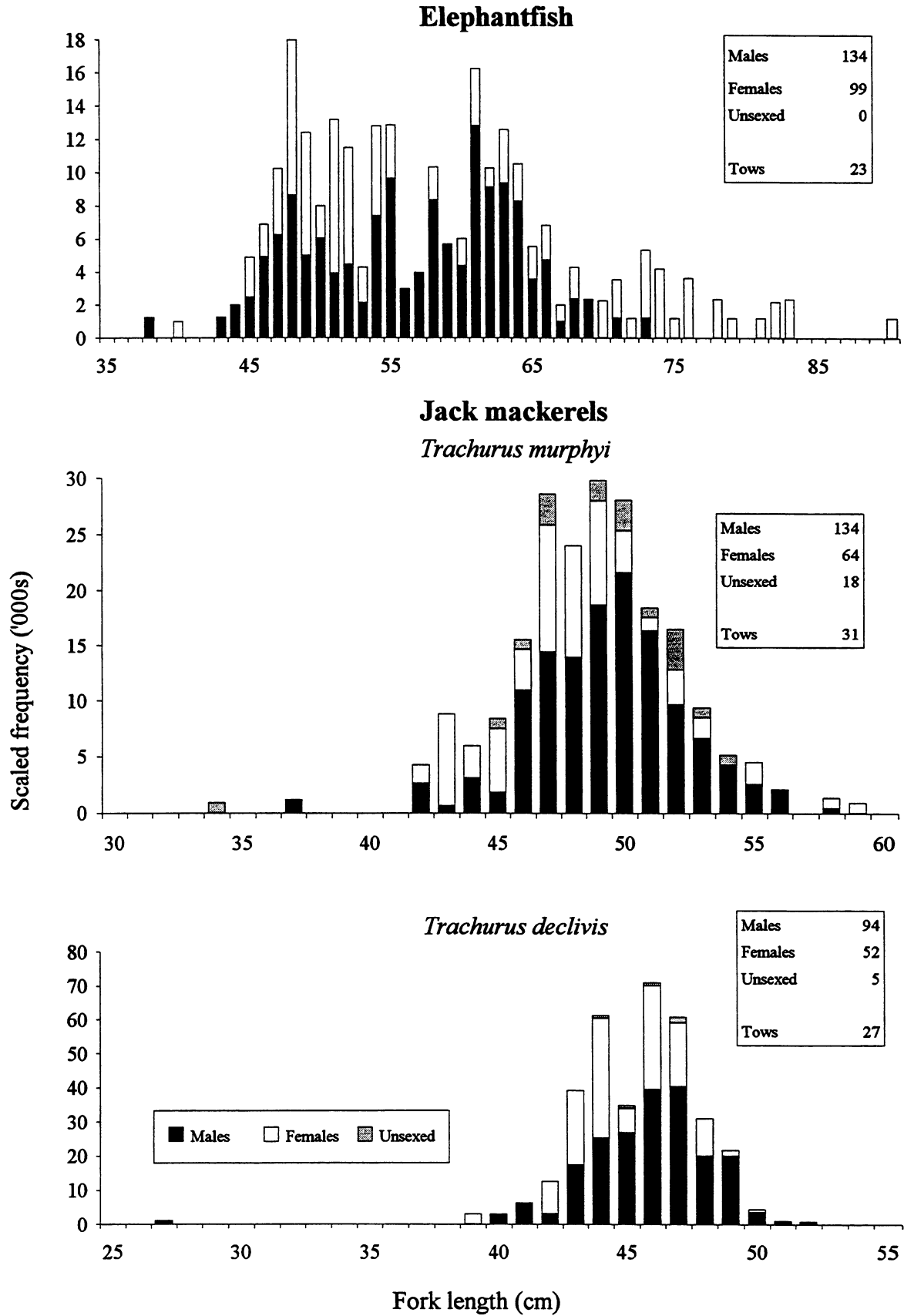


Figure 28: Scaled length frequency distributions for elephantfish, and jack mackerels, *T. murphyi*, and *T. declivis* (numbers of males, females, and unsexed are actual numbers measured).

