Design and data analysis procedures for inshore trawl surveys

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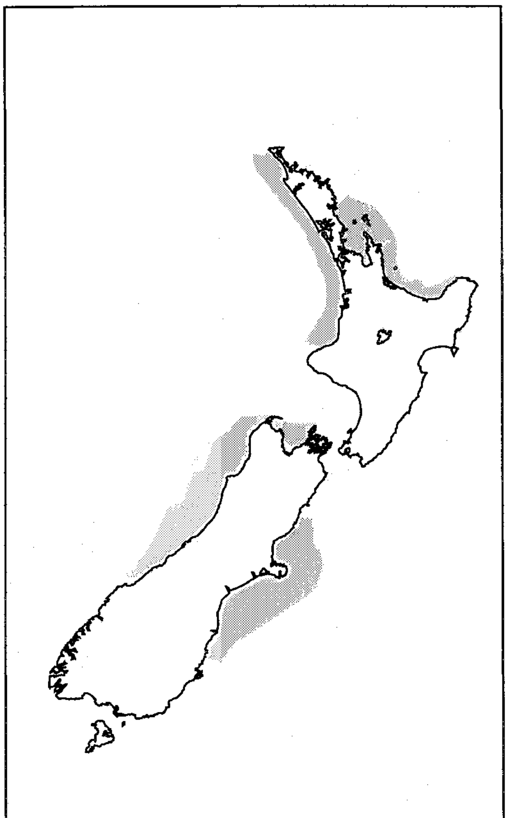

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Contents

Introduction

This report documents the general procedures and specifications used by NIWA to design and conduct inshore bottom trawl surveys and to analyse and present the results. It complements the reports on standards for trawl surveys in deep water (McMillan 1996) and middle depths (Hurst *et al.* 1992). It is principally concerned with time series surveys for stock assessment which estimate fish abundance (or biomass indices) of inshore species, including the target species elephantfish, giant stargazer, red cod, red gurnard, snapper, tarakihi, and other commercial species living at depths less than 400 m.

The 1998–99 Ministry of Fisheries research plan included five inshore bottom trawl survey time series; east coast South Island, west coast South Island, west coast North Island, Bay of Plenty, and Hauraki Gulf. Stratum numbers, stratum areas, and total survey areas are given in Table 1 and shown in Figures 1–5.

Survey design

Design details may differ between surveys and readers are referred to recent items in the *NIWA Technical Report* series for further details of survey designs and analyses, i.e., Morrison (1997, 1998), Stevenson (1998), Stevenson & Hurst (1998), and Morrison & Francis (in press).

Established designs should be retained for future surveys unless there is good justification for change, such as the need to include new target species or to subdivide strata to sample target species with better precision. Stratum areas generally include areas of foul (untrawlable) ground where fish distribution or species composition is expected to be similar to adjacent areas, but exclude areas where it could reasonably be expected to differ considerably (e.g., inshore reefs, steep slopes).

Four of the NIWA inshore trawl survey series use a stratified random two-phase design (Francis 1984) and the fifth is a single phase design, with an optional second phase if time permits (Morrison 1998).

The two-phase approach aims to improve the precision of the abundance estimates from phase 1, and is particularly useful for species which vary in distribution between years. The improved precision, however, also results in a slight negative bias associated with the biomass estimates for those species targeted in the second phase. Therefore, the proportion of phase 2 stations should not be too high and should be kept reasonably constant between years. It is recommended that not more than 20% of stations be allocated to phase 2.

The time required to carry out a survey is determined by the size of the area, number of strata, target precision of the abundance estimates, need to tow during daylight hours, and resources available. In good weather on flat ground 5–8 one hour tows or up to 10 half hour tows per 12 hours may be expected.

Optimal allocation of phase 1 stations should be determined using catch rate data from previous surveys where available (Francis 1981). If there are no previous surveys, or there are new strata not previously surveyed, commercial catch rate data from the same season can be used. Each stratum should have a minimum of three stations allocated to ensure that at least two are completed and that a mean catch rate can be estimated (*see* Table 2).

