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Michael L. Stevenson
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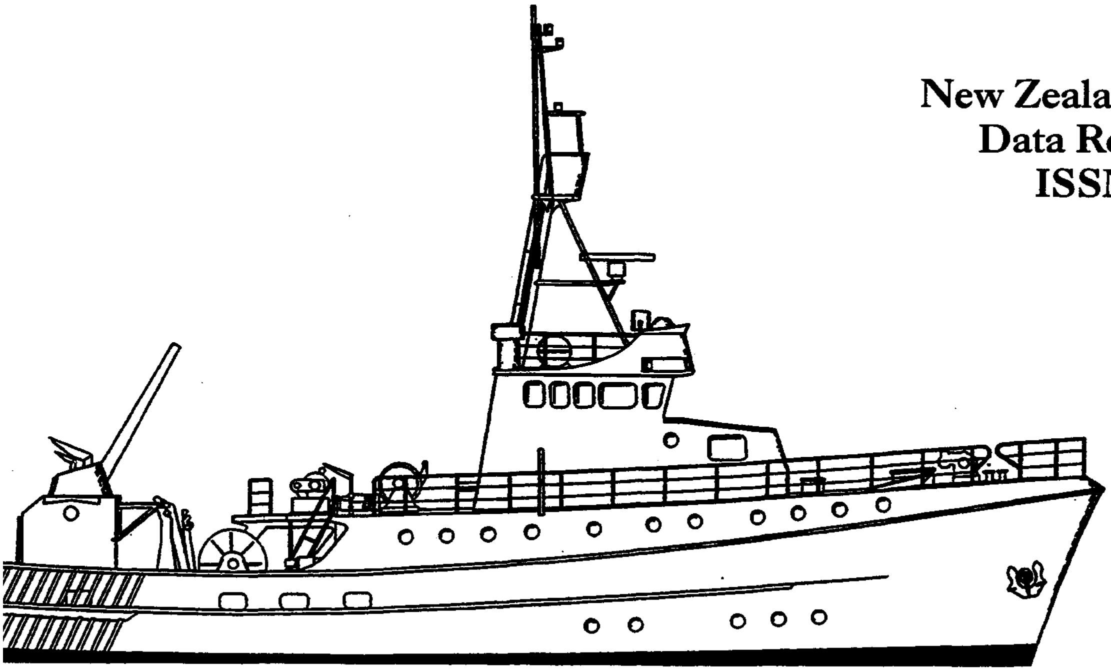

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Contents

Introduction

This report presents the results of the second in a time series of stratified random trawl surveys in depths between 20 and 400 m off the east coast of the North Island, New Zealand. The first survey in this series (March–April 1993) was described by Kirk & Stevenson (1996). March–April was originally chosen as the time period for this series because it was planned to alternate with the west coast South Island survey to make best use of *Kaharoa*'s time.

The principal aim of the time series is to estimate the relative abundance of snapper (*Pagrus auratus*), tarakihi (*Nemadactylus macropterus*), and trevally (*Pseudocaranx dentex*). A standardised index of relative abundance estimates for these species will assist with stock assessment and management strategies.

This report describes the survey design and methods and provides stock assessment data for commercially important Individual Transferable Quota (ITQ) species and non-ITQ species.

Project objectives

The major objectives of this research programme are as follows.

1. To develop a time series of relative abundance indices of adult snapper, tarakihi, and trevally along the east coast of New Zealand between Cape Runaway and Turakirae Head.
2. To determine the distribution of adults of commercially important inshore finfish species along the east coast of New Zealand between Cape Runaway and Turakirae Head.
3. To determine parameter inputs for the stock assessment of these species by collecting and analysing biological data (length/age frequency, length-weight, reproductive condition, and fecundity).

Survey objectives

The specific objectives of the trawl survey were as follows.

1. To obtain relative biomass data for snapper, tarakihi, and trevally sampled by bottom trawling off the east coast of New Zealand between Cape Runaway and the Turakirae Head during February–March 1994.
2. To collect data on the length, sex, and reproductive condition of snapper, tarakihi, trevally, and other commercially important species.
3. To collect otoliths of kahawai, snapper, stargazer, tarakihi, and trevally.
4. To collect data on the length and sex of all other ITQ and selected non-ITQ species.
5. To tag lively school shark as part of a national study on the growth and movement of this species.

Project and voyage personnel

P. Kirk and M. Stevenson, assisted by K. Drummond and J. Hadfield, were the project leaders. The survey was divided into two parts (4–16 February and 17 February–2 March); voyage leaders were K. Drummond and M. Stevenson, respectively. The skipper was A. Muir.

Methods

Survey area

The survey area covered depths of 20–400 m off the east coast of New Zealand between Cape Runaway and Turakirae Head (20–200 m between Tolaga Bay and Cape Kidnappers).

The total survey area of 19 127 km^2 (which includes non-trawlable ground) was divided into 15 strata by water depth (20–50, 50–100, 100–200, 200–400 m) and latitude (Table 1, Figure 1). Stratum boundaries used during the 1993 survey were revised and new latitudinal boundaries were established for the 1994 survey at Tolaga Bay, Cape Kidnappers, and Castlepoint. The new latitudinal boundaries were chosen after examining information on the distribution of target species and substrate type from the 1993 survey, and comments from commercial fishers.

The bottom between Tolaga Bay and Cape Kidnappers in 200–400 m was steep and rugged with virtually no trawlable ground and was not included as a stratum.

The trawlable ground within the survey area represented 56% of the total survey area. Of the 8491 km^2 of non-trawlable ground, 3860 km^2 were in strata 9, 11, and 14. The east coast South Island portion of the 1993 survey area, from Port Underwood to Kaikoura, was excluded from the 1994 survey (Kirk & Stevenson 1996).

Survey design

The survey was of a modified two-phase stratified random design (*after* Francis 1984). The time chosen for the survey was about 1 month earlier than in 1993 (March–April) because *Kaharoa* was not available during March–April 1994.

Because of the difficulty of locating suitable trawl positions during the 1993 survey, all phase 1 stations that were successfully trawled in 1993 were occupied. Before the survey began, sufficient trawl stations to cover any required additional phase 1 stations and all phase 2 stations within each stratum were generated randomly by the computer program 'rand_stn v2.1' (*see* Vignaux 1994). The locations of new stations were checked to ensure a minimum distance of 5.6 km (3 n. miles) from any revisited station.

Each tow was 1 h long during daylight hours. Non-trawlable ground was identified before the voyage from data collected before the 1993 survey and from new information from that survey. The amount of non-trawlable ground in each stratum is given in Table 1.

Snapper, tarakihi, and trevally were chosen as target species. Gemfish was dropped as a target species for the 1994 survey because its depth range was not adequately covered. A total of 83 stations was assigned to phase 1, with a minimum of 3 stations in each stratum. The remaining phase 1 stations were allocated to minimise the variance of the expected catch rates of the three target species. The expected catch rates were assumed to equal the catch rates from the 1993 survey. Fewer stations were allocated south of Cape Kidnappers than in 1993 as a result of excluding gemfish as a target species and of allocating phase 1 stations based on the expected catch rates. Phase 2 stations were planned for completion during any survey time remaining to improve the precision of the biomass estimates for the target species and were allocated after phase 1 had been completed. Allocation of phase 2 stations was based on the combined catch rates of the target species.

Vessel and gear specifications

RV *Kaharoa*, a 28 m stern trawler with a beam of 8.2 m, a displacement of 302 t, and engine power of 522 kW, is capable of trawling to depths of 500 m.

The net used during this survey was a high-lift, bottom-wing trawl fitted with a codend constructed of 80 mm (inside measurement) mesh. The net was specially designed and constructed for fishing the target species on the soft substrate off the east coast of the North Island. The design was based on nets used by commercial fishers in this area (Kirk & Stevenson 1996).

Doorspread was estimated as 78 m, using the method of Koyama (1974), from five measurements taken during the survey in depths less than 50 m. Headline heights were recorded during each tow using a Koden NM 860 (type 8601) netsonde attached to the headline of the trawl net. Headline heights were averaged for each tow and ranged from 7.5 to 9.2 m.

Trawling procedure

All trawling was conducted during daylight hours. When necessary, upon arrival at the shot location the sea floor along the proposed tow path was surveyed. If a station occurred in an area of foul ground, an area within 3 n. miles searched for suitable bottom on which to establish a replacement position. If no tow was possible, the station was abandoned and replaced with an alternative position from a list of random station positions.

Tows were generally 1 h long at a speed of about 3.5 kn. The distance covered was measured by Magnavox GPS. Tow duration was measured from the time the gear reached the bottom to the start of hauling. As far as possible the station position was at the centre of the tow track. The direction of the tow was influenced firstly by a combination of weather conditions and bottom contours, and secondly by the location of the next tow (to minimise steaming between stations).

A minimum of 250 m of warp was deployed for each trawl. In depths over 60 m a reduced warp to depth ratio was used, starting at 4 : 1 and dropping to 3 : 1 for depths below 150 m.

Sea surface temperature

Sea surface temperature at each station was recorded from a hull-mounted sensor. The calibration of the sensor was uncertain, so surface temperatures are only relative. Bottom temperatures were not recorded as the sensor on the net monitor was not functioning.

Catch and biological sampling

The catch at each station was sorted into species and weighed to the nearest 0.1 kg on motion-compensating Seaway scales. Weights of some large sharks and rays were estimated.

Length, to the nearest whole centimetre below actual length, and sex were recorded for all ITQ and some non-ITQ species, either for the whole catch or a randomly selected subsample of at least 100 fish per tow

More detailed biological data were collected from a sample of 20 snapper, tarakihi, and trevally, when available. Fish for these analyses were sampled non-randomly to ensure that a full size range of each species was sampled from the catch. For these samples, individual length and weight to the nearest 10 g were recorded along with sex and state of maturity. Similar biological data were collected at some stations for gemfish, giant stargazer, hapuku, John dory, kahawai, red cod, and red gurnard.

Up to four pairs of otoliths per 1 cm size class, per sex, were collected from snapper, tarakihi, trevally, kahawai, and giant stargazer.

Tagging

Lively school shark were measured, sexed, and tagged using a single dart tag and released within minutes of being removed from the codend. For each tagged school shark a release factor was assigned on a scale of 1–3, with 1 corresponding to the fish swimming away weakly, 2 freely, and 3 vigorously. A handling factor on the same 1–3 scale was also recorded to assess the liveliness of individual sharks before release.

Data analysis

Doorspread relative biomass estimates and scaled length frequency distributions were estimated by the area-swept method described by Francis (1981, 1989) using the Trawlsurvey Analysis Program (Vignaux 1994).

A constant doorspread of 78 m was assumed for all tows, irrespective of depth. The catchability coefficient (an estimate of the proportion of fish in the survey area available to be caught in the net) is the product of the vulnerability (v), vertical availability (u_v), and areal availability (u_a) as defined by Francis (1989). The following assumptions were made.

1. The area swept during each tow equalled the doorspread multiplied by the distance towed.
2. Vulnerability was 1.0. This assumes that all fish in the volume swept were caught and there was no escapement.
3. Vertical availability was 1.0. This assumes that all fish in the water column were below the headline height and available to the net.
4. Areal availability was 1.0. This assumes that the fishstock being sampled was entirely within the area sampled at the time of the survey.
5. Within the survey area, fish were evenly distributed over both trawlable and non-trawlable ground.

Although these assumptions are unlikely to be correct, their adoption provides the basis for a time series of relative biomass estimates if the catchability coefficient remains constant between surveys.

Length-weight coefficients were determined for snapper, tarakihi, and trevally using the geometric mean functional relationship.

Biomass estimates were calculated using data from all stations where gear performance was considered to be satisfactory, i.e., the gear performance code was 1 or 2 (this excluded stations 6, 8, and 87). Biomass estimates were scaled to include non-trawlable ground. All length frequencies were scaled by the percentage of catch sampled, area swept, and stratum area using the Trawlsurvey Analysis Program. Length-weight coefficients used in the scaling are given in Appendix 2.

The coefficient of variation (*c.v.*) associated with estimates of biomass was calculated as $c.v. = S_B / B * 100$, where S_B is the standard deviation of biomass and B is the biomass.

Results

Trawl stations

Eighty phase 1 stations and 19 phase 2 stations were successfully completed (Table 1, Figure 1, Appendix 1). A further three stations were trawled but excluded from biomass analysis because of poor gear performance (stations 6 and 87) or a catch too large to be handled on deck (station 8). Completed phase 1 stations were those numbered 1–81 and 102. Station 102 replaced station 8 in stratum 1 to give three stations in the stratum. Phase 2 stations were those numbered 82–101 (Table 1). The completed station density ranged between 1 station per 115 km^2 in strata 3 and 11 to 1 station per 700 km^2 in stratum 10 (*see* Table 1). The positions of all stations occupied are shown in Figure 2 and individual station data are presented in Appendix 1.

Gear performance

The trawl achieved an average headline height of 7.7 m at the 99 stations where the netsonde was working. Estimated doorspread was 78 m with ground-rope hard down at a speed of 3.5 kn.

The gear came fast only once during the survey (station 6) and once a large hole was torn in the belly of the net (station 87). Occasionally the gear would tow off centre due to tide or wind.

Catch composition

During the survey 102 species were recorded: 19 elasmobranchs, 76 teleosts, 4 crustaceans, and 3 cephalopods. The total catch for the survey was 71.2 t from 102 tows at an average of 698 kg per tow. The total catch of each target species was tarakihi, 5044 kg, snapper, 1116 kg, and trevally, 659 kg. Target species made up 6.8 t (9.6%) of the total catch. The total catch and occurrence are given for all species in Table 2. The weight of tagged school shark was estimated from the length-weight coefficients given in Appendix 2.

Barracouta, the most abundant species by weight (21.6 t), occurred at more stations (92) than any other species. The largest catches were made south of Portland Island in the 50–100 m depth range (*see* Figure 2).

Other species with catches over 5 t were southern spiny dogfish (8.4 t), hoki (6.9 t), frostfish (5.9 t), and tarakihi (5.0 t) (*see* Table 2). Jack mackerel (*Trachurus novaezelandiae*) and arrow squid were the only other species to occur at more than 75% of the stations (*see* Table 2).

Catch rates and species distribution

Catch rates and distributions for all species combined, the 12 most abundant ITQ species, and the two most abundant non-ITQ species are presented in Figure 2. (Catch rates are given in terms of $kg.km^{-2}$, so a catch rate of 1000 $kg.km^{-2}$ equates to a catch of 510 kg in a standard tow (as it covers 0.51 km^2 on average).) Seventeen of the 18 total catch rates over 2000 $kg.km^{-2}$ were made south of Cape Kidnappers.

The catch rates by stratum for the 20 most abundant species are given in Table 3.

Biomass estimation

Relative biomass estimates for the major ITQ and non-ITQ species are given in Table 4. For species subject to a regulatory or processing size limit, estimates above a given size are provided. For red cod, the processing size limit varies between years (38 cm in 1993, 45 cm in 1994, and 40 cm in 1995). The 38 cm size limit is used as the minimum size of recruited red cod in this report. The relative biomass estimates by stratum for the target species are given in Table 5.

Species with *c.v.*s of 20% or less on their relative biomass estimates were rough skate (12%), rig (14%), red gurnard (16%), and tarakihi (20%).

Sea surface temperatures

Uncalibrated surface water temperatures are included in Appendix 2. Isotherms estimated from the temperature data are shown in Figure 3.

School shark tagging

Seventy-five school shark (48 males and 27 females) were tagged and released. The total length range was 74–165 cm.

Length frequencies and biological data

The numbers of length frequency and biological samples taken during the survey are given in Table 6. Scaled length frequency distributions of the major commercial species are shown in Figure 4. The length frequency histograms represent the estimated population structure for the survey area. The numbers of each of the target species at each gonad stage are given in Table 7.

Target species

Snapper. Over 94% of the relative biomass estimate of 368 t (*c.v.* = 21%) was found to be north of Cape Kidnappers and 96% was in depths less than 100 m (*see* Table 5). The sex ratios (males : females) were 0.88 : 1 inside 50 m, 0.71 : 1 in 50–100 m, and 0.81 : 1 overall (*see* Figure 4). Of the 149 males, sampled 35 had immature or resting gonads, 107 maturing, 6 running ripe, and 1 spent. Of the 143 females sampled, 62 had immature or resting gonads, 73 maturing, and 8 spent (*see* Table 7).

Tarakihi. Of the total biomass estimate of 1339 t (*c.v.* 20%), 970 t (74%) was found to be north of Cape Kidnappers (*see* Table 5 and Figure 2) and 717 t (54%) was in the 100–200 m depth range. For all fish the sex ratio was 0.81 : 1 but this altered significantly with depth: the ratios were 0.54 : 1 inside 50 m, 0.50 : 1 in 50–100 m, 1.05 : 1 in 100–200 m, and 0.90 : 1 in 200–400 m (*see* Figure 4). All tarakihi less than 20 cm long had immature gonads, but a full range of gonad stages was recorded from larger length classes (*see* Table 7).

Trevally. The relative biomass estimate for trevally was 242 t (*c.v.* 25%), all inside 200 m with 198 t (82%) north of Cape Kidnappers (*see* Table 5 and Figure 2). The sex ratios by depth were 1.15 : 1 in 20–50 m, 0.54 : 1 in 50–100 m, and 0.82 : 1 in 100–200 m: the ratio for all fish was 0.76 : 1 (*see* Figure 4). Of the 298 trevally sampled, only 8 had resting gonads and 6 were spent. Most of the remainder were in a late stage of development (199) or running ripe (87).

Discussion

Revisiting previously successful stations and improved definition of foul ground allowed more stations to be completed than in 1993. The precision of the biomass estimates, expressed as the coefficient of variation, for the target species increased from the 1993 survey (snapper 21% vs 31% in 1993, tarakihi 20% vs 27%, and trevally 25% vs 35%). This is probably due to the increased number of stations completed and improved station allocation.

Although barracouta were caught at more stations than any other species, the variability in the catches resulted in a moderate *c.v.* of 32%.

Only the southernmost area of stratum 15 was trawlable. The remainder was foul ground or trawlable only at slack tide in good weather (not trawlable for all practicable purposes). For future surveys, consideration should be given to moving the northern boundary of the stratum south to Waikahawai Point at 37° 57.9' S.

The net used appears to sample pre-recruits of the target species poorly (no trevally pre-recruits were caught in either 1993 or 1994). If the gear remains unchanged, future reports should not separately list pre-recruit and recruited biomass estimates.

Designation of snapper and trevally as target species should be reviewed, especially if future surveys are conducted at the earlier dates used for this survey. The greater percentage of later stage gonad development recorded for these species indicates that spawning is still active at this time. The fluctuating availability of snapper and trevally to bottom trawling due to schooling and changes in their position in the water column could significantly affect the results of this series. However, these species should be retained as target species until the completion of the third survey in the time series scheduled for February–March 1995. This will provide better comparability between surveys and additional data on which to base a decision.

Doorspread is known to vary with depth and bottom conditions, but the biomass estimates in this report, based on indirect measurements, assume a constant spread of 78 m (based on indirect measurements). Trials on other vessels have shown that indirect doorspread measurements underestimate spread by 15–30%, particularly at depths greater than 75 m (Hurst & Bagley 1992). For the 1995 survey, Scanmar sensors will be fitted to monitor doorspread throughout the tow and establish the relationship between doorspread and depth. Biomass estimates and scaled length frequency distributions for the 1993 and 1994 surveys should then be recalculated.

The completion of a third survey in 1995 will establish a time series of relative abundance estimates and should allow conclusions to be made on recent trends in size, distribution, and abundance for several of these species. Improved monitoring of doorspread and net performance will improve the precision of the survey estimates.