Appendix 1: Station data*

Station	Stratum	Date	Start position		Gear depth (m)	
			Lat ° ' S	Long ° ' E	Min.	Max.
1	2	9/05/93	44 22 66	171 35 94	43	48
2	2	9/05/93	44 28 07	171 35 56	51	54
3	1	10/05/93	45 26 84	170 59 90	45	49
4	1	10/05/93	45 26 80	171 04 18	54	55
5	1	10/05/93	45 10 34	171 09 66	35	38
6	1	10/05/93	45 12 55	171 14 26	57	58
7	2	11/05/93	44 09 33	172 01 07	42	42
8	2	11/05/93	44 07 98	172 15 27	40	50
9	2	11/05/93	44 08 36	172 23 82	55	56
10	2	11/05/93	44 11 02	172 18 84	55	56
11	2	11/05/93	44 14 60	172 20 71	67	72
12	2	12/05/93	44 14 05	172 04 70	51	52
13	2	12/05/93	44 16 79	171 53 04	50	53
14	2	12/05/93	44 20 70	171 56 24	60	67
15	2	13/05/93	44 35 99	171 22 43	35	40
16	1	13/05/93	44 47 04	171 24 67	45	46
17	5	13/05/93	44 57 60	171 44 26	120	122
18	5	13/05/93	44 54 84	171 54 71	131	132
19	1	14/05/93	45 16 90	171 18 98	87	94
20	8	14/05/93	45 20 39	171 27 60	219	227
21	8	14/05/93	45 17 80	171 30 66	248	254
22	5	14/05/93	45 23 93	171 16 28	104	105
23	8	15/05/93	44 54 76	172 03 92	238	333
24	5	15/05/93	44 48 90	172 00 16	127	134
25	5	15/05/93	44 40 90	171 57 19	105	109
26	4	21/05/93	43 12 61	173 15 92	49	55
27	4	21/05/93	42 57 09	173 20 28	40	48
28	9	21/05/93	43 02 59	173 41 23	312	327
29	7	22/05/93	43 04 90	173 36 06	131	149
30	7	22/05/93	43 09 65	173 33 64	119	120
31	4	22/05/93	43 15 25	173 26 98	92	93
32	7	22/05/93	43 24 19	173 40 18	108	117
33	3	23/05/93	43 36 54	173 35 73	89	92
34	3	23/05/93	43 42 30	173 16 00	66	67
35	3	23/05/93	43 41 64	173 11 80	47	47
36	4	24/05/93	43 21 67	173 13 95	44	46
37	6	24/05/93	43 28 62	173 30 60	103	105
38	9	24/05/93	43 30 57	173 58 82	273	289
39	9	24/05/93	43 41 92	174 02 06	326	337
40	9	25/05/93	43 49 07	174 02 05	348	378
41	3	25/05/93	43 43 80	173 38 69	90	90
42	3	25/05/93	43 48 80	173 35 56	89	91
43	6	25/05/93	43 57 01	173 35 32	100	107
44	6	25/05/93	44 04 86	173 30 20	120	130
45	6	26/05/93	44 18 78	173 01 75	127	130
46	9	26/05/93	44 25 01	173 04 16	242	253
47	9	26/05/93	44 27 49	173 04 40	347	358
48	9	26/05/93	44 29 11	173 00 55	361	403
49	9	26/05/93	44 29 94	172 53 17	282	291
50	3	30/05/93	43 51 44	173 10 49	74	75
51	3	30/05/93	43 54 72	173 21 03	78	78
52	3	30/05/93	44 10 25	173 06 49	93	98
53	6	30/05/93	44 15 33	173 03 48	116	128
54	8	31/05/93	44 49 59	172 11 74	237	249
55	8	31/05/93	44 42 98	172 25 92	334	339
56	8	31/05/93	44 38 38	172 39 19	384	399
57	8	31/05/93	44 38 54	172 32 39	252	254
58	2	1/06/93	44 31 34	171 53 57	74	74
59	2	1/06/93	44 25 79	172 09 19	75	79