Station positions should be generated using a computer program which produces random latitude and longitude positions within each stratum, or combinations such as random longitude and depth, or latitude and depth pairs. In general, two to three times the number of stations required should be generated because some positions may not be suitable for trawling and some may be required for phase 2. The minimum distance between stations should be set at not less than the standard tow length for the survey.

Trawl gear set up and deployment

Vessel

RV *Kaharoa* is a purpose-built fisheries research vessel that has been used for all time series of inshore surveys since 1982. Specifications were given by Morrison (1997).

Trawl gear

To ensure surveys within a time series are comparable it is important that the trawl gear is the same, and is used in the same manner for each survey in a series (*see* Sissenwine & Bowman (1978) and Hurst (1988)). The trawl gear includes all aspects of the net and its configuration: type, panel numbers and size, mesh size, twine type and size, groundrope components, weight and dimensions, headrope components, flotation and dimensions, net monitor, sweeps, bridles, trawl doors, and warps.

The west coast North Island, Bay of Plenty, and Hauraki Gulf time series use the same gear set up and net but the east and west coast South Island series use different nets and trawl gear. Details of individual series gear parameters and net plans were given by Drury & McKenzie (1992), Drummond & Stevenson (1995), and Stevenson (1997).

Voyage leader's responsibilities

The voyage leader is responsible, in conjunction with the NIWA Vessel Management Company and the vessel staff, for checking that the trawl gear is set up and maintained correctly for each survey. In particular, the voyage leader should ensure that the following steps are completed.

Before the survey starts

1. Obtain a copy of the trawl gear configuration for the time series.

2. Discuss with the Vessel Company Operations Manager or the skipper any parts of the gear rigging or terminology that are unclear before the trip starts.

3. In consultation with the skipper:

   a. record the net number on the trip record;
   b. check the sweeps and bridles are the correct length, that both sides are the same length, and when they were last measured. (The ship's log should say if they were measured at the end of the previous trip.);
   c. check and record the length of the backstrops and layback;
   d. check the number of floats on the net and their placement.

Sweep and bridle lengths should be measured on shore because it is difficult to accurately measure them when the gear is being shot.

During the survey

1. When the sweeps, bridles, and trawl are hauled onboard watch for:
   a. even polish on the ground gear along the full length of the ground rope;
   b. good polish on the sweeps and bottom bridle;
   c. fouled gear that may warrant a poor performance code;
   d. any missing trawl floats.

2. Ensure that checks on the length of the sweeps, and particularly the bridles, are carried out, to ensure that they are even after the gear comes fast. Adjustments may need to be made with hammerlocks and/or chain to even up the wires. Record readings on data sheets and in ship's log.

3. Minor changes: record any changes to the trawl (e.g., extra hammerlocks added to prevent twisting, etc., extra chain added to even up the sweeps or bridles, wire cut off main trawl winches) on station data sheets.

4. Minor damage: if the damage is minor, holes will be repaired and some damaged panels may be replaced with spares. The size and type of twine used for minor repairs should be similar to the panel being repaired.

5. Major damage: sometimes gear may have to be replaced. The new number of the trawl gear is entered in the ship's log and the station record and must match the number allocated on the trip record.

6. No other changes to the trawl gear other than that previously mentioned should be made as this will alter the accepted standardised trawl set-up.

End of the survey

1. Request that the sweeps and bridles be measured at the end of the trip.

2. Obtain a copy of the appropriate pages of the ship's log for the voyage to ensure any changes can be noted in the voyage report.

Deployment procedures

An echosounder run may be required over each newly generated position to determine if a trawl can be performed. The tow should be made as close as possible to the random position. If this position is untrawlable (i.e., there is risk of serious gear loss or damage), an area within a specified radius (e.g., 2 n. miles) of the generated position may be surveyed to find suitable trawl ground. If the ground is still not suitable, the next position on the list is substituted. The direction of the tow will depend on weather, currents, terrain, and bathymetry, but is often carried out along a depth contour where possible, or in the direction of the next tow to save time. All trawling in the current series should be carried out during daylight hours.