Acknowledgments

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Table 1: Stratum depth ranges, survey area, non–trawlable area, number of successful phase 1 and phase stations, and station density

Stratum	Depth (m)	Area (km^2)	Non-trawlable area (km^2)	Number of stations Phase 1	Number of stations Phase 2	Station density (no. per km^2)
Castlepoint–Turakirae Head						
1	20–50	432	223	3	0	1 : 144
2	50–100	568	104	3	0	1 : 189
3	100–200	692	321	6	0	1 : 115
4	200–400	468	191	3	0	1 : 156
Cape Kidnappers–Castlepoint						
5	20–50	422	347	3	0	1 : 141
6	50–100	1 011	217	3	0	1 : 337
7	100–200	1 590	149	12	0	1 : 133
8	200–400	1 362	56	3	0	1: 454
Tolaga Bay–Cape Kidnappers						
9	20–50	2 605	1 345	4	6	1 : 261
10	50–100	2 801	857	3	1	1 : 700
11	100–200	2 182	1 163	16	3	1 : 115
Cape Runaway–Tolaga Bay						
12	20–50	594	506	3	2	1 : 119
13	50–100	1 015	302	3	3	1 : 169
14	100–200	1 816	1 352	12	3	1 : 121
15	200–400	1 018	758	3	1	1 : 255
Total (average)		18 576	7 891	80	19	(1 : 193)

Table 2: Species caught, total weight, and number of stations out of 102 at which species occurred

Common name	Scientific name	Code	Catch (kg)	Occurrence
Barracouta	*Thyrsites atun*	BAR	21 562	92
Spiny dogfish	*Squalus acanthias*	SPD	8 359	60
Hoki	*Macruronus novaezelandiae*	HOK	6 923	34
Frostfish	*Lepidopus caudatus*	FRO	5 888	65
Tarakihi	*Nemadactylus macropterus*	TAR	5 044	72
Red cod	*Pseudophycis bachus*	RCO	4 721	66
Gurnard	*Chelidonichthys kumu*	GUR	2 298	69
Jack mackerel	*Trachurus novaezelandiae*	JMN	1 587	77
Rattails	Macrouridae	RAT	1 511	25
Snapper	*Pagrus auratus*	SNA	1 116	38
Arrow squid	*Nototodarus sloanii*	SQU	1 091	89
School shark	*Galeorhinus galeus*	SCH	936	45
Gemfish	*Rexea solandri*	SKI	935	31
Carpet shark	*Cephaloscyllium isabellum*	CAR	710	59
Bluenose	*Hyperoglyphe antarctica*	BNS	687	3
Trevally	*Pseudocaranx dentex*	TRE	659	41
Rig	*Mustelus lenticulatus*	SPO	614	63
John dory	*Zeus faber*	JDO	523	36
Murphy's mackerel	*Trachurus murphyi*	JMM	509	46
Rough skate	*Raja nasuta*	RSK	509	49
Ling	*Genypterus blacodes*	LIN	417	41
Sea perch	*Helicolenus* spp.	SPE	407	44
Hapuku	*Polyprion oxygeneios*	HAP	392	29
Smooth skate	*Raja innominata*	SSK	377	31
Blue moki	*Latridopsis ciliaris*	MOK	371	16
Silver warehou	*Seriolella punctata*	SWA	257	24
Mirror dory	*Zenopsis nebulosus*	MDO	204	27
Giant stargazer	*Kathetostoma giganteum*	STA	202	35
Electric ray	*Torpedo fairchildi*	ERA	192	20
Seal shark	*Scymnorhinus licha*	BSH	185	3
Jack mackerel	*Trachurus declivis*	JMD	180	46
Silver dory	*Cyttus novaezelandiae*	SDO	153	19
Blue warehou	*Seriolella brama*	WAR	152	12
Alfonsino	*Beryx splendens*	BYS	150	5
Kingfish	*Seriola lalandi*	KIN	130	11
Trumpeter	*Latris lineata*	TRU	129	9
Lookdown dory	*Cyttus traversi*	LDO	97	7
Stingray	*Dasyatis* spp.	STR	92	4
Kahawai	*Arripis trutta*	KAH	86	20
Dark ghost shark	*Hydrolagus novaezelandiae*	GSH	78	9
Sand flounder	*Rhombosolea plebeia*	SFL	63	11
Broadsnouted sevengill shark	*Notorynchus cepedianus*	SEV	60	1
Conger eel	*Conger* spp.	CON	52	6
Leatherjacket	*Parika scaber*	LEA	35	6
White warehou	*Seriolella caerulea*	WWA	35	2
Lemon sole	*Pelotretis flavilatus*	LSO	34	21
Javelinfish	*Lepidorhynchus denticulatus*	JAV	34	9
Brown stargazer	*Gnathagnus innotabilis*	BRZ	33	18
Pufferfish	*Sphoeroides* spp.	PUF	32	10

Table 2—*continued*

Common name	Scientific name	Code	Catch (kg)	Occurrence
Octopus	*Octopus maorum*	OCT	30	36
Northern spiny dogfish	*Squalus blainvillei*	NSD	29	8
Thresher shark	*Alopias vulpinus*	THR	29	2
N.Z. sole, common sole	*Peltorhamphus novaezeelandiae*	ESO	26	6
Witch	*Arnoglossus scapha*	WIT	26	41
Elephant fish	*Callorhynchus milii*	ELE	23	3
Orange perch	*Lepidoperca* sp.	OPE	23	3
Japanese gurnard	*Pterygotrigla picta*	JGU	15	7
Anchovy	*Engraulis australis*	ANC	13	13
Sharpsnouted sevengill shark	*Heptranchias perlo*	HEP	10	2
Ruby fish	*Plagiogeneion rubiginosus*	RBY	9	2
Common roughy	*Paratrachichthys trailli*	RHY	9	7
Blue cod	*Parapercis colias*	BCO	8	3
Pilchard	*Sardinops neopilchardus*	PIL	8	14
Blue mackerel	*Scomber australasicus*	EMA	7	20
Northern bastard cod	*Pseudophycis breviuscula*	BRC	7	6
Eagle ray	*Myliobatis tenuicaudatus*	EGR	7	2
Ray's bream	*Brama brama*	RBM	6	4
Deepsea flathead	*Hoplichthys haswelli*	FHD	5	3
Ghost shark (dark)	*Hydrolagus novaezelandiae*	GSH	5	9
Prickly dogfish	*Oxynotus bruniensis*	PDG	5	1
Giant boarfish	*Paristiopterus labiosus*	BOA	4	3
Scaly gurnard	*Lepidotrigla brachyoptera*	SCG	4	32
Prawn killer	*Ibacus alticrenatus*	PRK	4	27
Silverside	*Arentina elongata*	SSI	4	37
Ahuru	*Auchenoceros punctatus*	PCO	3	3
Spotted stargazer	*Genyagnus monopterygius*	SPZ	3	3
Cucumber fish	*Chlorophthalmus nigripinnis*	CUC	2	4
Capro dory	*Capromimus abbreviatus*	CDO	2	21
Sooty shearwater	*Puffinus griseus*	XSH	2	1
Ribaldo	*Mora moro*	RIB	2	1
Sand stargazer	*Crapatalus novaezelandiae*	SAZ	2	3
Pale toadfish	*Neophrynichthys angustus*	TOP	2	2
Pigfish	*Congiopodus leucopaecilus*	PIG	1	4
Hake	*Merluccius australis*	HAK	1	2
Long-tailed skate	*Arhynchobatis asperrimus*	LSK	1	1
Scampi	*Metanephrops challengeri*	SCI	1	4
Yelloweyed mullet	*Aldrichetta forsteri*	YEM	1	1
Banded bellowsfish	*Centriscops obliquus*	BBE	1	1
Toadfish	*Neophrynichthys* spp.	TOA	1	1
Spiny sea dragon	*Solegnathus spinosissimus*	SDR	1	8
Yellow boarfish	*Pentaceros decacanthus*	YBO	1	2
Opalfish	*Hemerocoetes* spp.	OPA	1	11
Sprats	*Sprattus antipodum, S. muelleri*	SPR	1	5
Mantis shrimp	Crustacea	CRU	< 0.5	9
Lucifer dogfish	*Etmopterus lucifer*	ETL	< 0.5	2
Lantern fish	Myctophidae	LAN	< 0.5	2
Barracudina	*Magnisudis prionosa*	BCA	< 0.5	1
Scabbardfish	*Benthodesmus* spp.	BEN	< 0.5	1

Table 2—*continued*

Common name	Scientific name	Code	Catch (kg)	Occurrence
Crested bellowsfish	*Notopogon lilliei*	CBE	< 0.5	1
Unidentified cephalopod	Cephalopoda	CPH	< 0.5	1
Paddle crab	*Ovalipes catharus*	PAD	< 0.5	1
Redbait	*Emmelichthys nitidus*	RBT	< 0.5	1
Snipefish	*Macrorhamphosus scolopax*	SNI	< 0.5	1
Porcupine fish	*Allomycterus jaculiferus*	POP	*	18
		Total	71 150	

* Not weighed

Table 3: Catch rates (to the nearest kg.km^{-2}) by stratum for the 20 most abundant species (species codes are given in Table 2)

		Species code																			
Stratum	Depth (m)	BAR	SPD*	HOK	FRO*	TAR	RCO	GUR	JMN	RAT*	SNA	SQU	SCH	SKI	CAR*	BNS	TRE	SPO	JDO	RSK*	JMM
1	20–50	1 217	253	0	0	1	1	277	14	0	19	1	0	0	16	0	18	27	23	23	0
5	20–50	1 549	81	0	0	0	6	0	13	0	0	0	0	0	17	0	4	48	51	32	0
9	20–50	17	7	0	0	0	5	135	17	0	31	9	19	0	0	0	13	17	6	12	0
12	20–50	14	0	0	0	340	4	67	5	0	183	0	4	0	5	0	26	19	2	5	0
2	50–100	3 890	209	0	0	97	57	30	81	0	0	31	1	0	49	0	6	17	16	0	11
6	50–100	1 098	64	3	1	12	467	61	192	0	16	13	0	2	76	0	30	32	25	50	3
10	50–100	935	199	0	10	8	2	87	12	0	7	33	7	0	5	0	16	5	66	20	0
13	50–100	104	13	0	12	59	18	50	4	0	113	3	2	0	16	0	28	6	21	20	1
3	100–200	455	237	25	21	151	9	0	83	189	0	159	3	148	6	0	0	8	0	1	59
7	100–200	200	12	311	80	60	435	0	18	53	0	16	6	15	7	0	0	2	0	2	15
11	100–200	165	28	5	334	114	111	18	50	0	3	20	33	12	27	0	10	14	9	11	14
14	100–200	80	9	2	244	148	11	7	18	2	5	10	29	5	8	0	29	4	3	7	10
4	200–400	0	0	2757	2	0	15	0	0	339	0	4	0	53	0	334	0	3	0	2	0
8	200–400	8	0	420	9	2	22	0	0	8	0	11	0	30	0	109	0	17	0	0	0
15	200–400	6	0	4	17	262	1	0	0	26	0	8	89	50	8	0	0	2	0	0	3

* non-ITQ species

Table 4: Estimated biomass of the 16 most abundant ITQ species and 5 most abundant non–ITQ species

Common name	Lower 95% confidence interval	Biomass (t)	Upper 95% confidence interval	*c.v.* %
Barracouta	3 020	8 433	13 845	32
Southern spiny dogfish	99	1 179	2 260	46
Hoki (all)	318	3 914	7 510	46
Hoki (65+ cm)	134	3 088	6 042	48
Frostfish	267	1 387	2 507	40
Tarakihi (all)	810	1 339	1 869	20
Tarakihi (25+ cm)	804	1 332	1 861	20
Red cod (all)	7	1 550	3 093	50
Red cod (38+ cm)	0	1 024	2 069	51
Gurnard (all)	683	1 009	1 336	16
Gurnard (30+ cm)	610	816	1 023	13
Jack mackerel (*Trachurus novaezelandiae*)	211	565	920	31
Rattails	216	602	988	32
Snapper (all)	217	368	519	21
Snapper (25+ cm)	217	367	518	21
Arrow squid	128	377	627	33
School shark	165	302	438	23
Gemfish	114	309	504	32
Carpet shark	142	250	359	22
Bluenose	0	489	1 192	72
Trevally (all)	121	242	362	25
Trevally (25+ cm)	121	242	362	25
Rig	163	226	288	14
John dory	124	315	507	30
Murphy's mackerel	48	126	204	31
Rough skate	173	225	277	12
Ling	95	244	393	30

Table 5: Relative biomass estimates (to the nearest tonne) by stratum for target species

	Depth			Biomass (t)
Stratum	(m)	Snapper	Tarakihi	Trevally
1	20–50	8	0	8
2	50–100	0	55	3
3	100–200	0	105	0
4	200–400	0	0	0
5	20–50	0	0	2
6	50–100	17	12	31
7	100–200	0	95	0
8	200–400	0	2	0
9	20–50	82	0	35
10	50–100	21	24	44
11	100–200	7	248	21
12	20–50	109	202	16
13	50–100	115	59	29
14	100–200	9	269	53
15	200–400	0	267	0

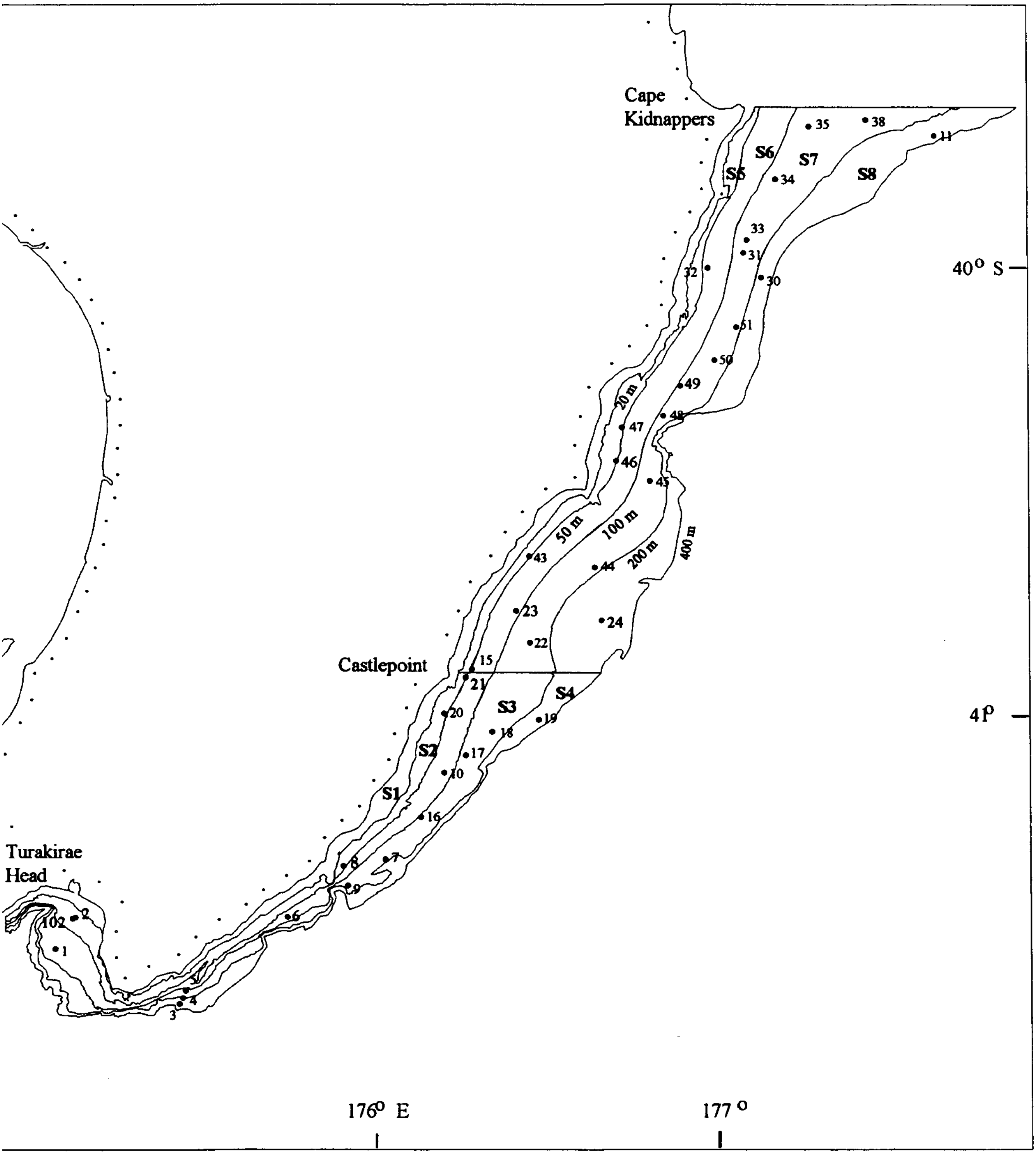
Table 6: Numbers of length frequency and biological samples collected (species codes are given in Table 2)

Common name	Length frequency data		Biologcal data	
	No. of samples	No. of fish	No. of samples	No. of fish
Alfonsino	6	219	0	0
Arrow squid	83	3128	0	0
Barracouta	87	4479	0	0
Blue cod	4	7	0	0
Blue mackerel	18	131	0	0
Blue warehou	12	47	0	0
Bluenose	4	142	0	0
Brown stargazer	18	33	0	0
Dark ghost shark	10	64	0	0
Elephantfish	4	11	0	0
Gemfish	32	483	26	163
Giant stargazer	34	67	29	61
Hake	3	3	0	0
Hapuku	28	63	1	9
Hoki	34	2118	1	20
Jack mackerel				
Trachurus declivis	42	348	0	0
T. novaezelandiae	73	2247	0	0
John dory	37	370	1	20
Kahawai	20	45	19	45
Leatherjacket	4	128	0	0
Lemon sole	21	109	0	0
Ling	42	266	0	0
Lookdown dory	6	99	0	0
Mirror dory	23	398	0	0
Moki	15	65	0	0
Murphy's mackerel	46	488	0	0
New Zealand sole	7	72	0	0
Northern bastard cod	1	1	0	0
Ray's bream	4	5	0	0
Red cod	65	1678	9	146
Red gurnard	68	3361	18	328
Rig	62	246	0	0
Sand flounder	12	108	0	0
Sand stargazer	2	4	0	0
School shark	46	189	0	0
Sea perch	4	506	0	0
Silver dory	2	37	0	0
Silver warehou	25	168	0	0
Snapper	37	612	38	292
Sowfish	1	1	0	0
Spotted stargazer	3	3	0	0
Tarakihi	73	3497	69	1118
Trevally	42	343	39	298
Trumpeter	9	27	0	0
White warehou	3	7	0	0
Yelloweyed mullet	2	4	0	0
Yellowtail kingfish	11	28	0	0

Table 7: Numbers of fish sampled at each reproductive stage for the target species

	Males					Females					
	Gonad stage					Gonad stage					
Fork length (cm)	1	2	3	4	5	1	2	3	4	5	
Snapper											
21–30	4	13	2	0	0	6	5	1	0	0	
31–40	19	48	9	3	0	34	38	0	0	0	
41–50	5	14	6	1	0	11	15	3	0	0	
51–60	6	3	8	0	1	7	6	2	0	4	
61–70	1	2	2	2	0	4	1	1	0	4	
71–80	0	0	0	0	0	0	0	0	0	0	
81–90	0	0	0	0	0	0	0	1	0	0	
Total	35	80	27	6	1	62	65	8	0	8	292
Tarakihi											
11–20	8	0	0	0	0	6	0	0	0	0	
21–30	63	37	8	0	2	54	19	0	0	1	
31–40	28	139	110	14	4	111	172	88	8	16	
41–50	0	21	40	4	0	4	40	107	4	0	
51–60	0	0	0	0	0	0	1	4	0	0	
Total	99	197	158	18	6	175	232	199	12	17	1113
Trevally											
21–30	0	0	2	0	0	0	0	0	0	0	
31–40	0	9	19	13	0	0	16	11	11	0	
41–50	2	15	30	51	0	4	20	64	12	5	
51–60	0	0	0	0	0	2	2	9	0	1	
Total	2	24	51	64	0	6	38	84	23	6	298

Gonad stages used were: 1, immature or resting; 2 maturing (oocytes visible in female fish); 3, mature (hyaline oocytes in female fish, milt expressible in male fish); 4 running ripe (eggs and milt free flowing); 5, spent.