Appendix 1 - continued

Station	Stratum	Date	Start position		Gear depth (m)	
			Lat ° ' S	Long ° ' E	Min.	Max.
60	2	1/06/93	44 20 98	172 28 68	81	90
61	5	1/06/93	44 23 63	172 35 48	107	113
62	5	1/06/93	44 33 44	172 22 03	117	119
63	2	2/06/93	44 07 53	172 33 41	59	65
64	3	2/06/93	44 12 65	172 51 73	82	84
65	3	2/06/93	44 06 22	172 59 71	78	80
66	6	2/06/93	44 09 44	173 27 14	139	144
67	5	3/06/93	44 37 36	172 09 64	111	114
68	5	3/06/93	44 32 42	172 35 84	138	139
69	6	3/06/93	44 25 57	172 59 08	150	168
70	6	3/06/93	44 18 80	173 10 38	136	145
71	6	4/06/93	44 03 40	173 37 93	145	200
72	6	4/06/93	43 49 91	173 56 00	160	200
73	6	4/06/93	43 41 64	173 50 27	101	102
74	7	4/06/93	43 33 03	173 32 47	101	110

*All tows were of 3 n.miles, except stations 20, 3.20; 71, 2.75; and 72, 2.01 n.miles.

Appendix 2: Default length weight coefficients used to scale length frequencies.

Determined from $W = aL^b$ where W = weight (g) and L = length (cm) *

Common name	<i>a</i>	<i>b</i>	Source	<i>N</i>	<i>cm</i>
Arrow squid	0.0096	3.25			
Barracoutta	0.00520	2.98	TAN9301	919	15–96
Dark ghost shark	0.0019	3.29	TAN9301	52	27–70
Elephantfish	0.0105	2.99	TAN9301	62	58–92
Hoki	0.002824	3.006	TAN9401	1 002	34–105
Jack mackerel (<i>T. declivis</i>)	0.0165	2.93	COR9001	200	15–53
Lemon sole	0.02323	2.833	IKA8003		
Ling	0.001026	3.34	TAN9401	896	36–162
Peruvian jack mackerel (<i>T. murphyi</i>)	0.0255	2.77	TAN9301	90	44–62
Red cod	0.004791	3.19008	KAH9306	405	11–73
Red gurnard	0.036684	2.7051	KAH9306	180	19–53
Sea perch	0.00363	3.45343	KAH9008, KAH9105, KAH9205	266	15–40
Silver warehou	0.006535	3.299	TAN9401	160	22–56
Spiny dogfish	0.0003	3.62	TAN9301	937	55–102
Stargazer	0.013745	3.05125	KAH9306	183	12–78
Tarakihi	0.028	2.879			

*Length weight coefficients for red cod, red gurnard and stargazer were derived from this survey (see Table 6). For most other species the source of the length weight coefficient is provided.

Appendix 3: Catch (kg) at each station of the 20 most abundant commercial species*