Minimum length of warp is dependent on the length of the sweeps and bridles but is usually about 200 m. Optimum doorspread ranges should be in a range to achieve angles of attack of 16°–19° (Prado 1990). At depths below 70 m the maximum warp to depth ratio is 3:1 decreasing to about 2.4:1 at 400 m.

The tow start is defined as the time when the net is observed to first touch and settle on the bottom (from the net monitor display), and the finish from when the net leaves the bottom. The planned length of the tow varies with the survey series (Table 2), and should be kept constant between years. Actual tow length may be shortened because of the approach of bad terrain or because a large amount of fish has entered the net. Tow length should not be less than half the standard distance to be acceptable for biomass estimates. Flying the net over an obstacle (e.g., a gully) during the tow and recording only the distance when the net was on the bottom must be avoided. The target towing speed (speed over the ground, SOG) varies with the survey (*see* Table 2) but should be kept constant between years. Tow speed should be kept reasonably constant during the tow and should be monitored by checking SOG. Door spread and headline height should be recorded every 10 min for tows lasting longer than 30 min and every 5 min for shorter tows. An average reading should be entered as the "final" value for the station. The length of warp used for each tow should be recorded. If a tow was unsuitable for biomass estimation it should be recorded as gear performance > 2.

Sampling procedures

Data recording

On *Kaharoa*, all station data are recorded by the voyage leader on 030 forms (as at March 1999) and are then entered on to computer. Station data should include data on time and position, gear parameters during the tow, and relevant environmental conditions

All the catch and biological data are entered directly on to computer in the wet lab using digitisers. All weights, including catch, individual fish, and gonad weights, are also captured electronically. Data are checked by eye at the entry point. There are software range and code checks for the wet lab data and software checks are also carried out when stations are closed before the data are loaded onto the database. Checks need to be made for outliers once the data have been loaded. Final software checks and edits are made at Greta Point before the data are loaded on to the research database.

Catch weight

Catches are sorted by species and all species are weighed and recorded. Small catches totalling less than about 3 t are weighed in full on motion-compensating scales. For catches over about 3 t, the weight of the most common species may be estimated by calculating an average case weight (from a sub-sample of 15–20 full cases) and multiplying by the number of full cases not weighed.

Species identification

All organisms are identified to species where possible. Three letter species codes are obtained on-line at each wet lab work station or from a printout. Fish are identified using Paulin *et al.* (1989), prawns and shrimps using Webber *et al.* (1990), and cephalopods using Roper *et al.* (1984). Rare or unusual fish, molluscs, and crustaceans should be labelled with a station number and frozen for the Museum of New Zealand Te Papa Tongarewa, Wellington. Other material, e.g., rocks, seaweed, and rubbish (cans, rope, etc.) should also be recorded using the appropriate codes.

Selection of samples

1. Length frequencies. If the total catch of a species is not measured, the length frequency sample should be taken at intervals throughout the catch because fish may not be distributed randomly with respect to size when being sorted (larger fish tend to be sorted out first). If there are large numbers of one or two size classes (usually juveniles) and relatively few of other size classes, the catch should be subdivided and each division treated as a separate sample. Very large catches may be divided before sorting to ensure random selection of samples.

2. Biologicals. Samples should always be taken from the length frequency sample. Usually the sample is random and it is preferable to take a few fish randomly from each LF fish box rather than just the first box. If special sampling requests indicate the sample is to be non-random (e.g., size structured), then this must be recorded.

Species sampling

Random samples of up to about 100 individuals of each of the target species and other quota and commercial non-quota species are taken at each station for length frequency (length to the nearest centimetre below actual length) and sex (*see* Appendix 1).