;ure 1a: Stratum boundaries (south of Cape Kidnappers) with station positions and numbers.

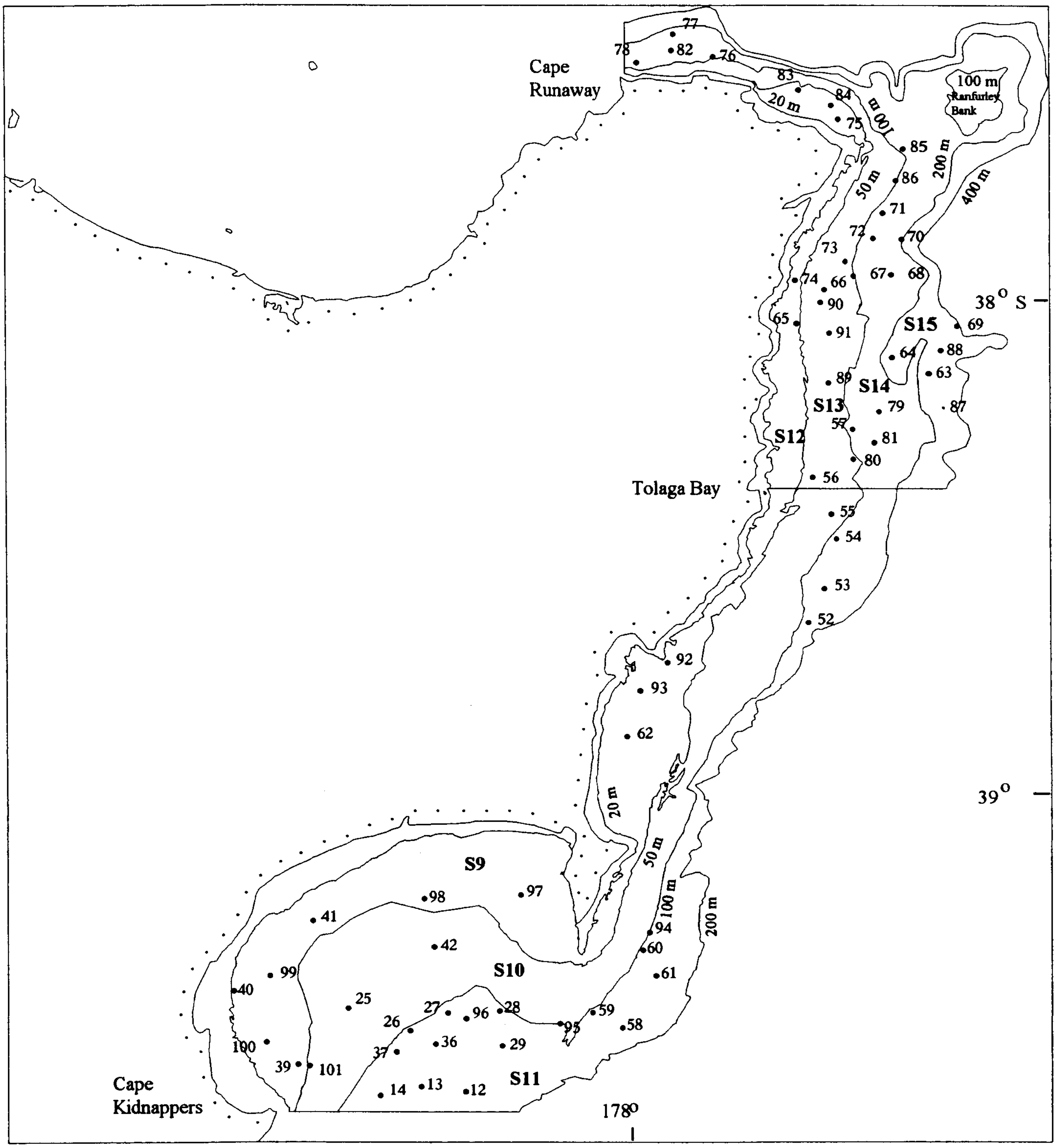


Figure 1b: Stratum boundaries (north of Cape Kidnappers) with station position and numbers.

All species combined

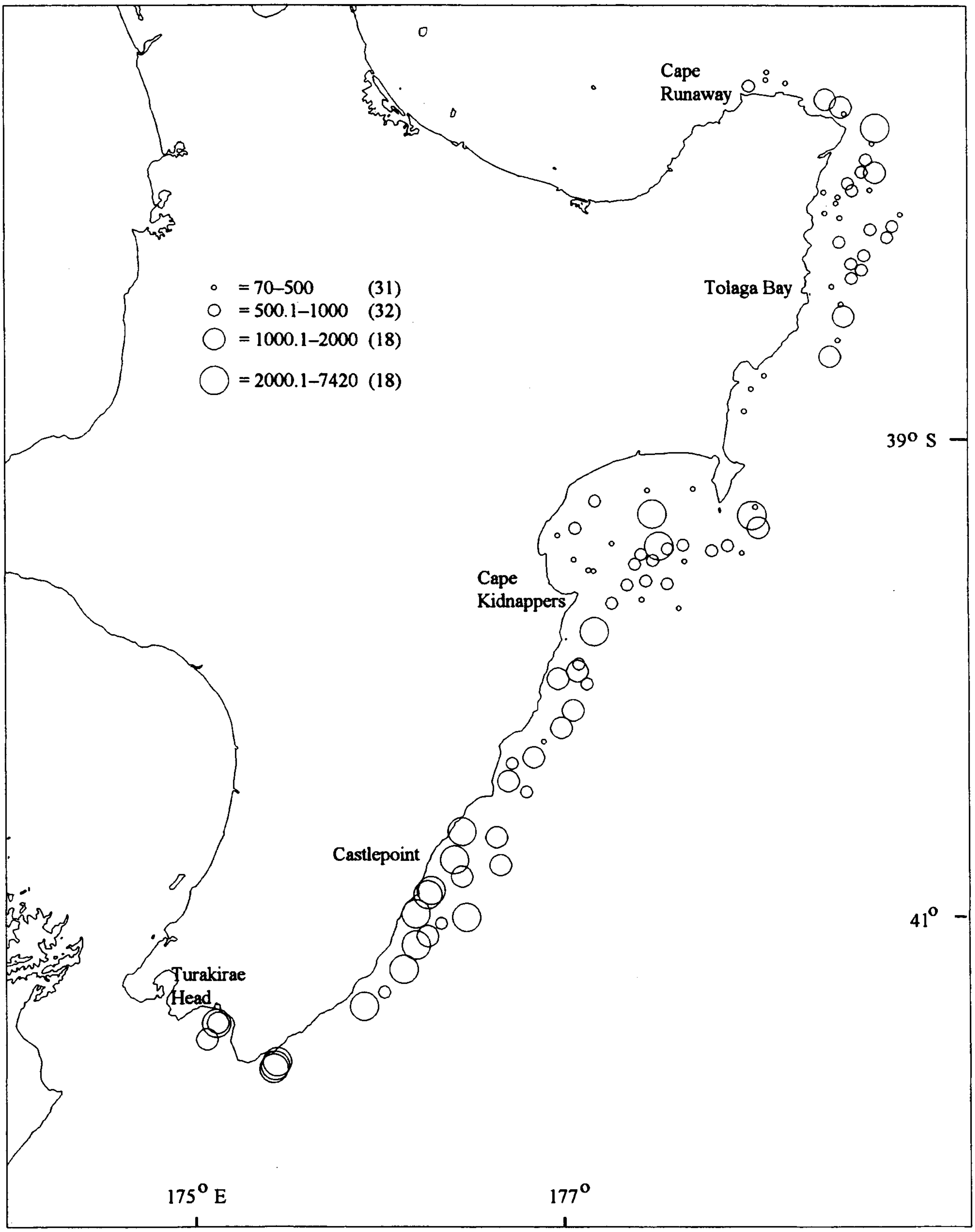


Figure 2: Catch rates (kg.km^{-2}) for all species combined and the 17 most abundant commercial finfish species for stations used for biomass calculations (numbers in parenthesis are the number of stations at which the species was caught).