Station	BAR	SPD	RCO	GSH	TAR	SPE	SQU	LIN	HOK	STA	GUR
1	33.7	12.0	0.6	0.0	15.8	45.4	8.1	7.6	0.0	0.2	13.4
2	148.3	371.9	418.3	0.0	5.4	0.0	2.2	3.8	0.0	3.4	0.0
3	64.2	55.7	8.9	0.0	0.0	9.3	2.9	0.1	0.0	8.4	59.6
4	1.9	71.0	69.7	0.0	1.9	26.0	1.8	11.1	0.0	18.5	9.3
5	15.1	193.1	0.0	0.0	166.5	0.0	3.5	6.3	0.0	0.7	81.0
6	2 084.2	1 350.4	4.1	0.0	4.7	15.8	9.7	33.9	0.0	14.6	1.9
7	628.2	96.0	1.4	0.0	6.8	0.0	12.6	0.2	0.0	0.3	86.5
8	69.1	11.6	21.2	0.0	58.7	0.0	35.7	1.2	0.0	34.3	63.7
9	45.6	28.9	0.0	0.0	94.2	0.0	10.6	0.6	0.0	33.8	53.2
10	10.8	55.5	3.1	0.0	48.9	0.0	0.5	0.0	0.0	19.6	4.8
11	475.0	525.6	17.6	0.0	39.6	0.1	35.2	0.3	0.0	12.3	0.7
12	276.3	17.0	15.8	0.0	64.5	0.0	18.5	0.0	0.0	15.0	0.0
13	1 013.8	28.2	0.0	0.0	8.9	0.1	134.7	0.0	0.0	20.1	0.0
14	317.6	395.4	1.7	0.0	102.1	0.0	0.0	0.2	0.0	5.7	0.0
15	4 218.3	111.9	43.4	0.0	0.0	0.0	43.2	26.4	0.0	0.0	12.9
16	881.1	619.9	0.0	0.0	0.4	0.0	6.5	0.0	0.0	0.2	0.0
17	1 122.3	436.5	774.2	7.5	0.0	2.6	8.4	3.3	0.0	9.1	0.0
18	604.9	694.6	84.6	1 505.3	0.0	6.2	9.2	14.5	0.0	11.8	0.0
19	331.8	224.1	11.1	0.0	25.1	225.3	32.4	28.4	0.0	10.9	0.0
20	33.7	54.6	403.3	319.3	0.0	0.5	95.6	13.7	0.0	26.8	0.0
21	32.6	32.4	17.6	661.7	0.0	0.0	397.8	7.9	41.9	17.4	0.0
22	14.9	63.2	954.2	22.7	4.0	204.3	21.5	76.3	0.0	20.3	0.0
23	0.0	0.0	262.4	142.4	0.0	0.0	22.8	232.3	30.4	0.0	0.0
24	1 454.2	194.9	240.9	30.2	0.0	328.2	7.0	33.0	0.0	10.3	0.0
25	693.9	119.7	32.3	0.0	12.1	101.6	7.2	24.9	0.6	8.9	0.0
26	124.9	202.4	100.6	0.0	90.7	834.6	31.8	15.9	0.0	0.0	2.5
27	94.6	937.0	8.3	0.0	251.7	80.2	29.7	0.0	0.0	0.0	93.1
28	0.0	31.4	21.7	2.0	0.0	76.4	5.1	124.3	302.4	6.3	0.0
29	28.0	2 376.6	210.9	0.0	522.1	17.5	43.5	2.6	0.0	66.2	0.0
30	93.7	205.5	236.7	0.0	39.6	82.7	8.4	0.0	0.0	43.2	0.0
31	64.2	105.8	57.2	0.0	98.1	127.7	5.0	0.0	0.0	32.7	0.0
32	12.8	61.7	13.1	0.0	3.8	99.3	22.1	0.0	0.0	5.6	0.0
33	259.0	1 213.9	0.0	0.0	32.8	0.0	2.5	6.3	0.0	7.6	0.0
34	190.8	83.1	2.1	0.0	0.6	0.2	39.6	0.9	0.0	14.8	0.0
35	11.3	106.5	8.5	0.0	0.0	0.2	1.3	1.3	0.0	0.7	18.1
36	5.7	19.3	43.3	0.0	0.0	0.0	10.0	3.5	0.2	2.2	122.7
37	20.8	98.1	0.0	0.0	0.3	2.4	4.3	6.7	0.0	8.5	0.0
38	51.6	70.4	0.8	109.3	5.0	0.8	118.6	0.0	8.2	7.4	0.0
39	6.9	27.7	0.0	67.2	0.0	0.0	6.2	38.8	186.9	3.2	0.0
40	0.0	1.8	0.1	13.4	0.0	0.0	5.1	11.2	3.2	4.6	0.0
41	35.7	275.5	0.0	0.1	25.8	17.4	0.0	4.8	0.0	14.8	0.0
42	0.0	1 501.1	2.2	0.0	129.7	173.1	0.0	0.0	0.0	0.6	0.0
43	626.3	1 017.9	0.2	0.0	6.8	15.7	0.7	0.0	0.0	4.6	1.4
44	2 083.4	416.6	8.2	52.4	1.3	156.4	4.7	1.3	0.0	124.5	0.0
45	1 228.0	76.5	469.2	0.0	0.0	2.1	5.3	7.8	0.0	12.8	0.0
46	363.6	108.6	6.4	9.5	0.0	0.2	126.4	0.2	21.1	0.0	0.0
47	9.7	103.7	48.1	146.2	0.0	0.5	24.3	97.1	366.4	24.7	0.0
48	0.0	24.5	1.9	17.9	0.0	2.8	7.7	509.9	210.4	7.4	0.0
49	31.3	57.1	245.0	116.1	0.0	1.3	72.1	7.0	42.6	2.0	0.0
50	739.1	238.0	74.8	0.0	0.4	0.0	52.9	14.6	0.0	7.7	0.0
51	21.8	290.2	0.1	0.0	18.2	0.0	3.1	0.0	0.0	2.1	0.0
52	288.6	221.4	1.1	0.0	9.3	2.8	2.7	0.0	0.0	25.9	0.0
53	311.8	305.3	1 449.9	1.6	0.7	255.9	3.0	2.6	0.0	26.2	0.0
54	25.2	455.8	173.2	19.9	0.0	4.4	328.3	17.2	2.7	3.1	0.0
55	0.0	1 179.9	506.4	2 140.1	0.0	0.0	327.8	178.2	168.7	1.1	0.0
56	0.0	107.2	17.6	11.4	0.0	0.0	3.6	68.3	10.5	0.0	0.0
57	16.2	756.2	1.8	2 131.6	0.0	0.4	105.7	0.0	3.3	2.1	0.0
58	106.3	139.4	2.3	0.0	178.6	21.2	13.5	21.7	0.0	4.1	0.0
59	259.1	14.8	0.0	0.0	2 702.2	0.0	4.6	3.4	0.0	0.4	0.0