Biological data should be collected (randomly or non-randomly) for 20 individuals from each target species and other species of interest (*see* Appendix 1). Sample size may vary if the species of interest have a clumped distribution. The minimum data should include fish length (to the nearest millimetre below actual length) and fish weight (to the nearest 5 g). In addition, gonad stage, gonad weight, and stomach contents may be recorded. Reproductive state is assessed by macroscopic gonad staging using the definitions in Appendix 1. Otoliths, spines, or vertebrae for ageing may be collected non-randomly from the random length frequency sample to ensure as wide a size range as possible is collected. Current practice is to collect up to four otoliths per sex per centimetre size class above a specified length, which varies depending on species (e.g., 35 cm for red cod and 20 cm for red gurnard).

Length-weight data should be collected on all target species for each survey. Additionally, length-weight data should be collected for non-target commercial species from at least one survey in each series.

Data analysis

Biomass estimation

Abundance estimates are based on the area-swept method described by Francis (1981, 1989). Assumptions about the effective fishing width of the net, as well as the distances estimated or measured between the doors and the wings of the net, must be clearly stated in the survey report to allow alternative assumptions about effective fishing width to be used if appropriate.

Abundance is calculated with the NIWA TrawlSurvey Analysis Program (Vignaux 1994). Biomass stations are selected from the required strata where gear performance is acceptable (1 or 2). Run parameters for the analysis usually include: recorded distance towed; recorded doorspread; catch weight as recorded in catch table; length-weight relationship calculated from data collected during the current survey or selected from a list available on the *trawl* database; fish vulnerability = 1.0; vertical availability = 1.0; and areal availability = 1.0.

Scaled length frequency distributions

Length frequency data are scaled or adjusted to represent the population in the survey area using the NIWA TrawlSurvey Analysis Program (Vignaux 1994). In addition to those listed above, options usually selected for running the program are scaled to percent sampled and distance towed. When non-survey length-weight parameters are selected, those calculated from a sample taken from the same area and time of year are preferable, but consideration of the range of lengths in the catch is also very important.

Reports

A voyage programme is required at least 1 month before the survey. A voyage report is required within 1 month after the survey ends. Copies of these should be deposited in the Central Data File (see Alan Hart, as at April 1999).

Guidelines on the results that should be presented in a report of a trawl survey were given by Hurst *et al.* (1992). As a minimum, total biomass and *c.v.* (%) should be presented for all important QMS and commercially important non-QMS species (*see* Appendix 1) which are caught in appreciable amounts (over 200 kg). Biomass estimates and *c.v.* for the target species should be presented by stratum. As a minimum, catch rate figures and scaled length frequency figures should be presented for the target species. Scaled length frequency distributions are also often presented for the more abundant commercially important species. The format of the report and species presented should follow that established in recent publications of the appropriate survey series, but should also take into account reviews of the series (Langley 1994).

A table of the length-weight coefficients used to calculate length class biomass estimates and for deriving the scaled length frequency distributions should be included in the final report.

Data management

All survey data should be stored in electronic form in the Ministry of Fisheries research *trawl* database to the standards described by Ng (1992). Where special circumstances apply to the data collected, such as commercial sensitivity or issues of confidentiality, access to parts of the database containing the sensitive information may be restricted. Decisions on data access in sensitive situations are the responsibility of the Ministry of Fisheries Data Manager. The voyage leader is responsible for ensuring that hard copies of the data are stored in the Central Data File or in the data store, NIWA, Greta Point (Allen Building).

Acknowledgments

This report was funded by the Ministry of Fisheries as part of project INT9801. Thanks to Rosie Hurst for her substantial input into the content and format of this report. Thanks also to Arthur Muir (skipper of the *Kaharoa*), Peter McMillan, Michael Beentjes, Mark Morrison, and Malcolm Francis for their contributions. Thanks also to Peter McMillan for helpful comments on an earlier draft of this report.