Barracouta

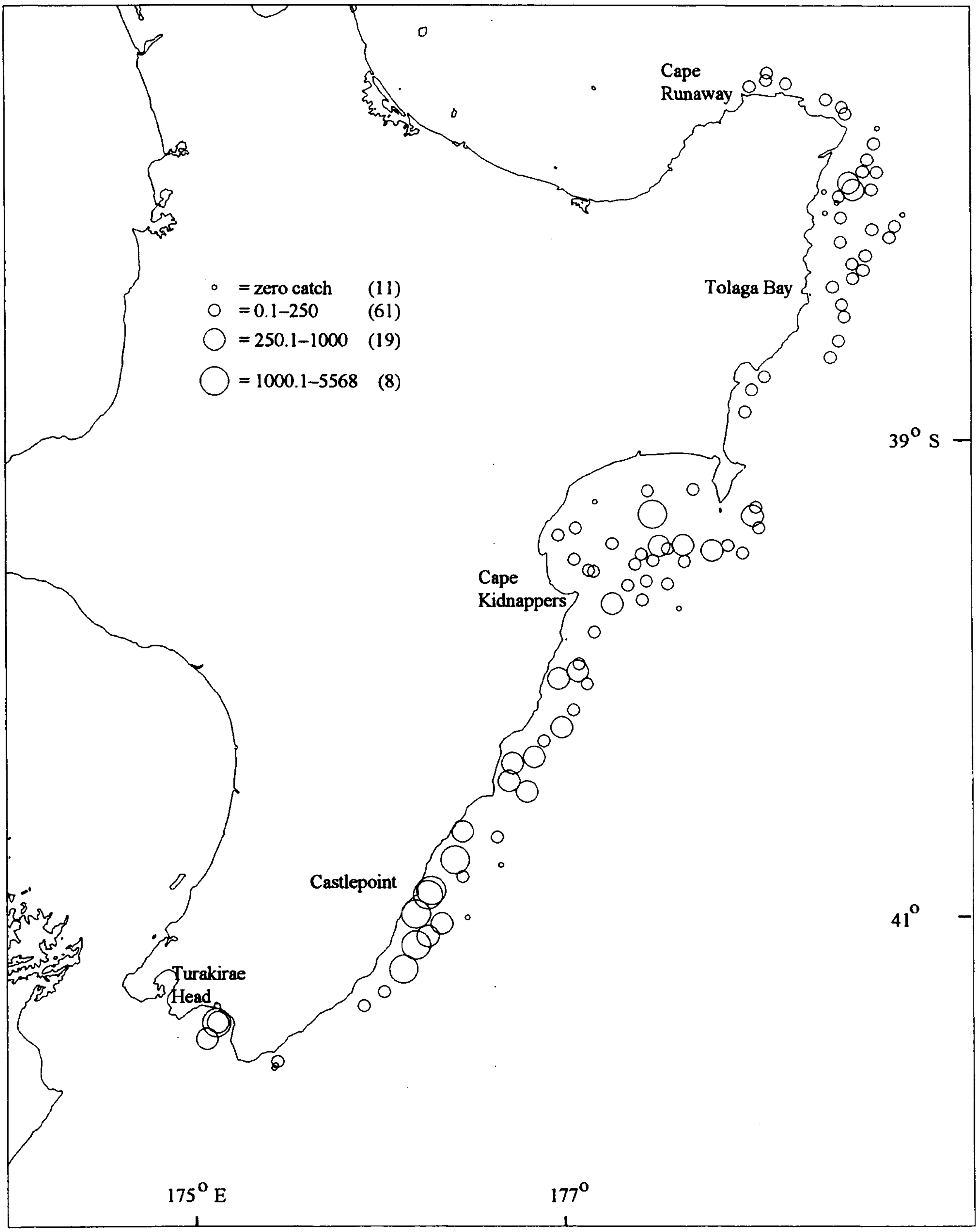


Figure 2—*continued*

Bluenose

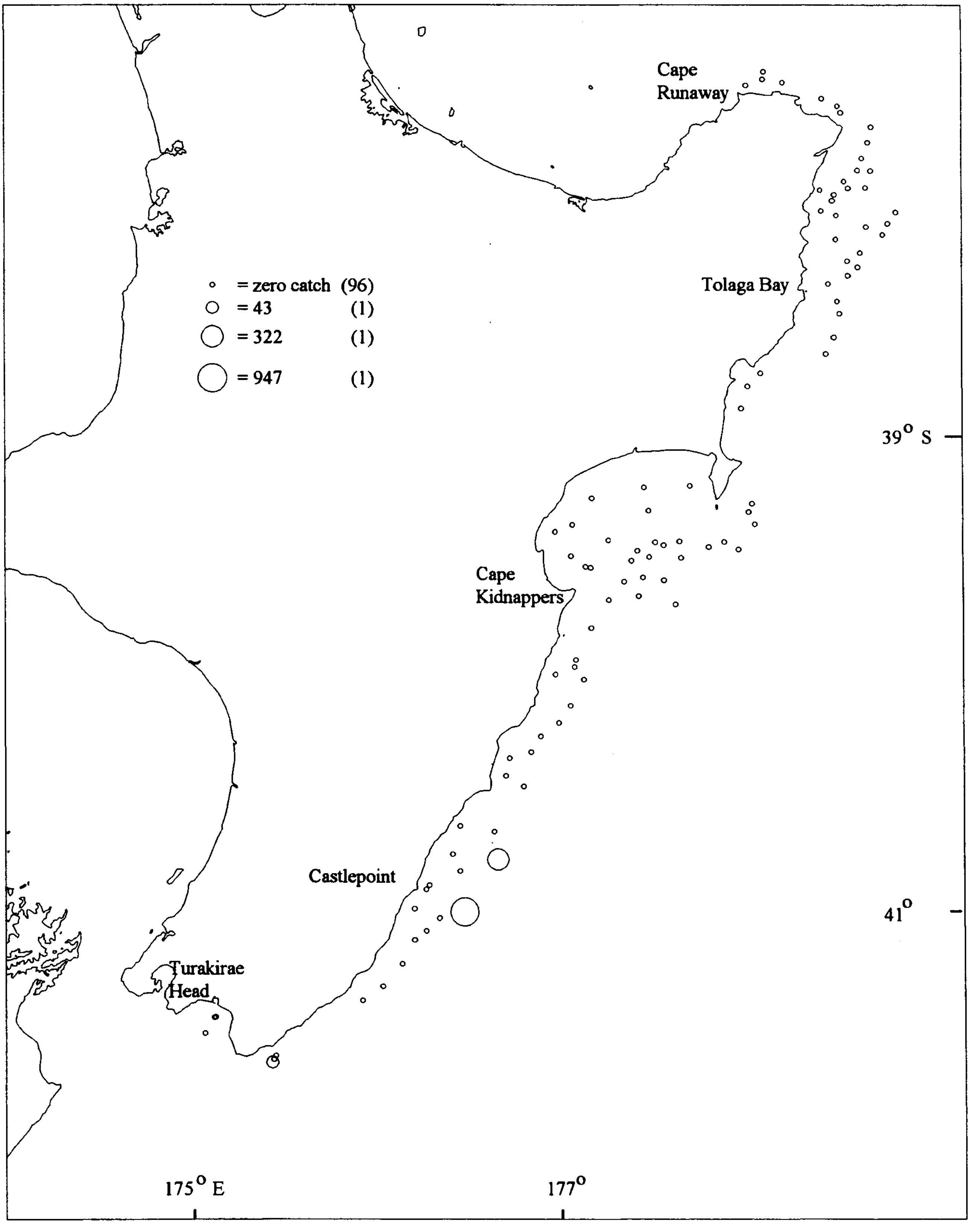


Figure 2—*continued*

Frostfish

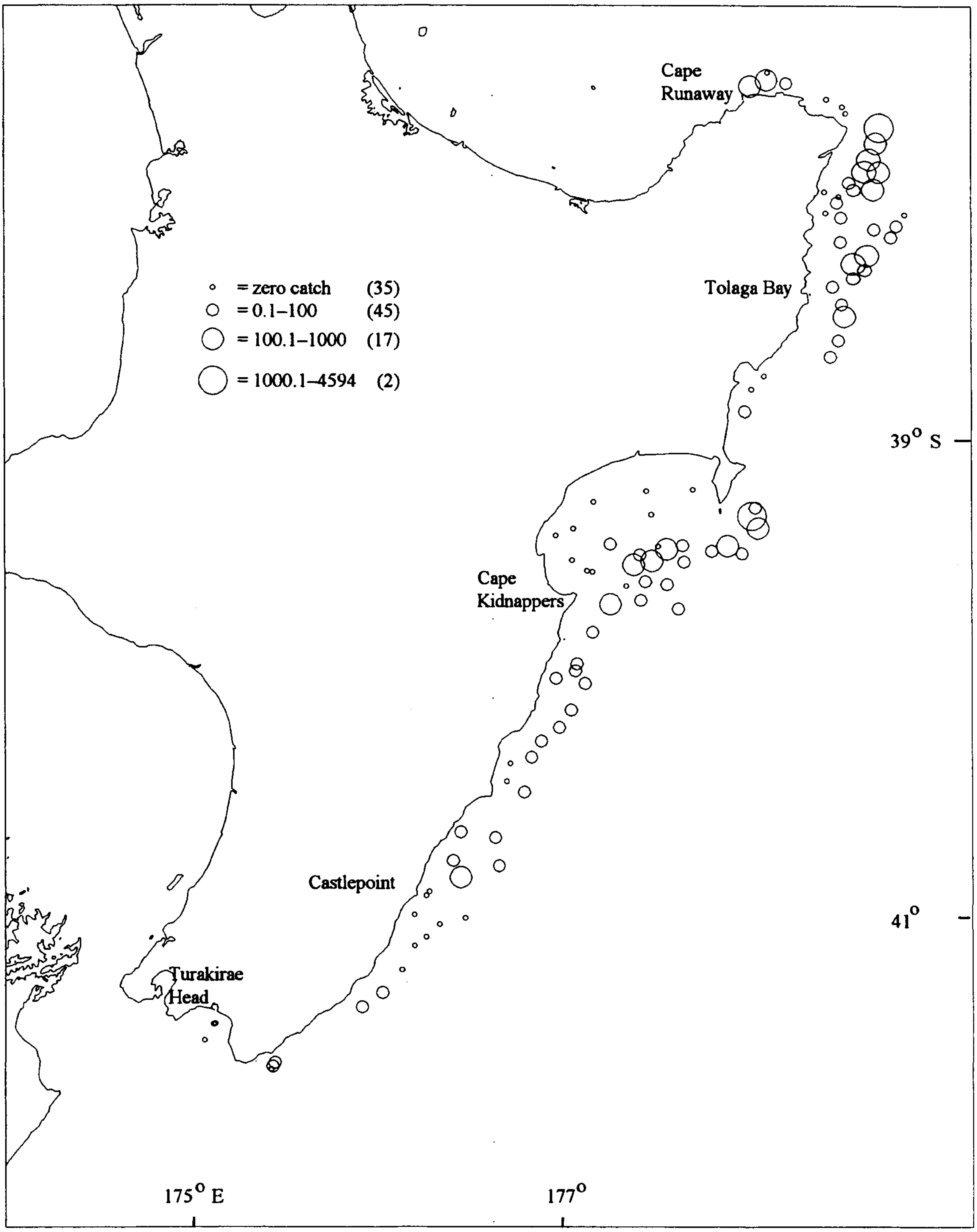


Figure 2—*continued*

Gemfish

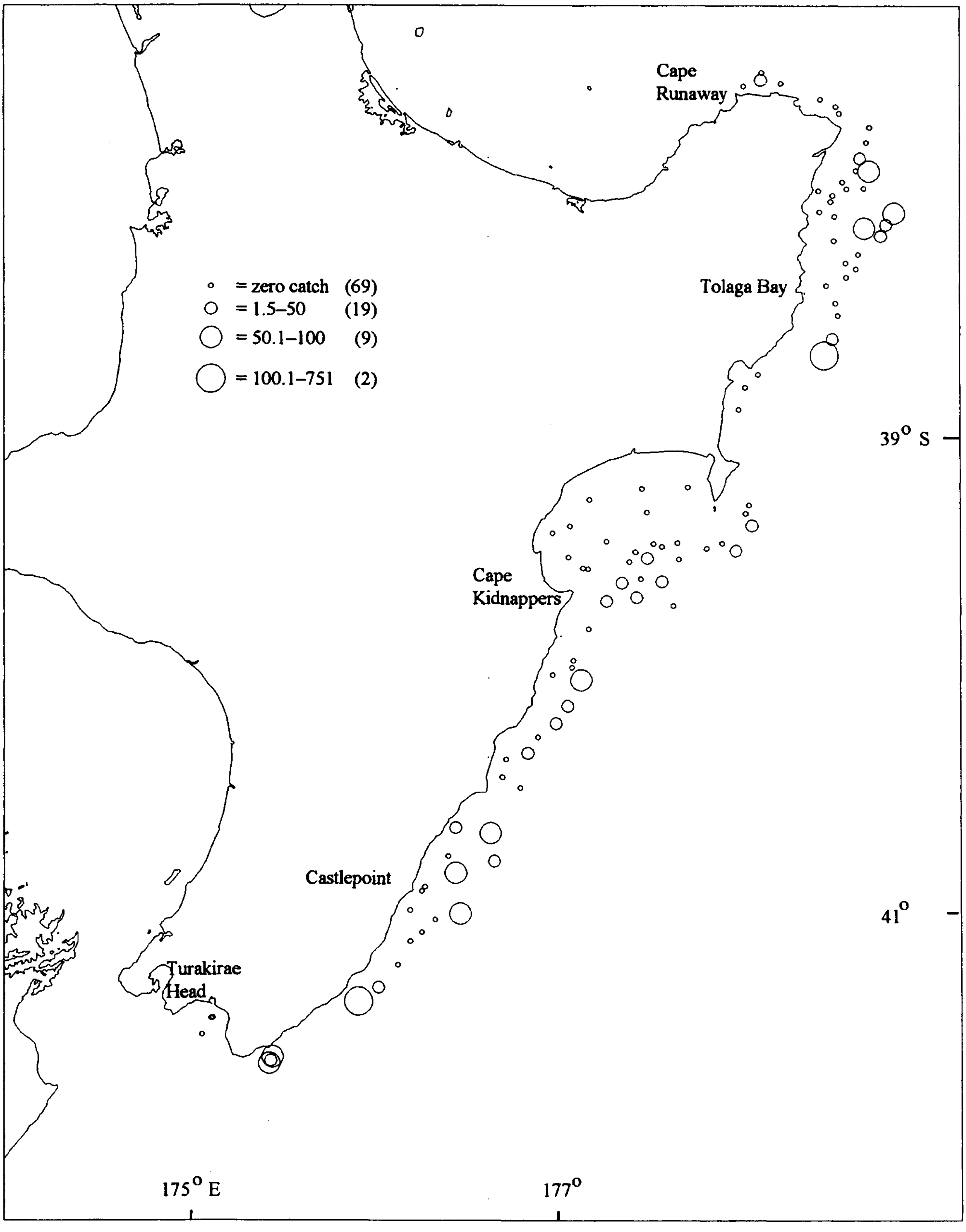


Figure 2—*continued*

Hoki

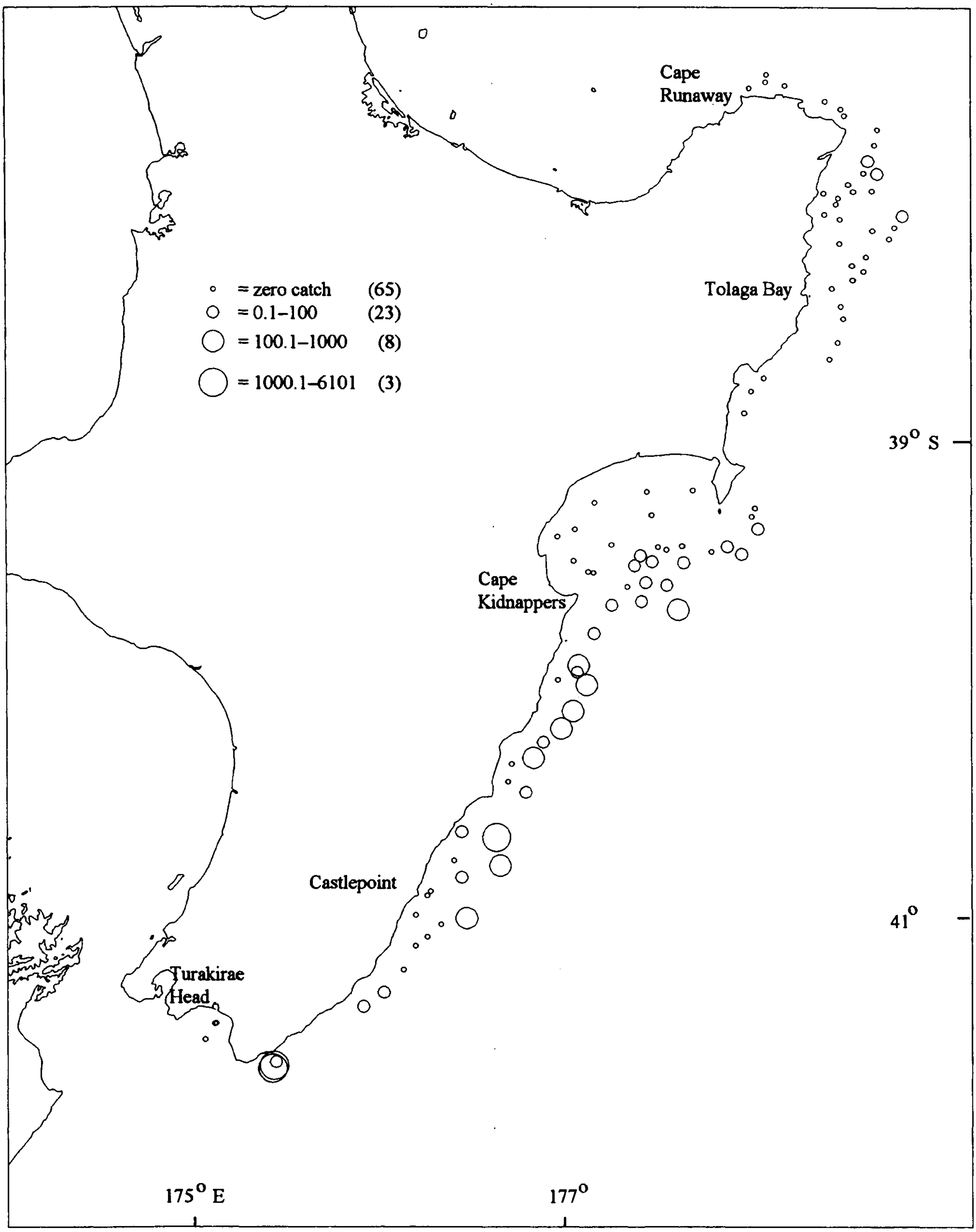


Figure 2—*continued*

Jack mackerel
Trachurus murphyi

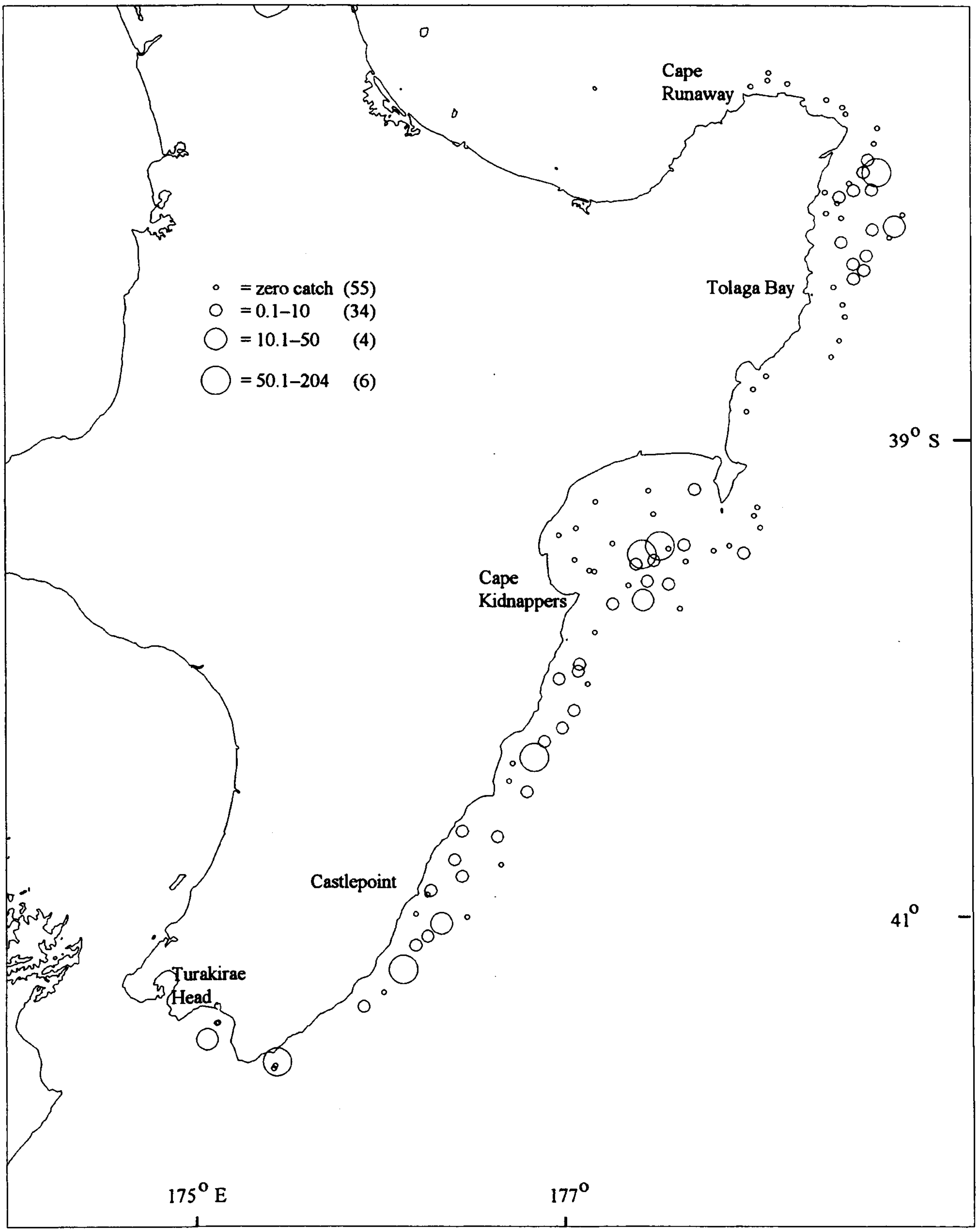


Figure 2—*continued*

Jack mackerel
Trachurus novaezelandiae

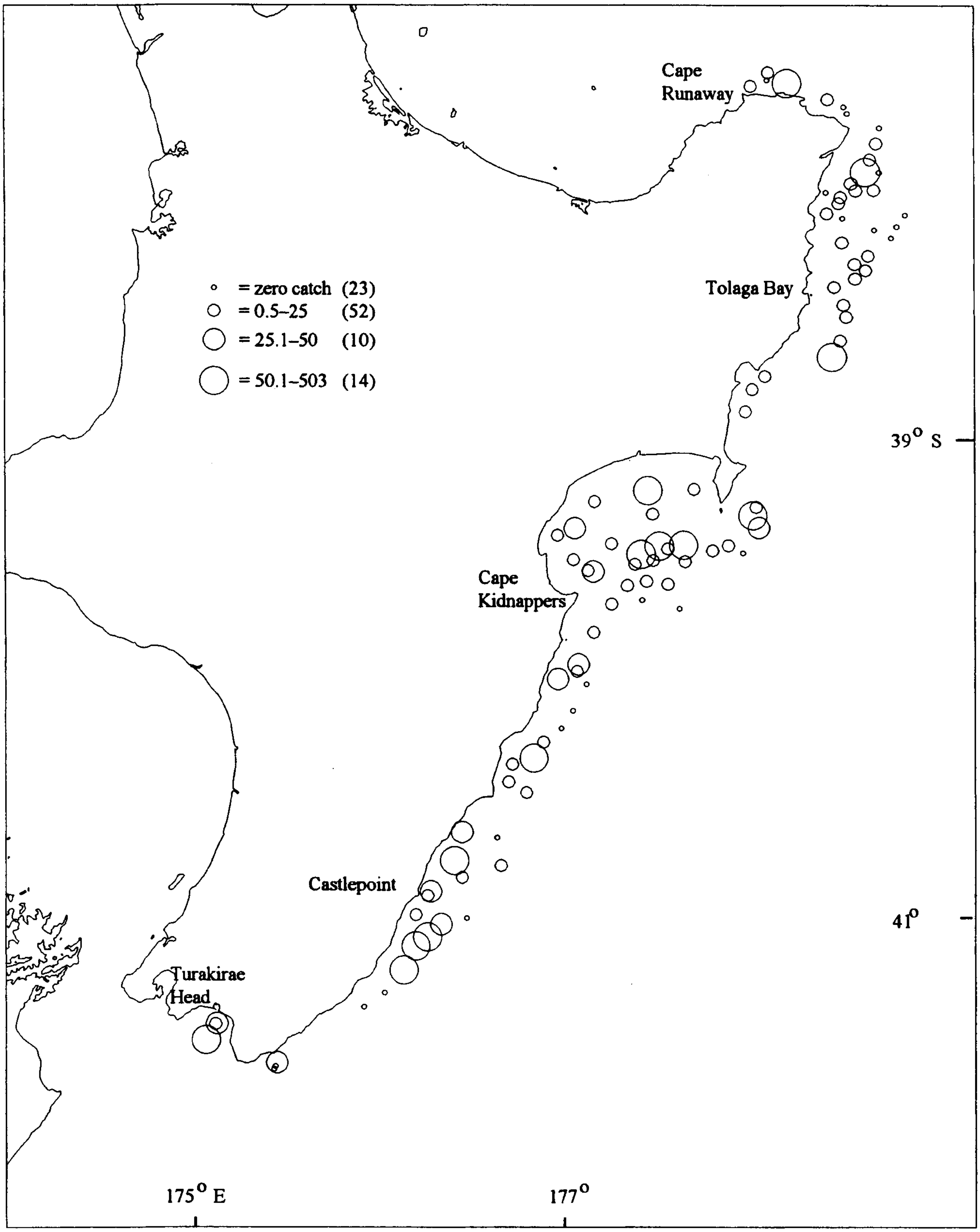