Appendix 3 - continued

Station	BAR	SPD	RCO	GSH	TAR	SPE	SQU	LIN	HOK	STA	GUR
60	2.5	88.9	3.8	0.0	4.2	7.1	0.3	0.2	0.0	43.0	0.0
61	51.4	60.0	0.4	1.7	0.0	177.2	2.5	0.1	0.0	4.8	0.0
62	1 313.5	195.0	58.8	0.0	0.3	75.3	5.0	1.6	0.0	4.7	0.0
63	999.6	110.5	7.7	0.0	24.9	0.0	11.8	0.0	0.0	40.1	1.5
64	853.6	352.8	0.0	0.0	73.0	0.6	0.8	0.0	0.0	9.0	0.0
65	238.9	224.6	0.0	0.0	10.5	59.7	1.7	0.0	0.0	5.3	0.6
66	4.2	350.3	1 475.6	25.6	0.3	442.6	3.8	4.5	0.0	73.1	0.0
67	328.2	168.9	17.6	0.0	2.6	94.7	4.0	39.6	0.0	12.7	0.0
68	494.8	648.5	107.4	1 072.4	2.1	212.7	0.5	2.7	0.0	1.0	0.0
69	3.9	367.6	3 511.2	1.1	0.0	1.4	24.4	0.0	0.0	2.2	0.0
70	14.9	19.2	3.2	13.8	0.0	6.6	10.4	2.7	0.0	6.1	0.0
71	15.6	106.7	70.0	4.2	0.0	69.9	48.3	10.2	0.0	4.2	0.0
72	0.0	24.1	0.0	0.0	0.0	12.2	136.9	3.5	0.0	18.9	0.0
73	14.3	175.5	0.0	0.0	0.0	1.0	3.5	0.0	0.0	12.9	0.0
74	0.0	117.8	0.0	0.0	3.5	24.9	2.1	0.0	0.0	26.8	0.0
Total	26 017.3	21 605.4	12 353.8	8 646.6	4 898.7	4 127.5	2 603.2	1 736.7	1 399.5	1 034.5	626.9