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Table 1 : **Stratum depth ranges, survey areas, and non-trawlable area as of 1 February 1999 for inshore trawl survey series**

East coast South Island

Stratum	Depth (m)	Area (km^2)
1	30–100	984
2	30–100	1 242
3	50–100	1 920
3A	30–50	1 111
4	50–100	1 853
4A	30–50	845
5	75–100	1 513
5A	30–75	961
6	30–100	2 373
7	30–100	2 089
8	100–200	628
9	100–200	1 163
10	100–200	1 192
11	100–200	1 483
12	100–200	764
13	100–200	997
14	200–400	752
16	200–400	751
17	200–400	724
18	10–30	1 276
19	10–30	987
20	10–30	794
21	10–30	520
Total		26 923

Bay of Plenty

Stratum	Depth (m)	Area (km^2)
1096	10–25	298
2096	10–25	134
32NH	10–25	26
4085	25–50	486
5187	25–50	233
5287	25–50	396
6085	50–100	740
7085	50–100	1 696
808C	100–150	324
808E	100–150	454
808N	100–150	526
909C	150–250	240
909E	150–250	304
909N	150–250	353
Total		6210

West coast South Island

Stratum	Depth (m)	Area (km^2)
1	20–100	1 343
2	100–200	4 302
5	25–100	1 224
6	100–200	3 233
7	25–100	927
8	100–200	2 354
9	200–400	1 877
11	25–100	1 438
12	100–200	2 054
13	200–400	1 101
14	25–100	851
15	100–200	881
16	200–400	319
17	20–33	307
18	20–42	947
19	20–70	2 436
Total		25 594

West coast North Island

Stratum	Depth (m)	Area (km^2)
A25	10–25	254
AA50	25–50	942
A100	50–100	624
A200	100–200	1 998
B25	10–25	104
BB50	25–50	323
B100	50–100	1 332
B200	100–200	970
C25	10–25	562
C50	25–50	612
C100	50–100	1 736
C200	100–200	1 045
D25	10–25	191
DD50	25–50	462
RG50	25–50	441
E25	10–25	312
E50	25–50	487
E100	50–100	3 635
E200	100–200	1 424
F25	10–25	329
F50	25–50	741
F100	50–100	2 490
F200	100–200	2 722
G25	10–25	492
Total		24 228

Table 1—continued

Hauraki Gulf

Stratum	Depth (m)	Area (km^2)
1149	10–25	65
1219	25–50	888
1268	25–45	312
1284	10–25	73
1386	10–25	68
1449	10–50	269
1518	75–150	3 212
1887	10–25	270
2229	25–45	560
4492	10–75	2 405
9292	10–25	67
		8 189

Table 2 : **Standards and specifications for NIWA inshore trawl survey series (*see* Appendix 1 for species codes)**

	ECSI	WCSI	BPLE	WCNI	HAGU
Tow speed (kn)	3.0	3.0	3–3.2	3–3.5	3–3.5
Tow distance (n. miles)	2.0	3.0	0.7 < 25 m 1.0 > 25 m	1.5	0.7
Gear parameters (reference)	Stevenson & Hurst (1998)	Stevenson (1998)	Morrison (1997)	Morrison (1998)	Morrison & Francis (in press)
Codend mesh size (mm)	28	74	40	40	40
Time of year	Dec-Jan	Mar-Apr	Feb	Nov	Oct-Nov
Survey design	2 phase	2 phase	2 phase	1 phase	2 phase
Minimum distance between stations (n. miles	2.0	3.0	2.0	2.0	1.0
Minimum phase 1 stations per stratum	3	3	3	4	3
Target species	ELE GUR pre-recruit RCO STA	GUR RCO STA TAR	GUR JDO TAR	pre-recruit SNA GUR JDO TAR	pre-recruit SNA