Figure 2—*continued*

John dory

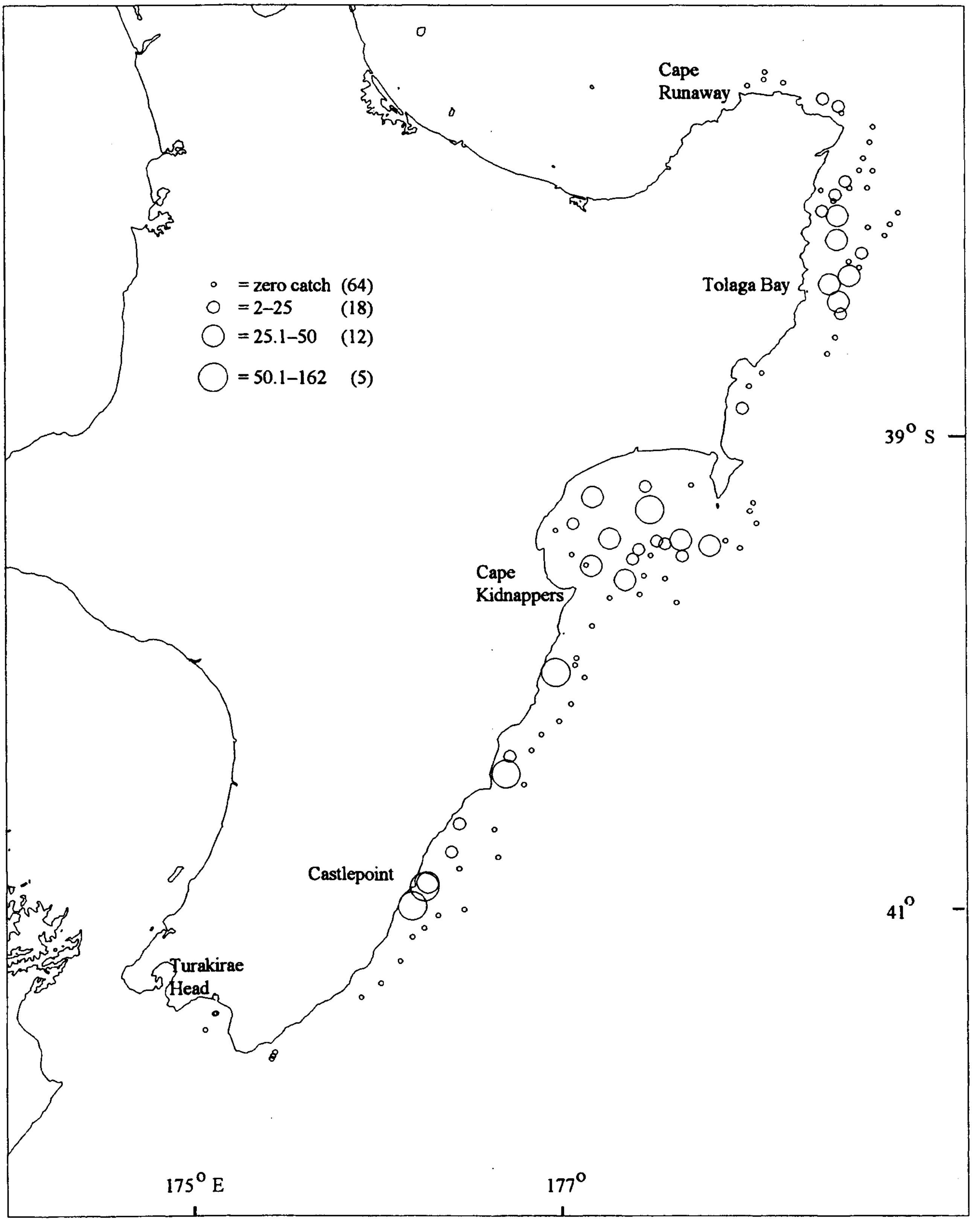


Figure 2—*continued*

Ling

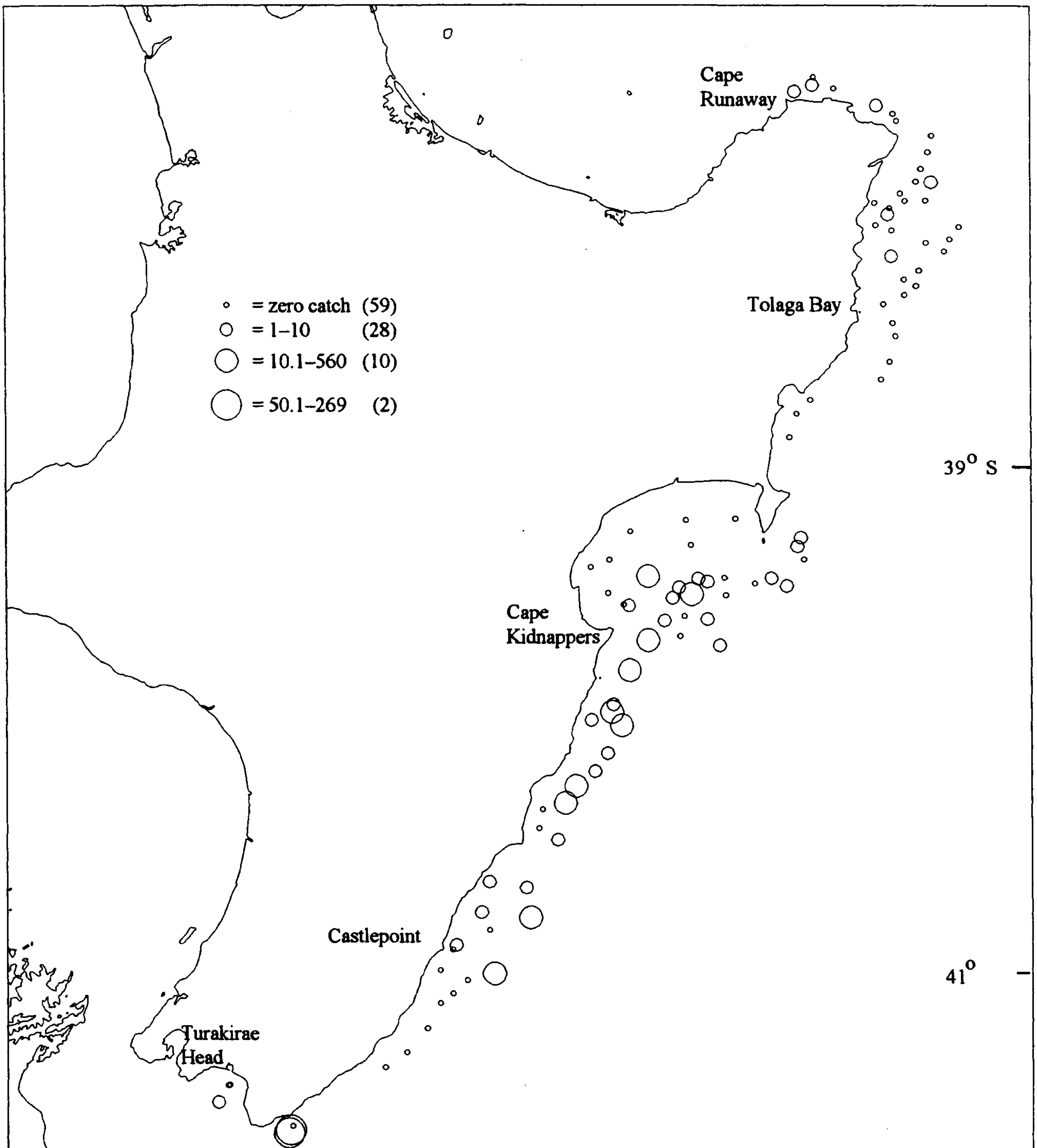


Figure 2—*continued*

Red cod

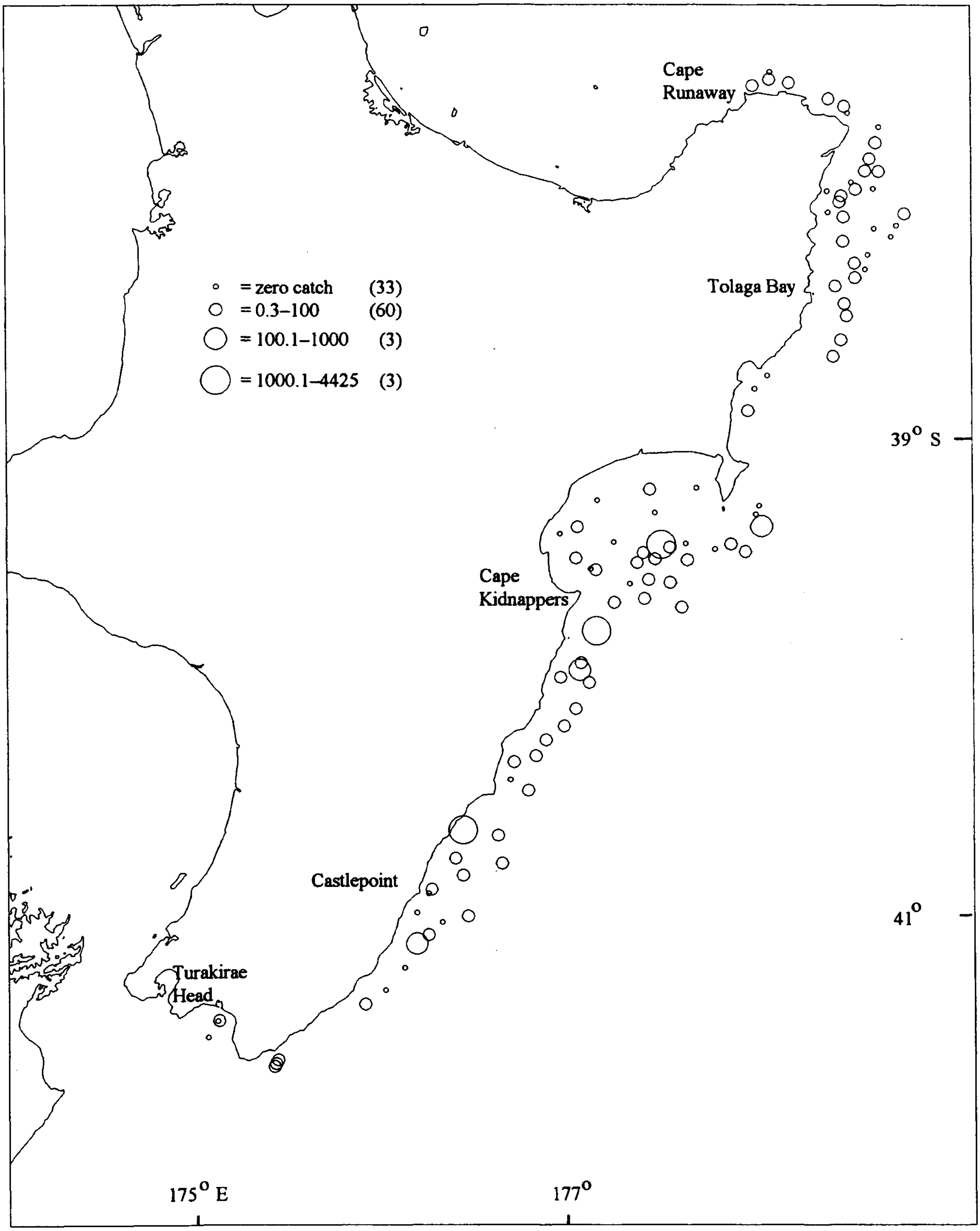


Figure 2—*continued*

Red gurnard

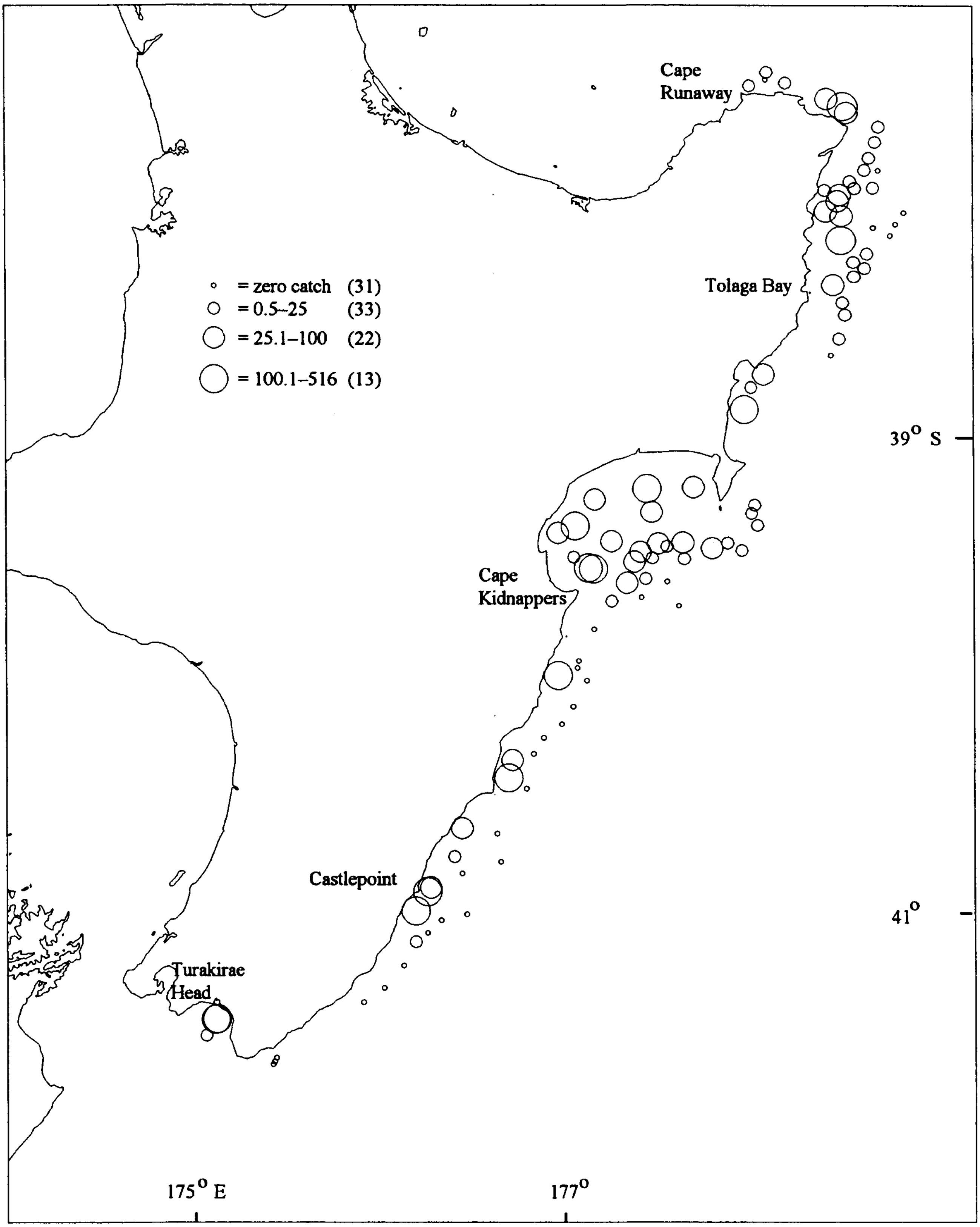


Figure 2—*continued*

Rig

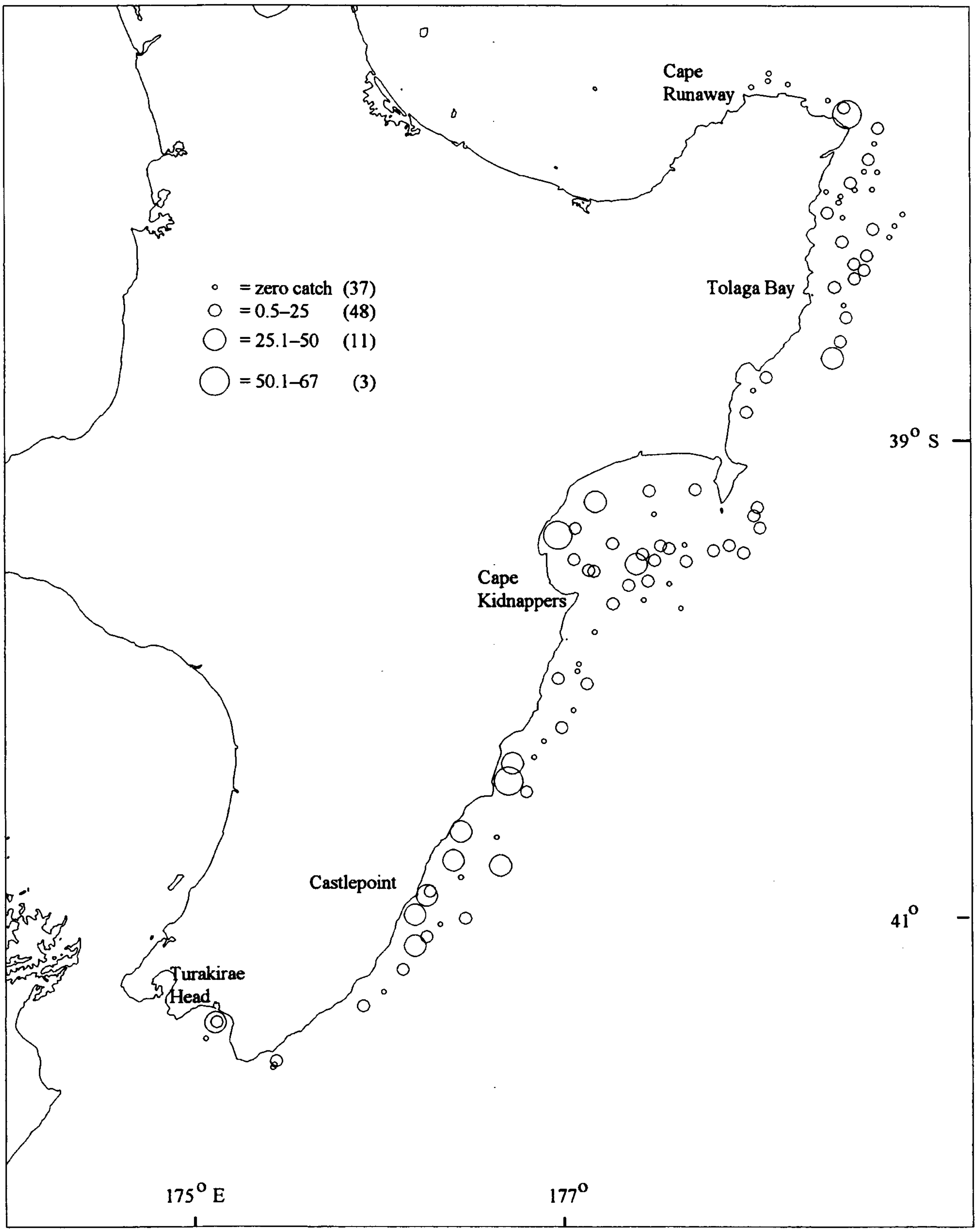


Figure 2—*continued*

School shark

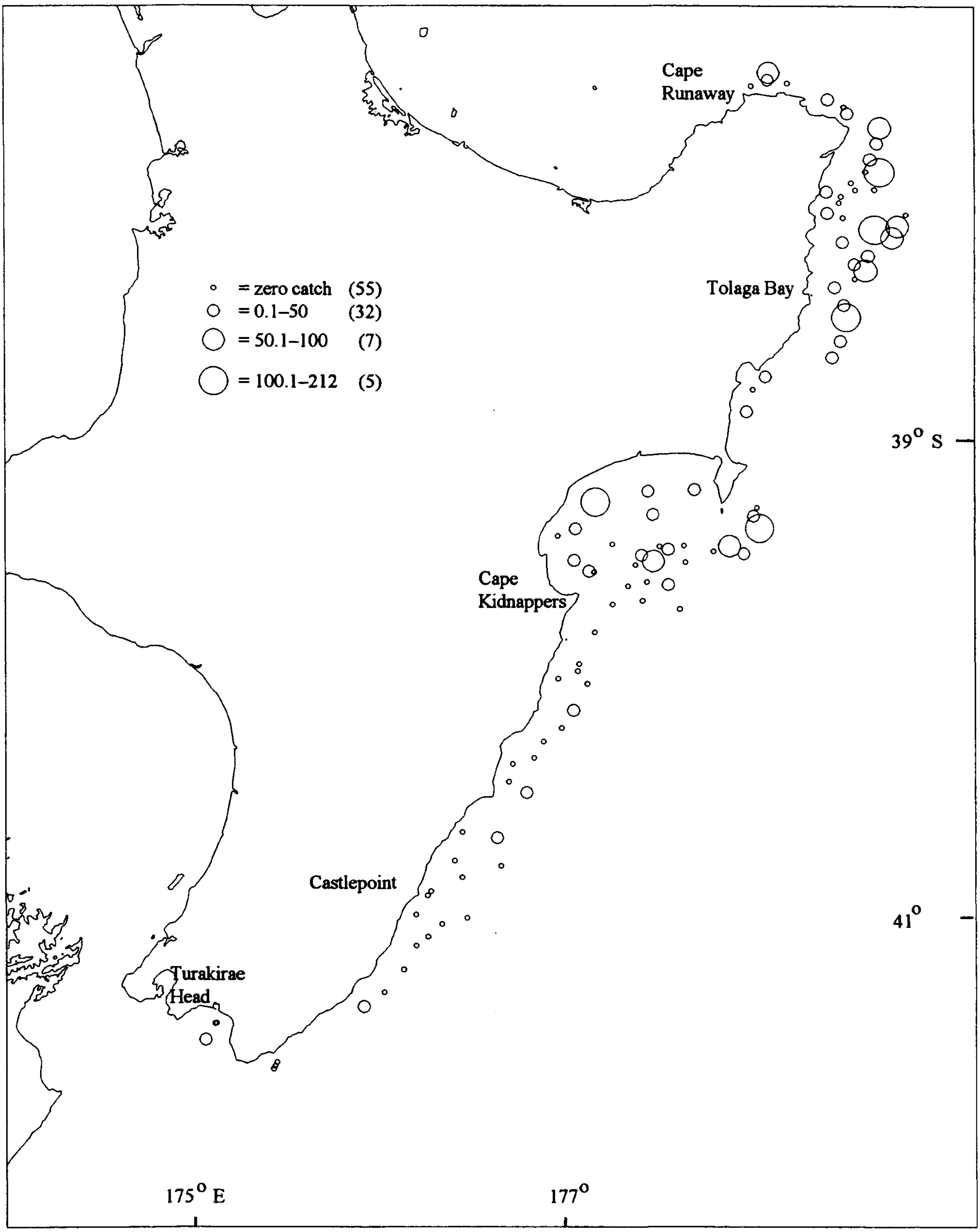


Figure 2—*continued*

Snapper

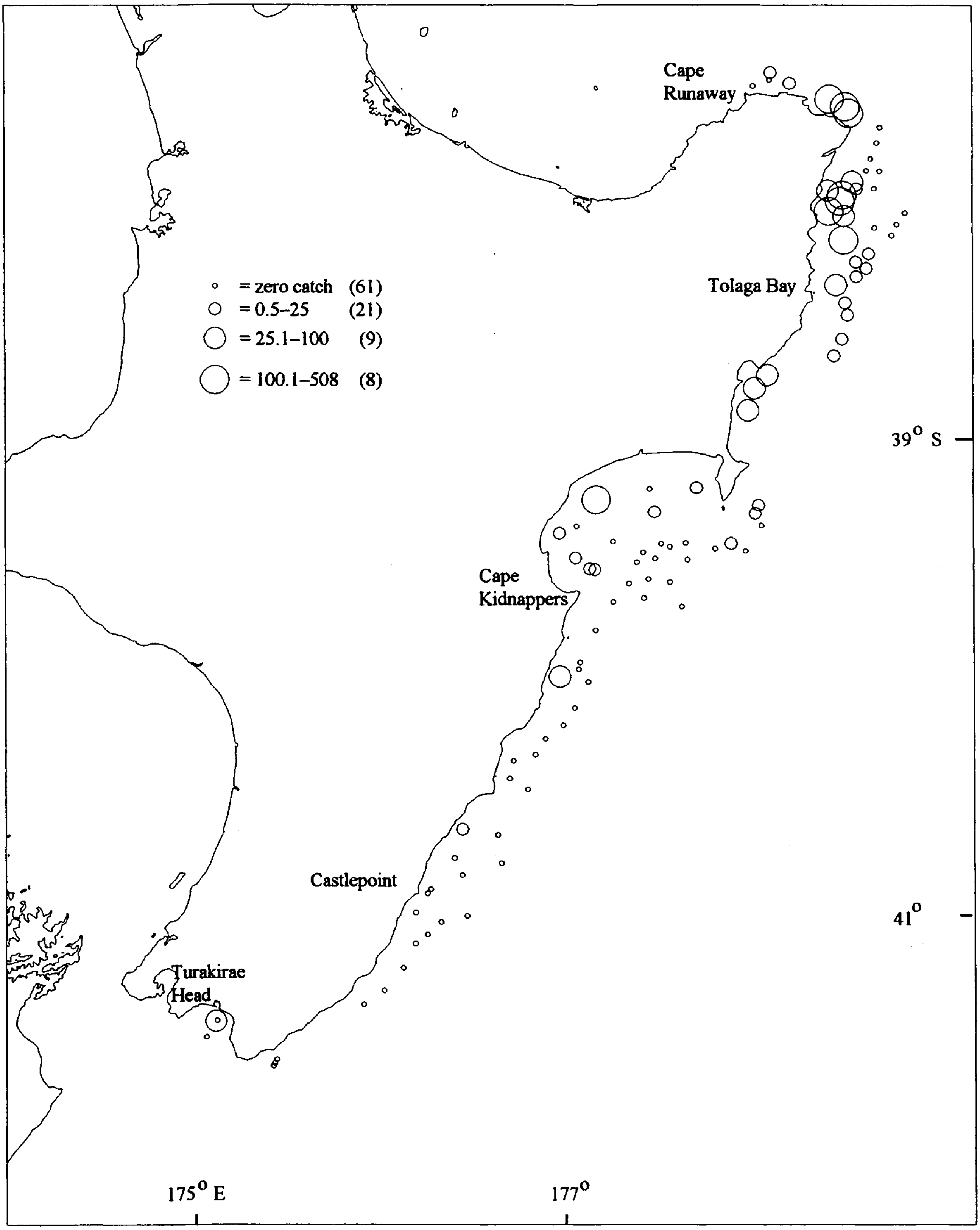


Figure 2—*continued*

Southern spiny dogfish