Appendix 3 - continued

Station	ELE	SCH	JMD	JMM	HAP	LSO	SPO	BCO	WAR	Total	All species
1	4.1	1.2	0.0	0.0	2.3	3.5	4.0	0.0	0.0	151.9	214.7
2	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.3	954.9	980.6
3	109.2	0.0	0.0	0.0	1.6	10.5	0.0	7.3	0.0	337.7	474.6
4	49.4	0.0	0.0	0.0	0.0	9.5	0.0	0.9	0.0	271.0	500.8
5	0.0	0.0	1.6	0.0	0.0	5.8	0.0	15.5	0.0	489.1	534.2
6	25.4	0.0	2.9	2.1	0.0	7.3	3.9	0.0	0.0	3 560.9	3 575.4
7	5.1	1.0	0.7	0.0	0.0	1.5	0.7	0.0	18.4	859.4	872.7
8	1.3	0.0	0.0	0.0	0.0	1.2	0.0	0.0	6.9	304.9	356.7
9	4.9	0.0	0.0	0.0	1.7	5.0	0.0	0.0	1.3	279.8	461.7
10	0.0	0.0	0.0	0.0	17.6	4.4	0.0	1.7	3.7	170.6	253.3
11	1.6	33.4	2.7	1.8	0.0	0.0	0.0	0.0	0.0	1 145.9	1 186.9
12	0.0	0.0	0.6	1.9	0.0	11.4	0.0	0.0	0.1	421.1	488.0
13	1.2	0.0	3.4	0.0	0.0	0.3	0.0	0.0	0.0	1 210.7	1 230.4
14	1.2	10.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	835.5	876.9
15	13.1	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	4 471.9	4 587.0
16	18.4	0.0	1.2	0.0	0.0	0.4	3.3	0.0	0.0	1 531.4	1 543.1
17	0.0	9.6	1.1	1.5	0.0	0.0	0.0	0.0	0.0	2 376.1	2 387.7
18	0.0	0.0	4.2	24.0	0.0	0.0	0.0	0.0	0.0	2 959.3	2 981.1
19	0.0	8.6	3.0	34.9	0.0	1.9	19.7	0.0	4.9	962.1	1 051.7
20	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	950.7	1 046.6
21	0.0	0.0	0.0	0.0	10.3	0.2	0.0	0.0	0.0	1 219.8	1 239.4
22	0.0	0.0	0.0	3.6	3.9	21.2	0.0	0.0	0.0	1 410.1	2 004.2
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	690.3	762.5
24	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	2 300.4	2 388.1
25	0.0	4.9	5.5	0.0	0.0	0.0	1.9	0.0	0.0	1 013.5	1 082.4
26	12.3	4.9	0.0	0.0	7.0	8.6	0.0	3.6	0.0	1 439.8	1 540.0
27	31.8	0.0	0.0	1.5	5.6	4.7	3.8	1.4	9.2	1 552.6	1 890.7
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	569.6	1 253.3
29	0.0	8.7	1.0	6.1	6.2	0.5	2.0	0.0	0.0	3 291.9	3 311.0
30	5.2	73.0	0.0	1.5	6.7	0.0	0.0	0.0	0.0	796.2	798.9
31	4.5	13.5	5.0	4.7	0.0	1.0	4.0	0.0	1.1	524.5	660.1
32	0.0	0.0	0.0	3.8	0.0	1.2	0.0	0.0	0.0	223.4	226.9
33	130.1	158.1	1.3	0.0	19.4	4.7	12.9	0.0	0.0	1 848.6	1 861.5
34	4.8	3.2	299.7	9.6	0.0	0.1	5.8	0.0	5.5	660.8	691.4
35	5.2	0.2	0.0	0.0	5.4	11.5	0.0	0.0	0.8	171.0	221.3
36	25.1	1.4	0.0	0.0	9.0	5.1	0.0	0.0	1.9	249.4	334.5
37	0.0	2.5	0.0	0.0	0.0	3.2	0.0	0.2	0.0	147.0	165.2
38	0.0	0.0	0.0	0.0	6.0	0.2	0.0	0.0	0.0	378.3	656.3
39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	336.9	345.9
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.4	71.1
41	74.9	4.8	0.0	0.0	1.6	4.0	0.0	6.3	0.0	465.7	493.6
42	0.0	19.5	0.0	0.0	27.2	1.3	4.3	18.9	0.7	1 878.6	1 938.9
43	2.1	6.9	0.0	1.5	13.8	0.1	0.0	0.0	0.0	1 698.0	1 716.1
44	0.0	0.0	8.2	25.6	0.0	0.5	0.0	0.0	0.0	2 883.1	2 951.5
45	0.0	0.0	1.3	50.1	0.0	0.0	0.0	0.0	0.0	1 853.1	1 898.8
46	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	641.1	653.9
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	820.7	861.6
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	782.5	1 404.2
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	574.5	906.3
50	0.0	0.0	9.6	1.4	7.1	2.5	6.6	0.0	1.2	1 155.9	1 278.4
51	0.0	15.2	0.0	0.0	2.4	0.0	0.1	0.0	0.0	353.2	360.3
52	0.0	4.9	2.4	8.3	0.0	0.0	1.0	0.0	0.0	568.4	603.8
53	0.0	8.5	0.0	0.7	4.7	0.3	0.0	0.0	0.0	2 371.2	2 487.2
54	0.0	0.0	0.0	0.0	3.1	1.0	0.0	0.0	0.0	1 033.9	1 782.1
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4 502.2	4 614.7
56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	218.6	247.2
57	0.0	0.0	0.0	1.3	3.3	1.4	0.0	0.0	0.0	3 023.3	3 872.7
58	0.0	38.4	2.0	19.1	0.0	0.0	0.0	0.0	0.0	546.6	624.4
59	9.4	0.0	2.5	5.3	0.0	0.0	0.0	0.0	0.0	3 001.7	3 038.8