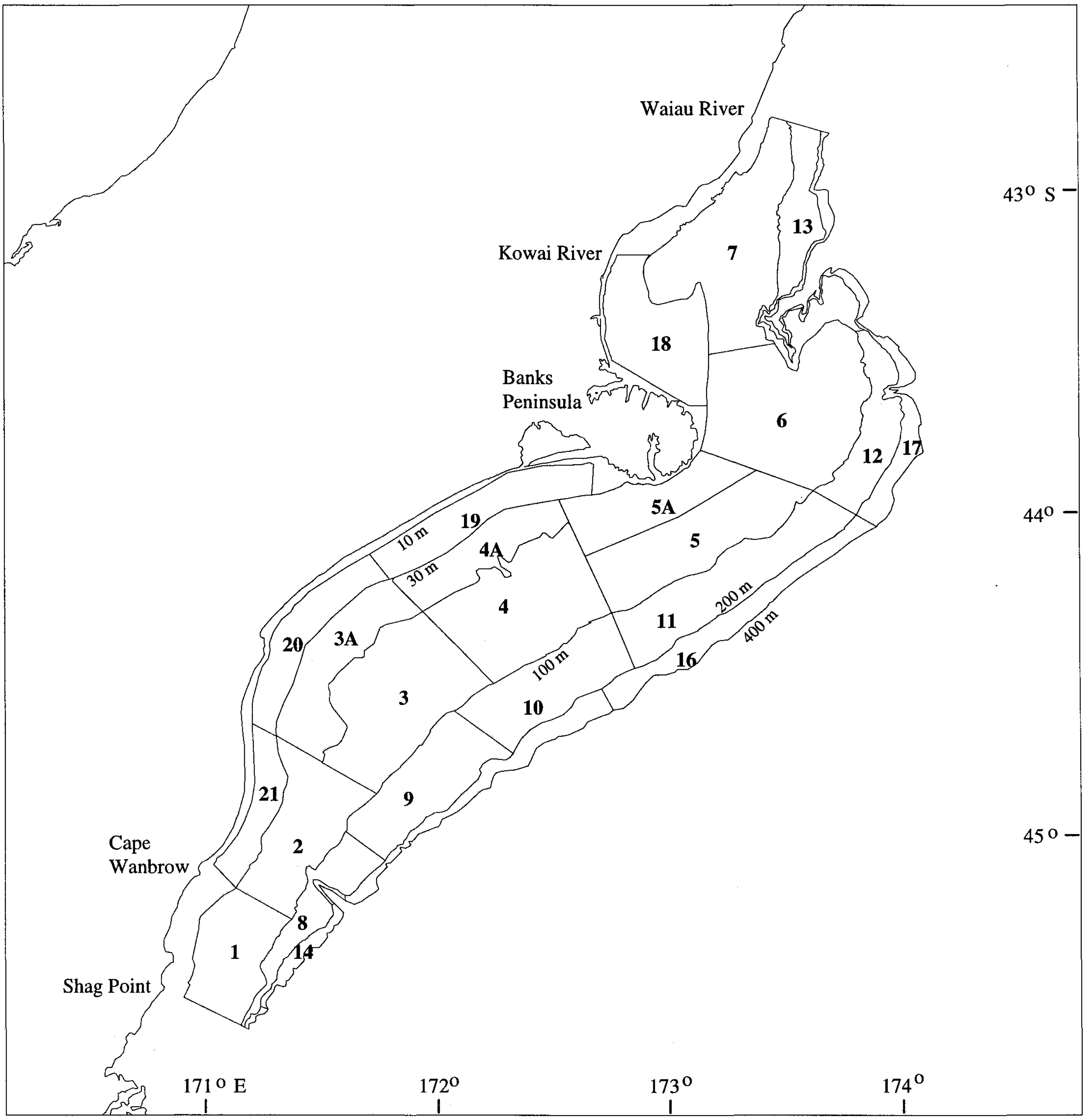

Figure 1 : **Stratum boundaries and numbers for the 1998–99 east coast South Island trawl survey (KAH9809) (foul ground not shown).**