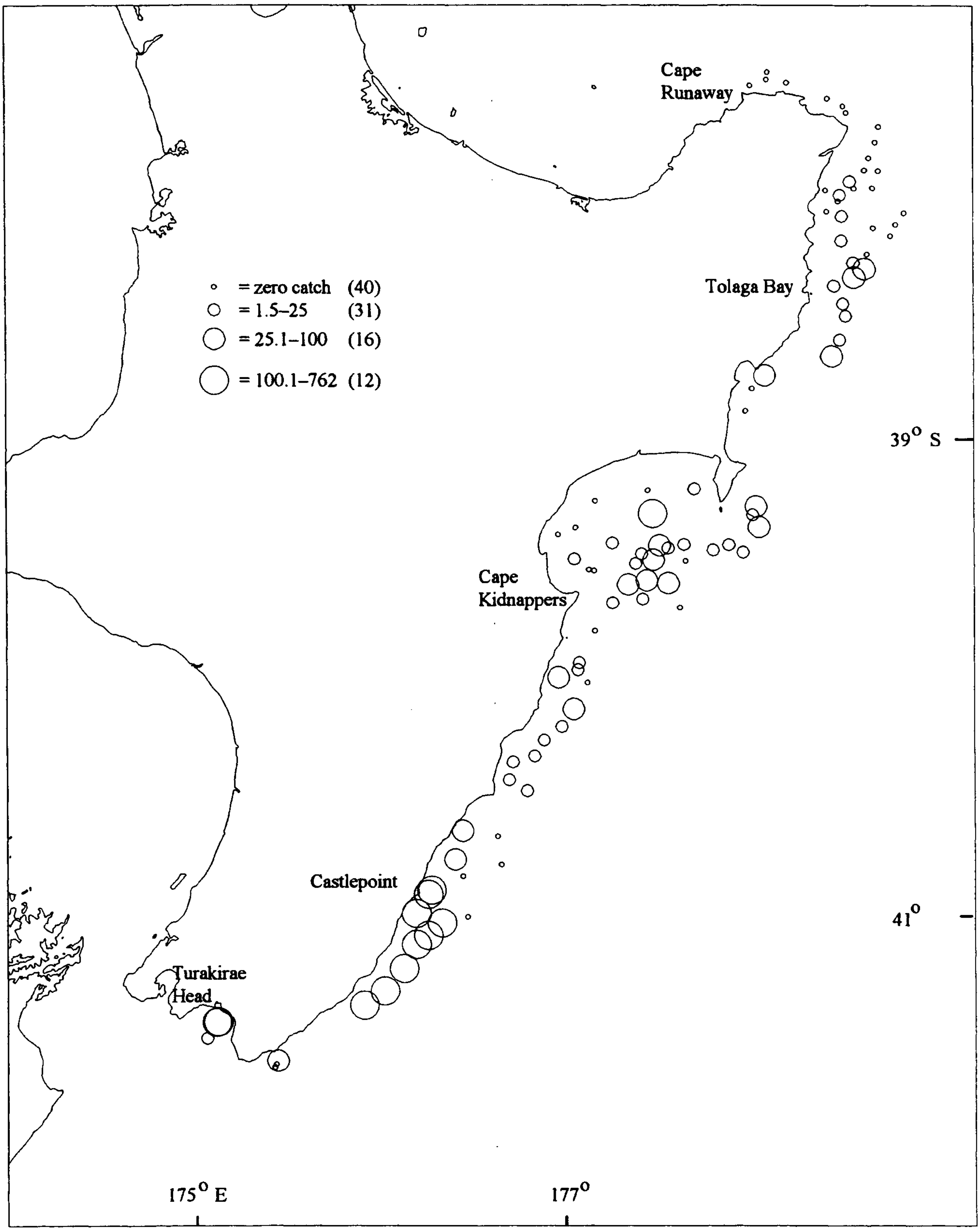


Figure 2—***continued***

Tarakihi

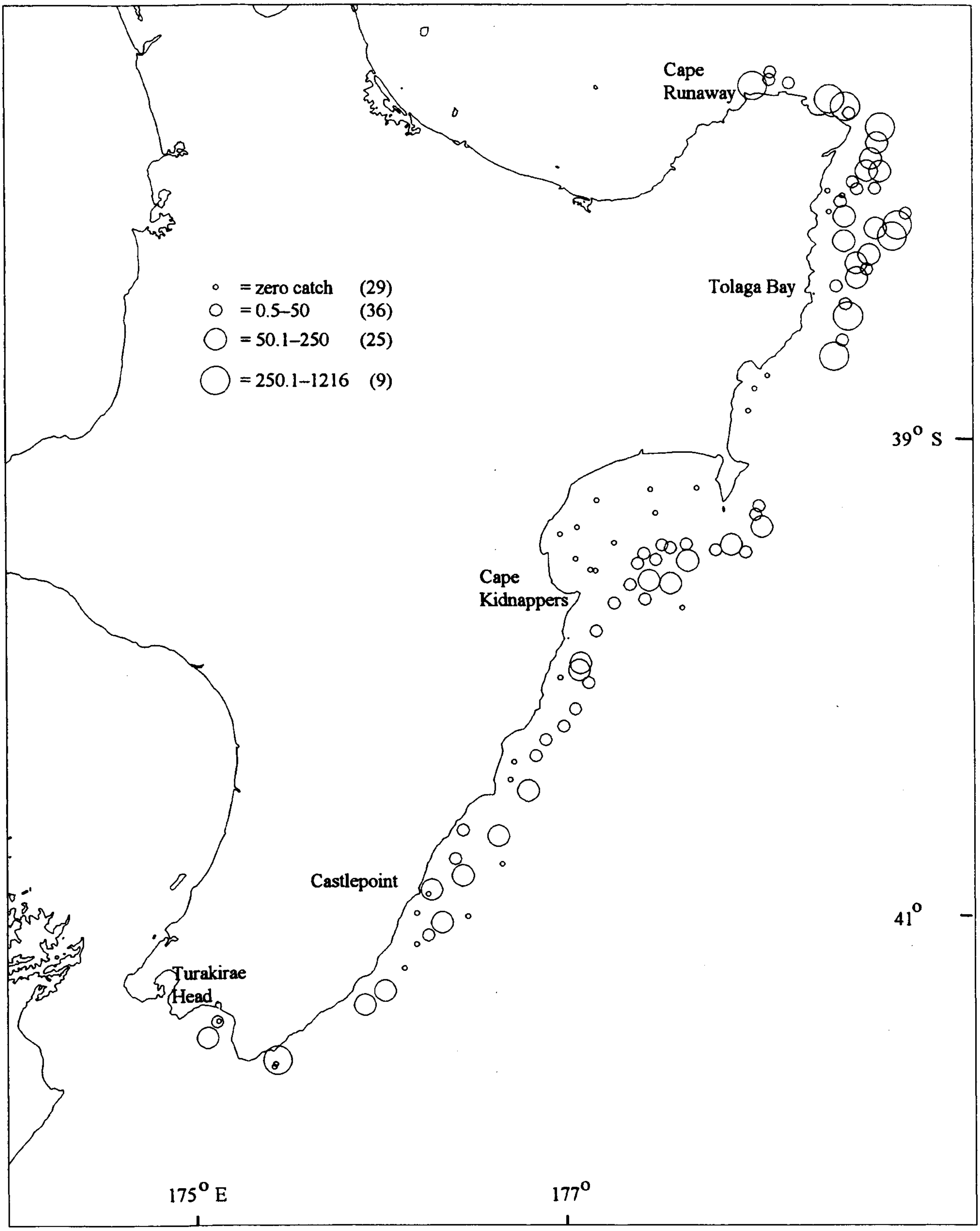


Figure 2—*continued*

Trevally

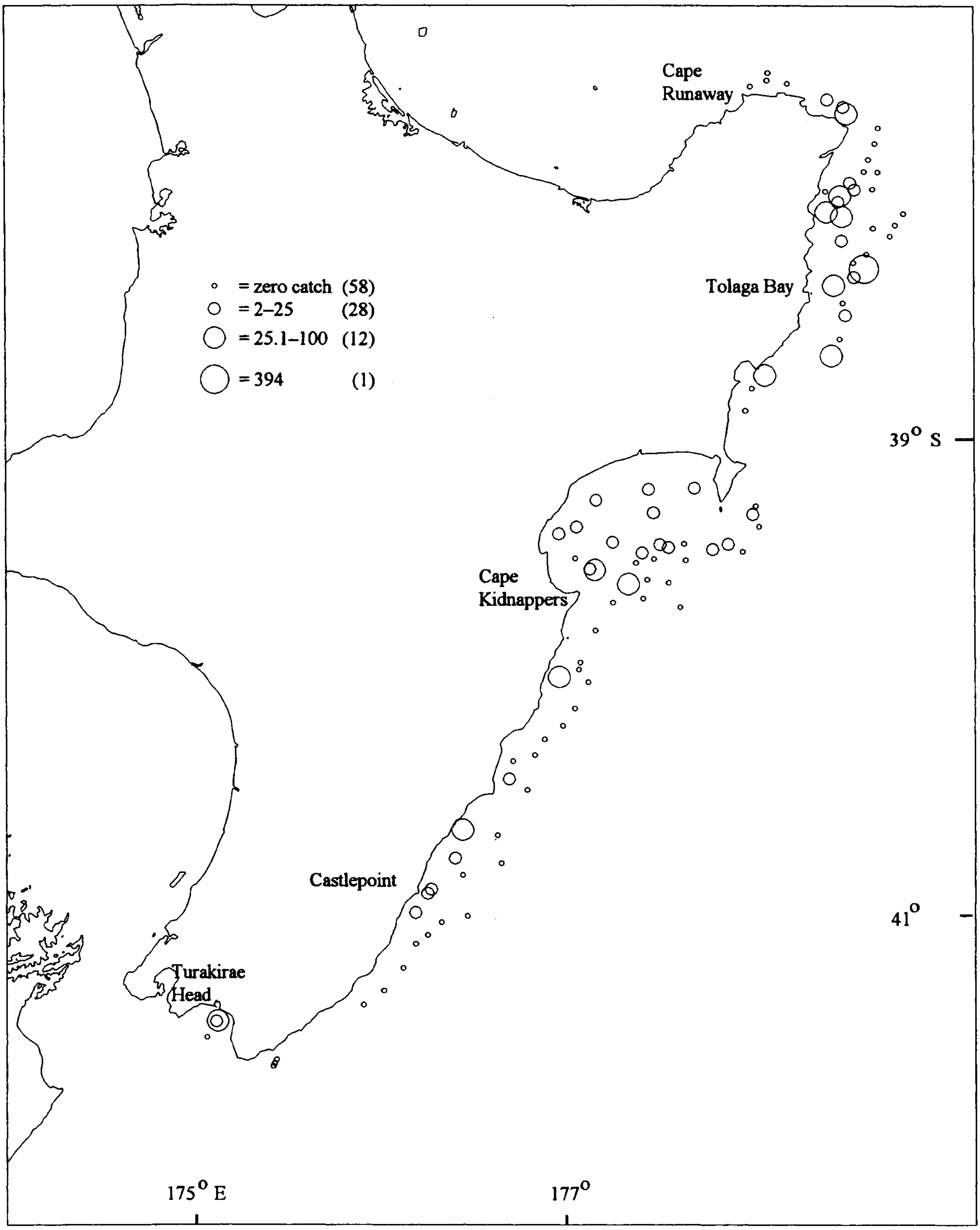


Figure 2—*continued*

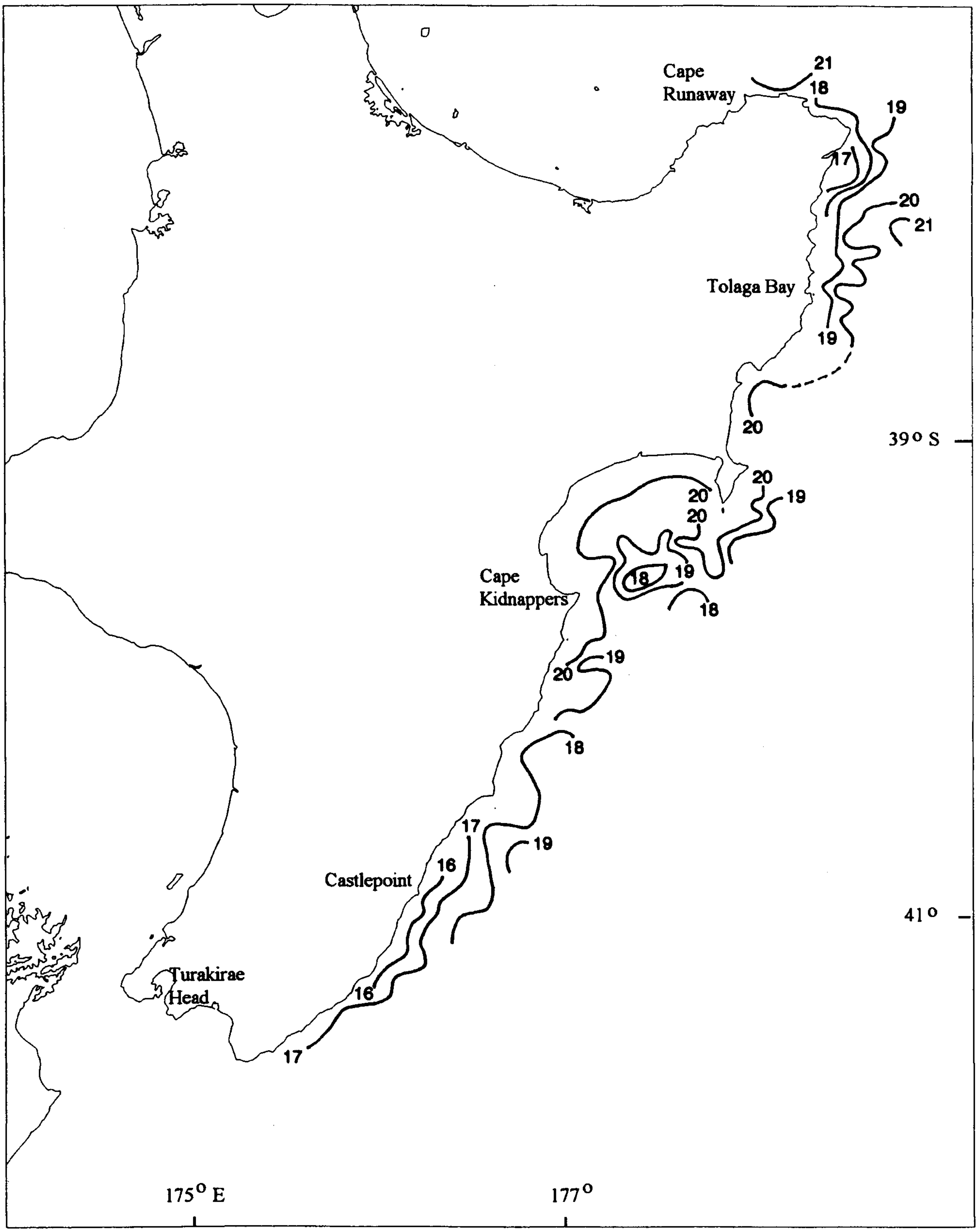


Figure 3: Sea surface isotherms estimated from station recordings.

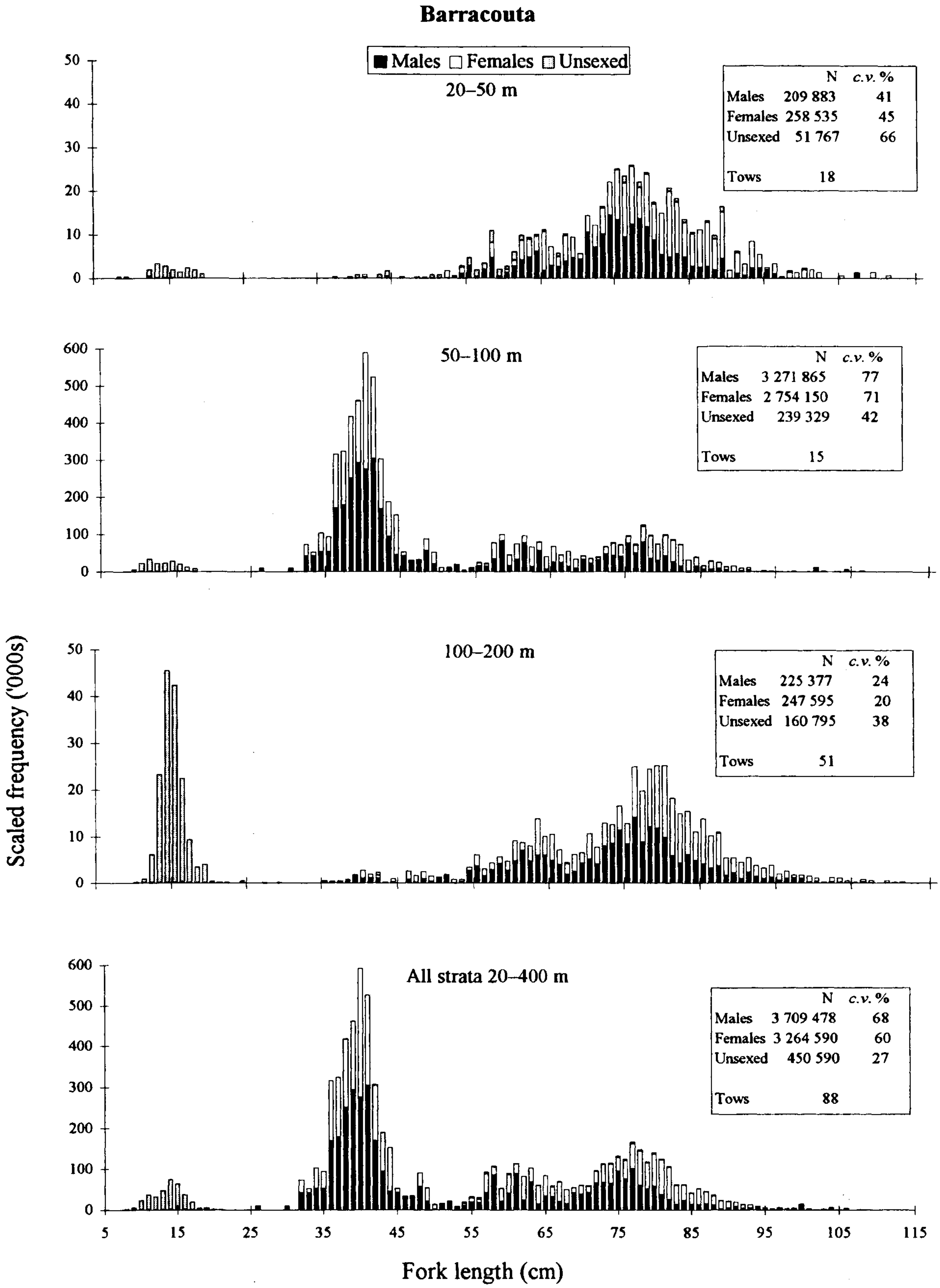


Figure 4: Scaled length frequency distributions for the 16 most abundant ITQ finfish species (N, estimated population; Tows, number of stations where species was caught).