Appendix 3 - continued

Station	ELE	SCH	JMD	JMM	HAP	LSO	SPO	BCO	WAR	Total	All species
60	0.0	8.8	0.0	0.0	3.2	0.0	2.5	0.0	0.0	164.5	202.5
61	0.0	13.5	0.0	0.0	2.5	0.0	2.2	0.0	0.0	316.3	355.7
62	0.0	0.0	7.6	35.0	3.1	0.0	0.0	0.0	0.0	1 699.9	1 711.0
63	0.0	0.0	28.5	52.7	0.0	1.9	0.0	0.0	0.0	1 279.2	1 297.5
64	0.0	4.5	0.0	1.6	0.0	0.1	0.0	0.0	0.0	1 296.0	1 430.8
65	0.0	1.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0	545.5	637.1
66	0.0	0.0	0.0	0.0	0.0	3.1	0.0	5.7	0.0	2 388.8	2 866.1
67	0.0	5.7	0.0	39.0	0.0	0.0	0.0	0.0	0.0	713.0	755.9
68	0.0	0.0	1.6	1.2	0.0	0.0	0.0	0.0	0.0	2 544.9	2 566.4
69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	3 914.3	3 950.2
70	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	82.1	128.4
71	0.0	0.0	0.0	3.2	3.2	10.0	0.0	0.0	0.0	345.5	541.3
72	0.0	0.0	0.0	0.0	76.0	1.9	0.0	2.2	0.0	275.7	283.8
73	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	213.5	226.0
74	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	177.4	205.0
Total	540.3	472.9	404.2	355.0	255.4	158.5	78.7	66.2	56.0	87 437.3	96 001.0

*Species codes are given in Table 2.

Appendix 4: Numbers of length frequency and biological samples collected*

	<u>Length frequency data</u>		<u>Biological data</u>	
	No. samples	Total	No. samples	Total
BAR	55	3 553	0	0
BCO	13	72	0	0
BNS	1	1	0	0
BRI	1	1	0	0
BSQ	1	1	0	0
ELE	23	233	0	0
EMA	4	4	0	0
ESO	5	22	0	0
GON	1	1	0	0
GSH	21	1 266	0	0
GUR	18	955	9	180
HAK	4	6	0	0
HAP	26	75	0	0
HOK	13	527	0	0
JMD	22	151	0	0
JMM	26	216	0	0
JMN	7	44	0	0
LDO	4	10	0	0
LIN	46	658	0	0
LSO	24	387	0	0
MIQ	2	3	0	0
MOK	3	7	0	0
RCO	53	2 605	25	405
SBW	2	10	0	0
SCH	26	144	0	0
SDO	3	4	0	0
SFL	4	13	0	0
SKI	3	3	0	0
SPD	59	3 986	0	0
SPE	32	2 085	0	0
SPO	17	45	0	0
SQU	58	1 600	0	0
STA	61	604	14	183
SWA	42	535	0	0
TAR	40	3 656	0	0
TRU	2	2	0	0
WAR	11	76	0	0
WWA	5	105	0	0

*Species codes are given in Table 2.

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