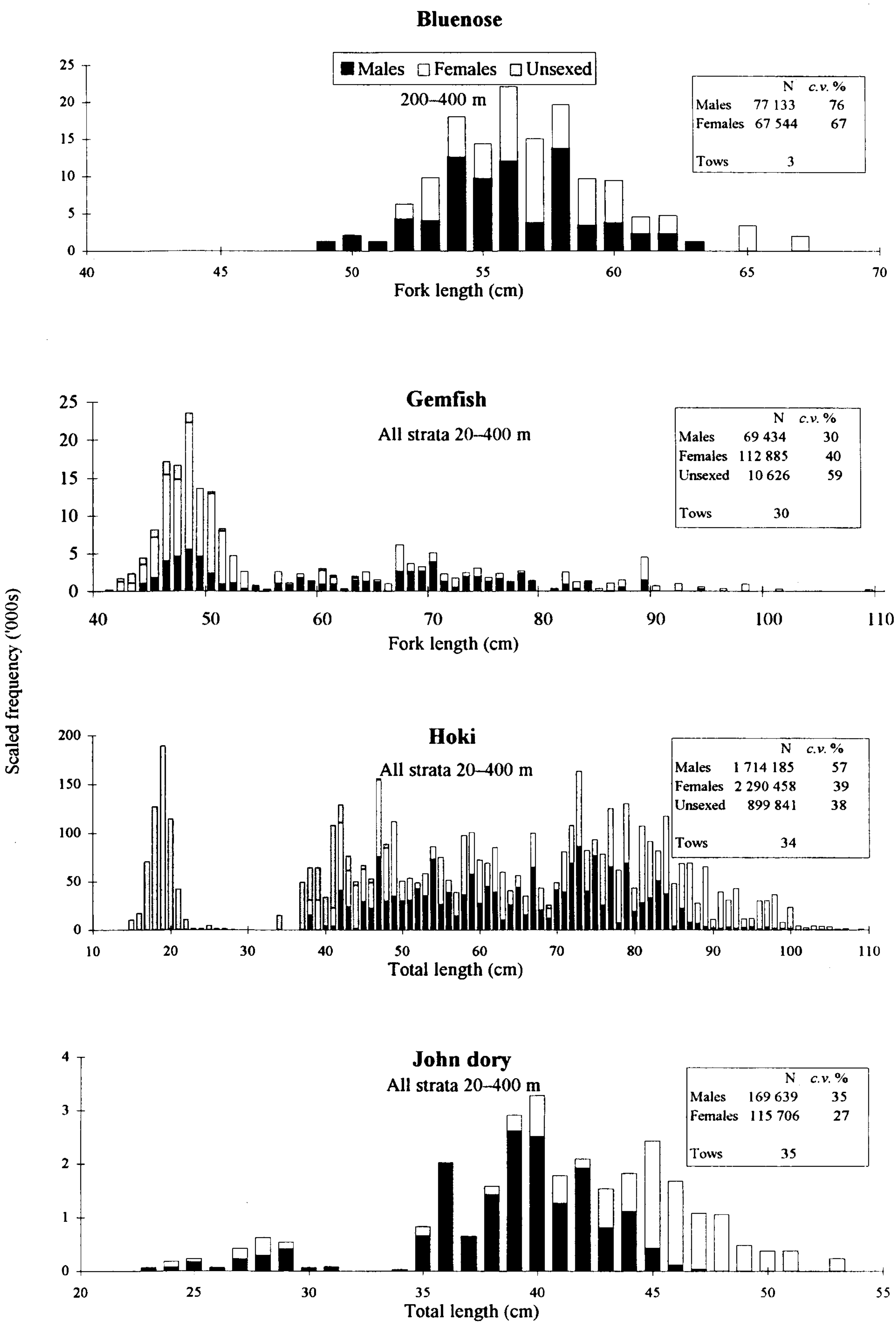


Figure 4—*continued*

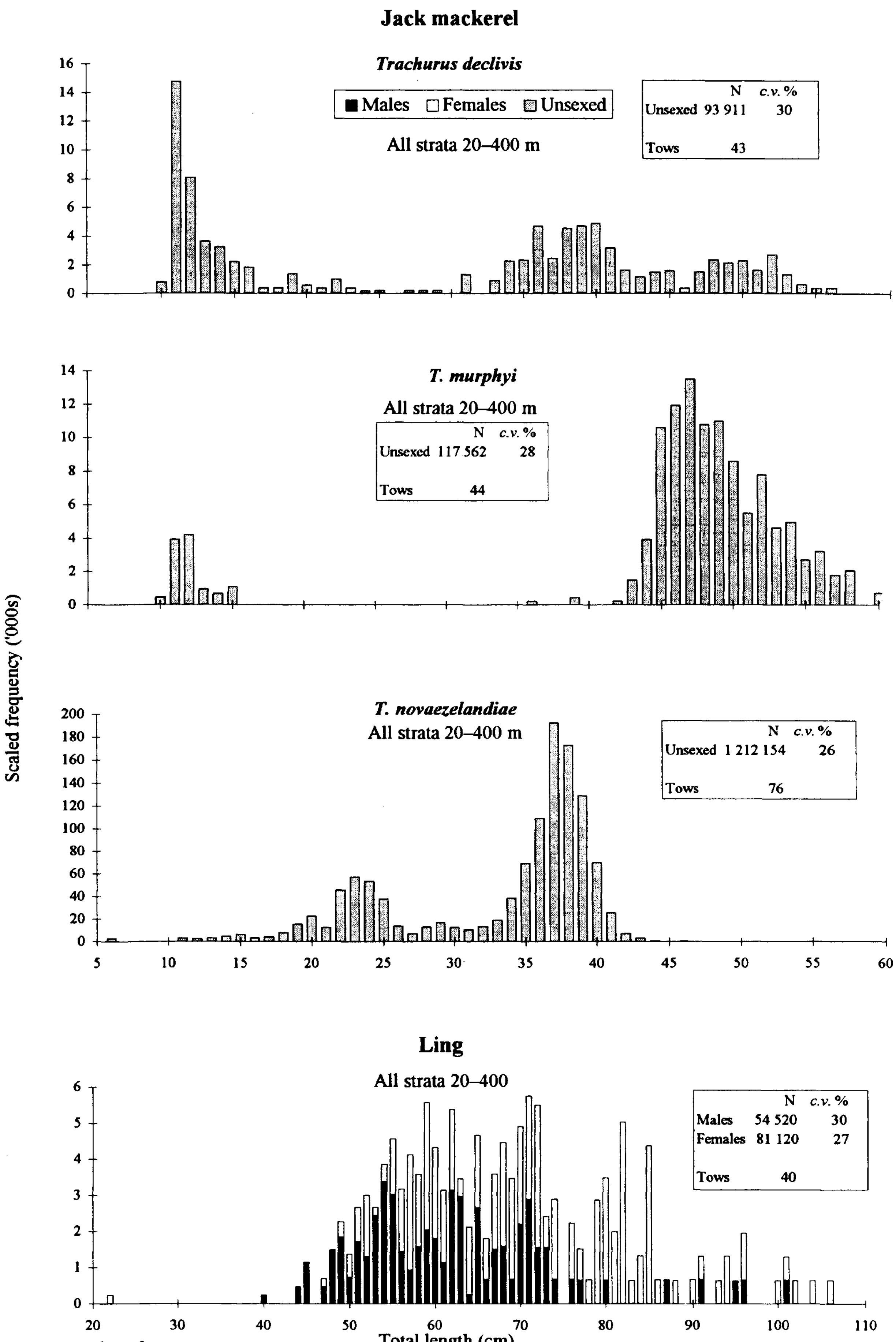


Figure 4—*continued*

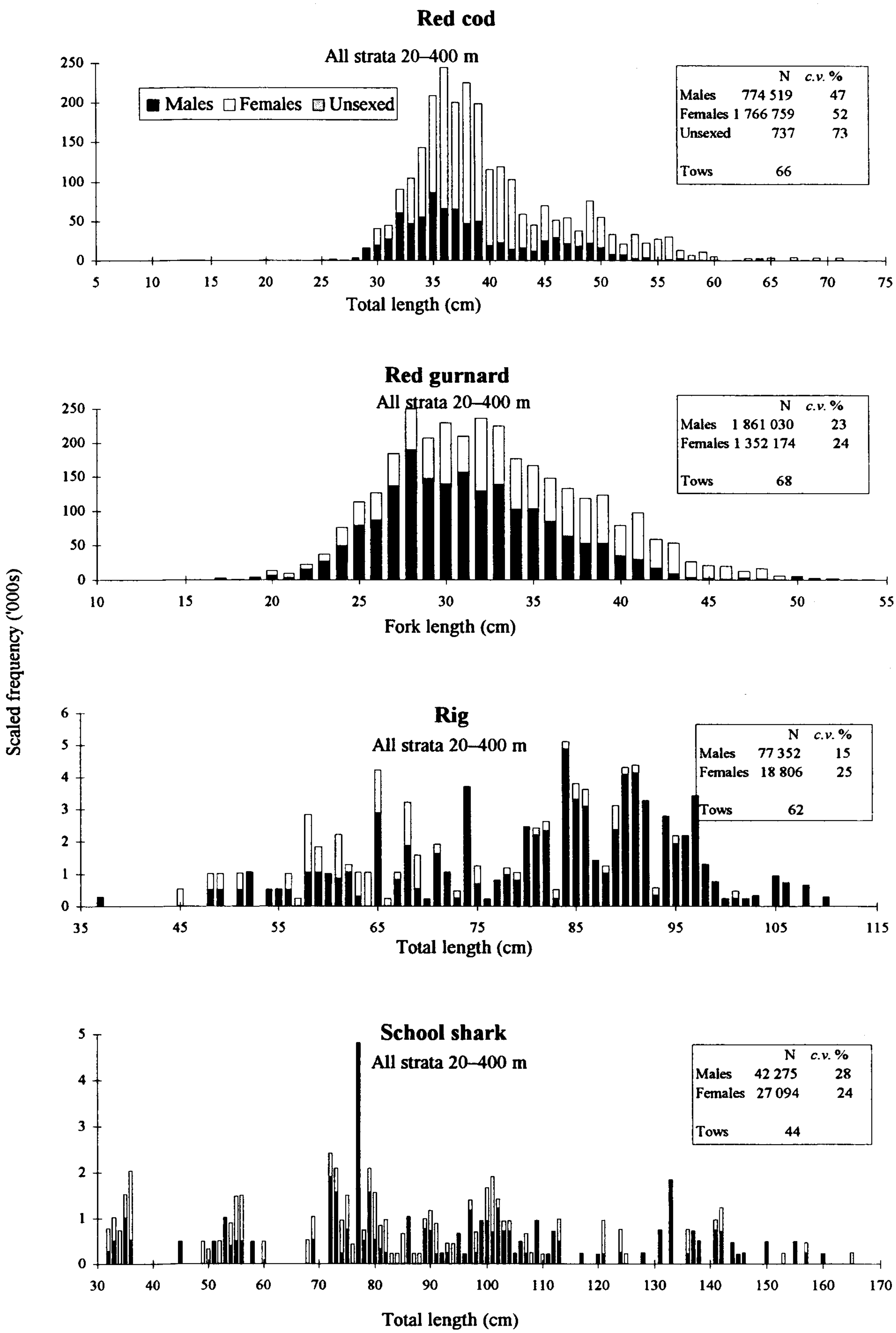


Figure 4—*continued*

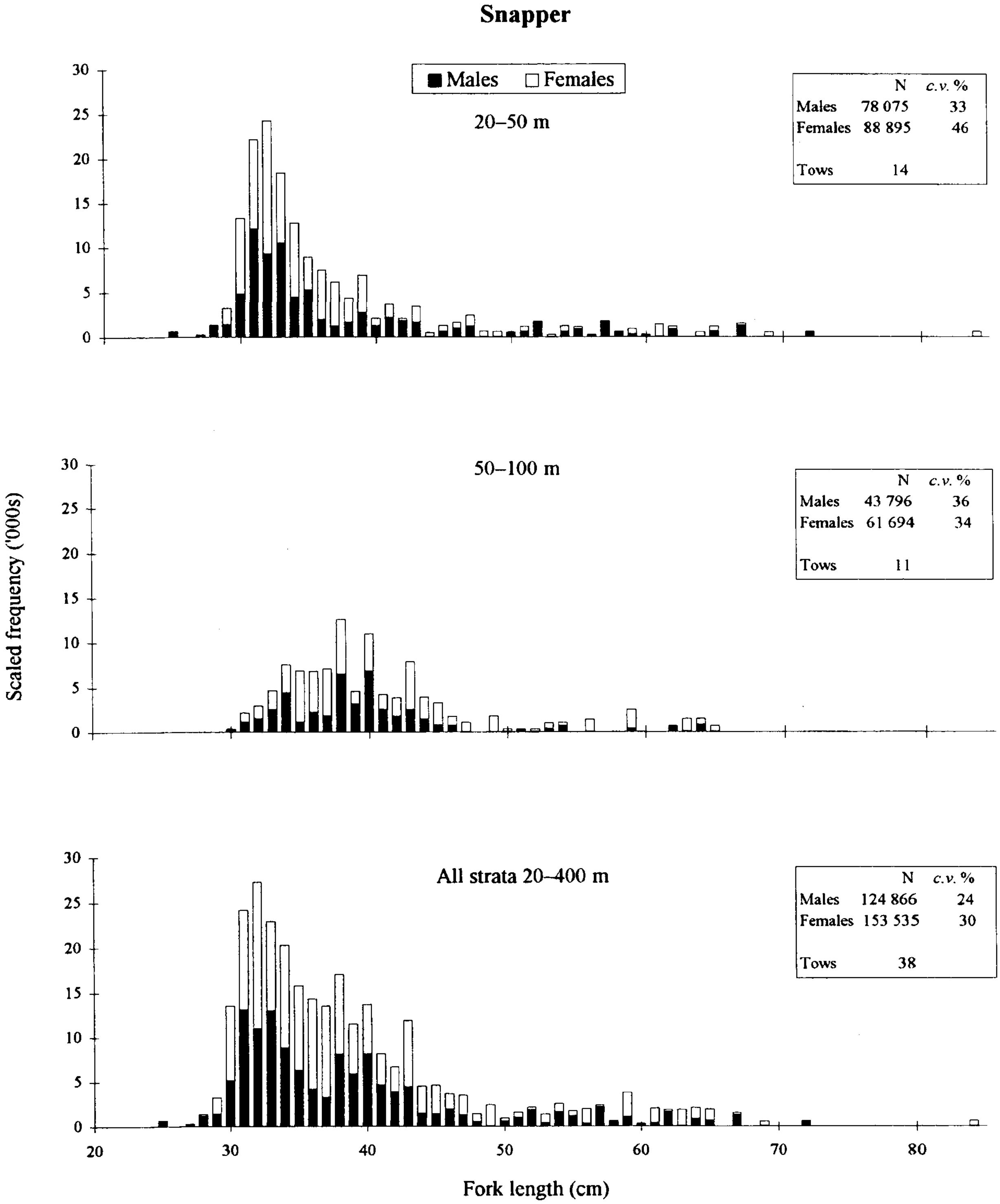


Figure 4—*continued*

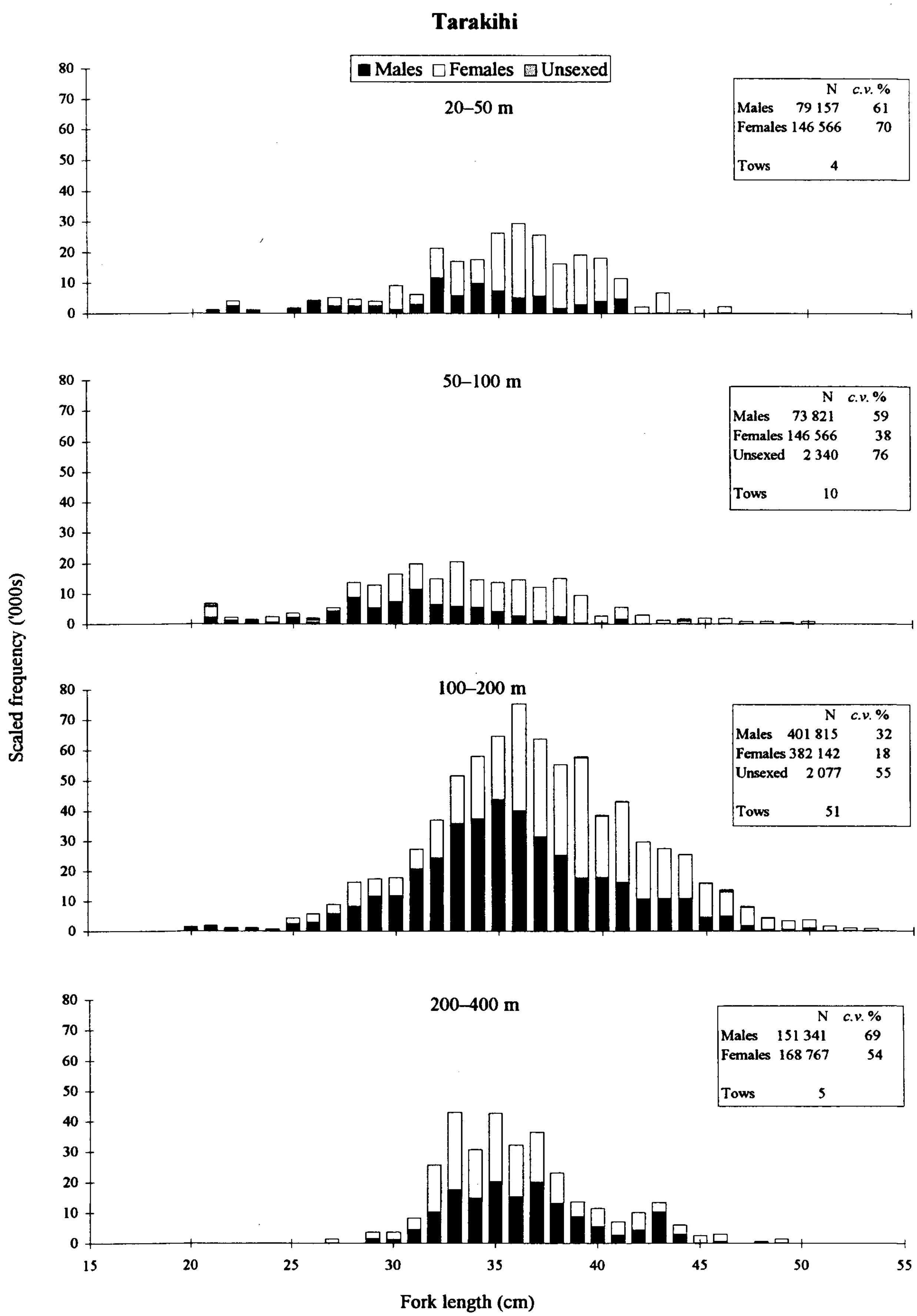


Figure 4—*continued*

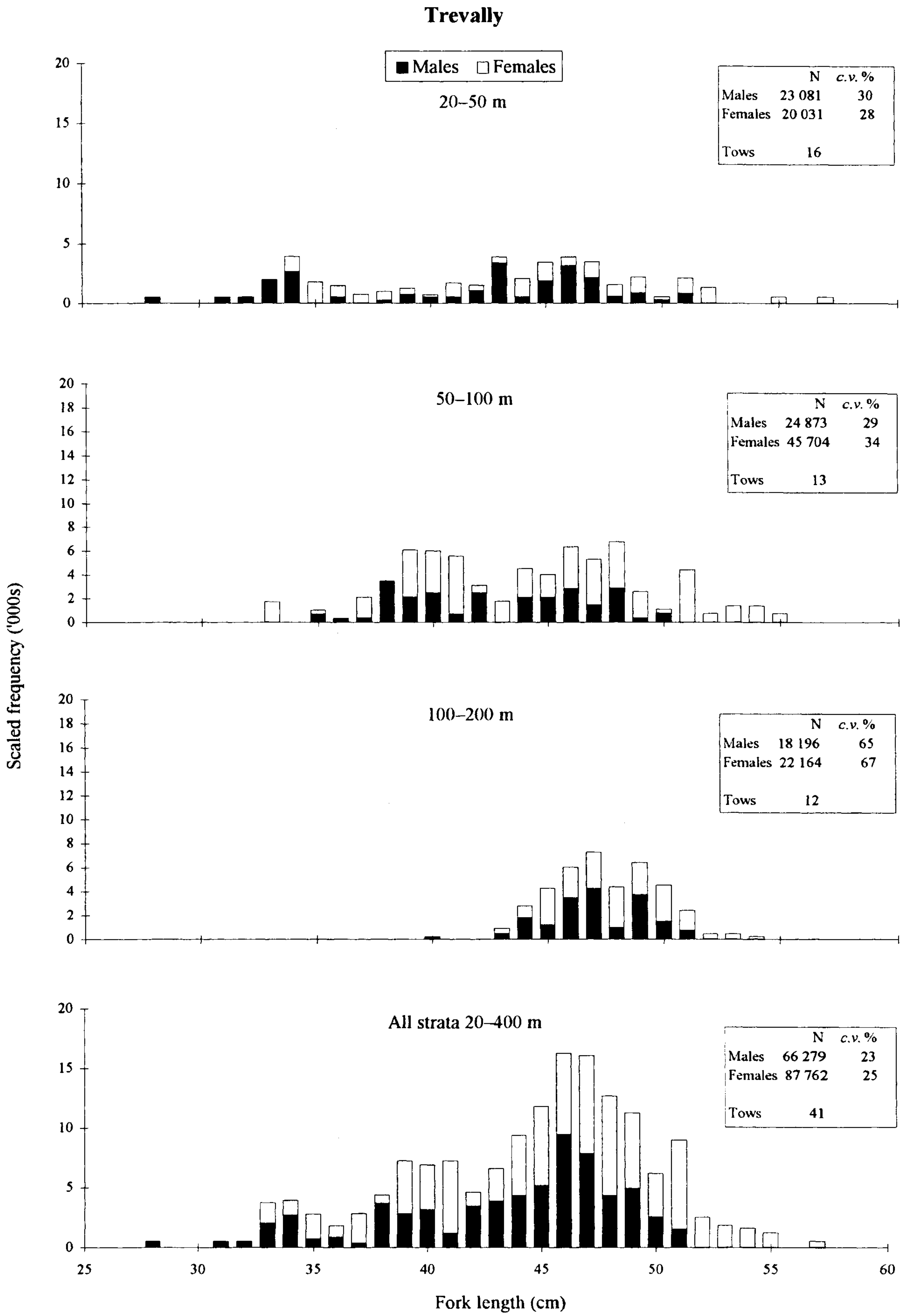


Figure 4—*continued*

Appendix 1: Summary of station data

Station	Stratum	Date	Time	Start of tow ° ' S	Start of tow ° ' E	End of tow ° ' S	End of tow ° ' E	Gear depth (m) Min.	Gear depth (m) Max.	Distance trawled (n. miles)	Surface temp. (°C)
1	2	4-Feb-94	651	41 31.03	175 03.60	41 28.02	175 01.70	69	84	3.33	13.9
2	1	4-Feb-94	850	41 26.85	175 07.11	41 29.55	175 10.07	29	37	3.46	13.8
3	4	4-Feb-94	1415	41 38.36	175 25.42	41 38.74	175 30.08	320	467	3.53	-
4	4	5-Feb-94	539	41 37.63	175 25.97	41 37.29	175 30.54	219	315	3.44	16.9
5	3	5-Feb-94	852	41 36.68	175 26.52	41 35.75	175 31.03	133	174	3.50	17.0
6	3	5-Feb-94	1143	41 26.84	175 46.43	41 26.41	175 47.89	120	127	1.18	17.2
7	3	5-Feb-94	1545	41 19.16	176 01.57	41 16.92	176 04.72	163	180	3.27	17.5
8	1	6-Feb-94	549	41 20.04	175 54.21	41 17.31	175 57.23	39	45	3.54	16.0
9	3	6-Feb-94	1152	41 22.68	175 54.91	41 20.88	175 59.18	162	193	3.67	16.9
10	2	6-Feb-94	1452	41 07.50	176 11.79	41 04.35	176 14.01	87	91	3.55	17.5
11	8	7-Feb-94	553	39 42.46	177 37.97	39 41.60	177 42.31	338	403	3.45	17.2
12	11	7-Feb-94	821	39 36.28	177 34.29	39 35.47	177 29.84	147	150	3.53	18.6
13	11	7-Feb-94	1036	39 35.65	177 27.40	39 36.34	177 22.95	132	142	3.49	17.7
14	11	7-Feb-94	1220	39 36.74	177 21.16	39 37.22	177 16.64	106	126	3.52	17.7
15	2	8-Feb-94	525	40 53.67	176 16.73	40 57.55	176 15.07	63	68	2.80	16.2
16	3	8-Feb-94	908	41 13.50	176 07.74	41 10.86	176 10.63	102	106	3.47	16.5
17	3	8-Feb-94	1138	41 05.16	176 15.66	41 02.74	176 19.22	116	140	3.61	17.6
18	3	8-Feb-94	1326	41 02.05	176 20.20	40 58.59	176 21.04	132	145	3.59	17.9
19	4	8-Feb-94	1544	41 00.42	176 28.46	41 03.04	176 25.21	320	378	3.55	17.7
20	1	9-Feb-94	533	40 59.61	176 11.80	40 56.51	176 14.07	45	45	3.54	15.9
21	5	9-Feb-94	720	40 54.76	176 15.67	40 51.29	176 17.14	40	52	3.64	16.0
22	7	9-Feb-94	939	40 50.13	176 29.95	40 52.74	176 30.17	163	188	3.57	17.5
23	6	9-Feb-94	1201	40 45.93	176 24.50	40 42.30	176 24.83	66	92	3.63	17.0
24	8	9-Feb-94	1450	40 47.17	176 39.46	40 49.68	176 42.99	332	373	3.67	19.2
25	10	10-Feb-94	826	39 26.11	177 16.10	39 25.84	177 20.58	67	74	3.48	19.0
26	11	10-Feb-94	1019	39 28.83	177 29.65	39 27.94	177 30.31	104	112	3.68	19.7
27	11	10-Feb-94	1201	39 26.70	177 31.47	39 27.56	177 35.92	111	116	3.55	18.8
28	11	10-Feb-94	1353	39 26.46	177 39.42	39 28.01	177 43.49	103	103	3.51	19.8
29	11	10-Feb-94	1539	39 30.38	177 39.92	39 33.18	177 36.62	125	139	3.57	19.2
30	8	11-Feb-94	543	40 01.47	177 07.79	39 58.17	177 09.36	230	234	3.50	19.4

Appendix 1—*continued*

				Start of tow		End of tow		Gear depth (m)		Distance trawled (n.	Surface temp.
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	miles)	(°C)
31	7	11-Feb-94	733	39 58.21	177 04.69	40 01.14	177 02.12	102	135	3.52	18.8
32	6	11-Feb-94	936	40 00.17	176 58.52	39 57.77	177 01.73	61	87	3.50	19.8
33	7	11-Feb-94	1118	39 56.43	177 05.28	39 53.28	177 07.42	124	146	3.54	19.8
34	7	11-Feb-94	1312	39 48.35	177 10.31	39 45.13	177 12.16	118	124	3.51	20.0
35	7	11-Feb-94	1525	39 41.27	177 16.14	39 39.77	177 20.24	127	139	3.50	19.6
36	11	12-Feb-94	546	39 30.46	177 29.61	39 32.93	177 26.47	125	131	3.46	-
37	11	12-Feb-94	738	39 31.42	177 23.64	39 33.87	177 20.46	110	112	3.47	18.9
38	7	12-Feb-94	1001	39 40.33	177 25.98	39 43.53	177 23.79	168	189	3.61	19.2
39	9	12-Feb-94	1300	39 32.92	177 08.50	39 35.04	177 04.85	25	43	3.52	20.5
40	9	13-Feb-94	806	39 24.08	176 58.51	39 21.64	177 01.81	24	30	3.52	20.3
41	9	13-Feb-94	1037	39 15.51	177 10.67	39 14.00	177 14.67	38	38	3.45	20.3
42	10	13-Feb-94	1308	39 18.72	177 29.39	39 20.24	177 33.51	70	80	3.53	19.6
43	6	14-Feb-94	544	40 38.68	176 26.88	40 41.37	176 29.13	54	100	3.19	17.7
44	7	14-Feb-94	804	40 40.12	176 38.30	40 36.48	176 38.67	128	187	3.63	17.6
45	7	14-Feb-94	1034	40 28.36	176 48.04	40 25.12	176 47.65	123	137	3.52	18.0
46	5	14-Feb-94	1225	40 25.95	176 42.18	40 22.29	176 42.29	36	49	3.65	17.9
47	5	14-Feb-94	1404	40 21.40	176 43.34	40 18.17	176 45.08	46	52	3.49	18.0
48	7	15-Feb-94	543	40 19.87	176 50.52	40 17.98	176 54.62	117	154	3.64	18.7
49	7	15-Feb-94	751	40 15.89	176 53.61	40 13.15	176 56.83	112	126	3.68	18.0
50	7	15-Feb-94	949	40 12.47	176 59.59	40 09.07	177 01.79	163	164	3.79	19.0
51	7	15-Feb-94	1210	40 08.09	177 03.40	40 04.44	177 03.69	153	184	3.64	19.4
52	11	16-Feb-94	544	38 39.13	178 27.30	38 36.30	178 30.19	121	131	3.61	19.7
53	11	16-Feb-94	734	38 35.04	178 29.83	38 32.28	178 32.63	123	128	3.52	19.8
54	11	16-Feb-94	918	38 28.97	178 31.75	38 26.11	178 34.59	109	113	3.62	20.3
55	10	16-Feb-94	1108	38 25.94	178 30.93	38 27.74	178 28.07	85	89	3.58	19.5
56	13	16-Feb-94	1220	38 21.43	178 28.07	38 18.54	178 30.84	69	86	3.61	20.4
57	14	16-Feb-94	1506	38 15.58	178 34.37	38 11.98	178 34.23	112	119	3.58	20.5
58	11	17-Feb-94	546	39 28.51	177 58.51	39 25.20	178 00.16	130	145	3.57	18.5
59	11	18-Feb-94	541	39 26.68	177 53.81	39 24.21	177 56.94	104	107	3.48	18.9
60	11	18-Feb-94	803	39 19.10	178 01.70	39 22.64	178 00.12	103	112	3.74	19.3

Appendix 1—*continued*

				Start of tow		End of tow		Gear depth (m)		Distance trawled (n.	Surface temp.
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.	miles)	(°C)
61	11	18-Feb-94	1417	39 22.19	178 03.73	39 19.29	178 06.05	137	142	3.41	20.0
62	9	19-Feb-94	548	38 52.91	177 59.43	38 49.68	178 01.58	44	49	3.63	20.0
63	15	19-Feb-94	1259	38 08.83	178 45.82	38 05.58	178 45.62	221	232	3.25	20.5
64	15	19-Feb-94	1511	38 06.90	178 40.43	38 03.34	178 40.80	206	208	3.56	20.6
65	12	20-Feb-94	541	38 02.73	178 25.71	37 59.62	178 25.60	46	49	3.10	18.5
66	13	20-Feb-94	835	37 58.61	178 29.94	37 55.26	178 31.52	72	79	3.57	19.2
67	14	20-Feb-94	1022	37 56.92	178 34.63	38 00.24	178 37.00	105	117	3.74	18.7
68	14	20-Feb-94	1248	37 56.76	178 40.39	38 00.42	178 40.26	140	148	3.65	19.6
69	15	20-Feb-94	1532	38 03.05	178 50.11	38 05.79	178 50.10	343	371	2.74	20.4
70	14	21-Feb-94	550	37 52.44	178 41.96	37 49.42	178 43.91	179	197	3.38	18.6
71	14	21-Feb-94	810	37 49.19	178 39.14	37 52.40	178 37.38	127	130	3.48	17.4
72	14	21-Feb-94	1011	37 52.31	178 37.64	37 55.73	178 37.89	129	130	3.40	17.1
73	13	21-Feb-94	1206	38 55.11	178 33.27	37 51.52	178 34.30	89	91	3.66	16.9
74	12	21-Feb-94	1433	37 57.41	178 25.43	37 54.22	178 27.40	48	48	3.47	17.0
75	12	22-Feb-94	554	37 37.75	178 32.19	37 39.17	178 36.24	36	50	3.51	17.4
76	14	22-Feb-94	1023	37 30.15	178 13.10	37 29.07	178 16.08	101	135	3.56	21.2
77	14	22-Feb-94	1307	37 27.45	178 06.87	37 28.29	178 11.30	139	163	3.62	21.3
78	14	22-Feb-94	1552	37 30.88	178 01.29	37 30.89	178 05.87	106	118	3.64	20.0
79	14	23-Feb-94	547	38 13.48	178 38.41	38 16.79	17 836.68	129	137	3.58	19.7
80	14	23-Feb-94	744	38 19.25	178 34.45	38 15.70	178 34.38	98	112	3.54	19.3
81	14	23-Feb-94	939	38 17.22	178 37.70	38 20.86	178 37.76	121	130	3.62	20.0
82	14	25-Feb-94	553	37 29.41	178 06.61	37 29.51	178 11.32	115	130	3.75	21.5
83	12	25-Feb-94	838	37 34.22	178 26.06	37 35.64	178 30.33	42	48	3.68	18.6
84	12	25-Feb-94	1024	37 36.08	178 31.06	37 48.49	178 34.44	37	40	3.60	18.3
85	14	25-Feb-94	1224	37 41.31	178 42.19	37 42.77	178 46.14	118	125	3.45	18.4
86	14	25-Feb-94	1427	37 45.19	178 41.10	37 48.33	178 39.22	102	115	3.47	19.8
87	15	26-Feb-94	545	38 13.00	178 47.98	38 11.48	178 44.25	198	295	3.30	20.9
88	15	26-Feb-94	1121	38 06.00	178 47.57	38 09.13	178 45.82	221	268	3.41	21
89	13	26-Feb-94	1405	38 10.03	178 30.52	38 06.64	178 29.18	70	80	3.54	20.1
90	13	27-Feb-94	610	38 00.17	178 29.40	38 03.08	178 27.06	58	71	3.44	19.1

Appendix 1—*continued*

				Start of tow		End of tow		Gear depth (m)		Distance trawled (n. miles)	Surface temp. (°C)
Station	Stratum	Date	Time	° ' S	° ' E	° ' S	° ' E	Min.	Max.		
91	13	27-Feb-94	755	38 03.91	178 30.69	38 07.12	178 32.66	73	88	3.55	19.2
92	9	27-Feb-94	1331	38 44.00	178 05.73	38 46.53	178 02.71	32	32	3.45	19.9
93	9	27-Feb-94	1504	38 47.35	178 01.50	38 49.65	177 58.28	34	42	3.40	20.3
94	11	28-Feb-94	605	39 16.97	178 02.78	39 20.07	178 00.78	100	102	3.46	19.9
95	11	28-Feb-94	907	39 27.97	177 48.84	39 28.05	177 44.64	102	104	3.25	20.6
96	11	28-Feb-94	1115	39 27.40	177 34.34	39 27.81	177 29.89	110	115	3.47	20.2
97	9	28-Feb-94	1452	39 12.37	177 42.77	39 09.65	177 45.52	34	38	3.46	19.9
98	9	1-Mar-94	546	39 12.81	177 27.87	39 12.78	177 23.21	42	49	3.61	19.8
99	9	1-Mar-94	847	39 22.22	177 04.10	39 25.87	177 03.91	34	38	3.65	20
100	9	1-Mar-94	1031	39 30.21	177 03.61	39 33.71	177 04.59	27	28	3.57	20.1
101	10	1-Mar-94	1217	39 33.13	177 10.18	39 36.43	177 11.50	54	70	3.45	20.3
102	1	2-Mar-94	657	41 27.02	175 06.65	41 24.50	175 03.39	26	32	3.51	15

Appendix 2a: Length-weight coefficients *a* and *b* calculated using the geometric mean functional relationship from data collected during this survey, and used to scale length frequencies and calculate biomass above a minimum size*

	a	*b*	*N*	Range (cm)
Snapper	0.0232	2.97	127	29–83
Tarakihi	0.0161	3.04	212	19–48
Trevally	0.0254	2.91	107	32–56

Appendix 2b: Additional length-weight coefficients *a* and *b* used to scale length frequencies and calculate biomass above a minimum size*

	a	*b*	Source	*N*	Range (cm)
Barracouta	0.0091	2.88	TAN9301	919	15–96
Bluenose	0.0096	3.17	Horn (1988)	–	–
Gemfish	0.0018	3.34	KAH9304	168	32–106
Giant stargazer	0.0155	3.03	KAH9004 KAH9105 KAH9205	522	16–78
Hapuku	0.0142	3.00	Johnston (1983)	164	50–130
Hoki	0.0046	2.88	SHI8301	525	22–110
John dory	0.0480	2.70	IKA8003	–	–
Ling	0.0010	3.36	SHI8302	398	45–135
Murphy's mackerel	0.0255	2.77	TAN9301	90	44–62
Red cod	0.0055	3.14	KAH9008 KAH9105 KAH9205	118	13–72
Red gurnard	0.0017	3.48	KAH9008 KAH9105 KAH9205	227	19–54
Rig	0.0005	3.47	Francis (unpub.)	120	65–137
School shark	0.0070	2.91	Seabrook-Davidson (unpub.)	804	30–166
Silver warehou	0.1398	3.08	TAN9401	160	22–56
Trachurus declivis	0.0165	2.93	COR9001	200	15–53
T. novaezelandiae	0.0163	2.92	COR9001	200	15–40

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

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