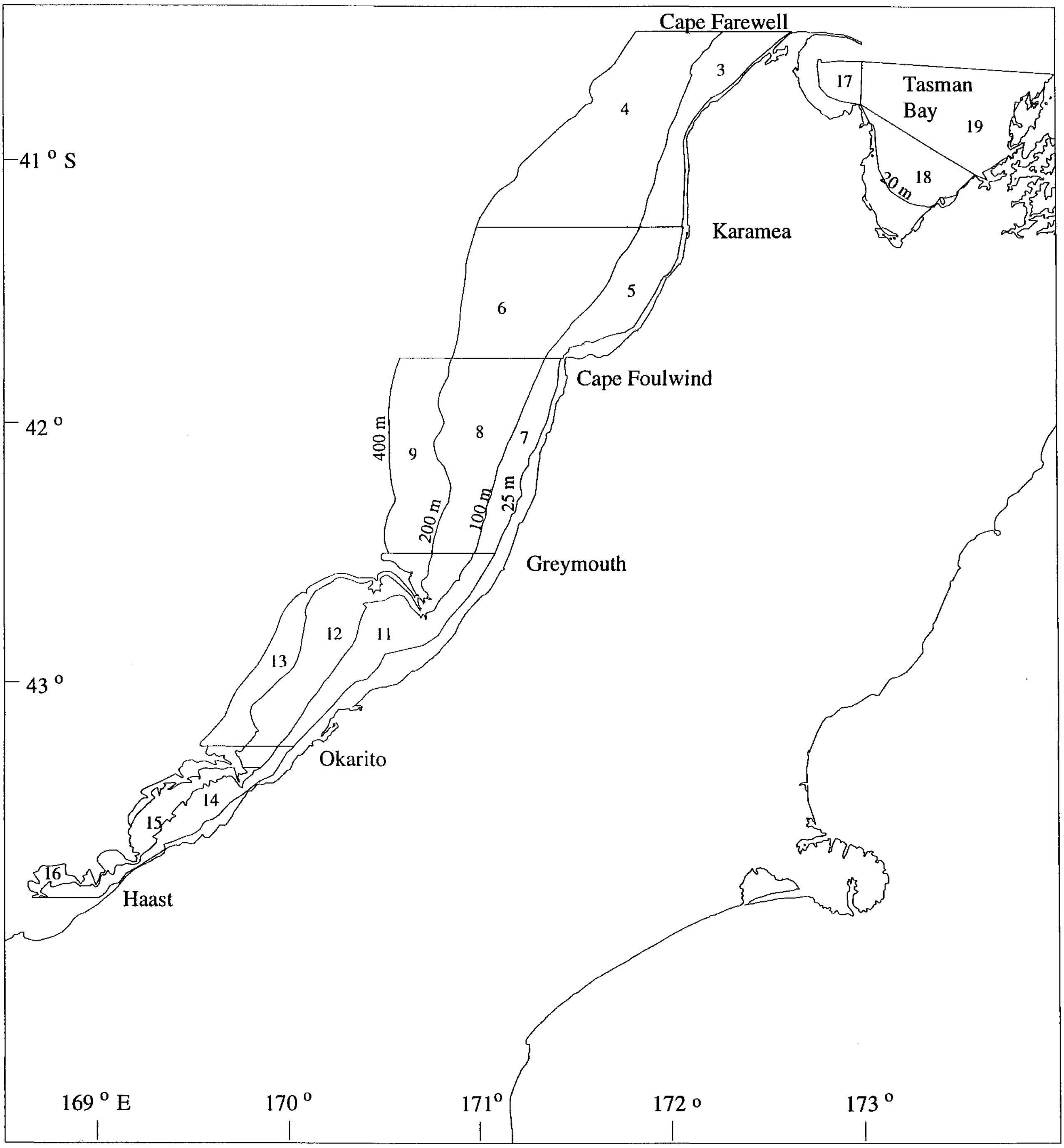

Figure 2: **Stratum boundaries and numbers for the 1997 west coast South Island trawl survey (KAH9701) (foul ground not shown).**

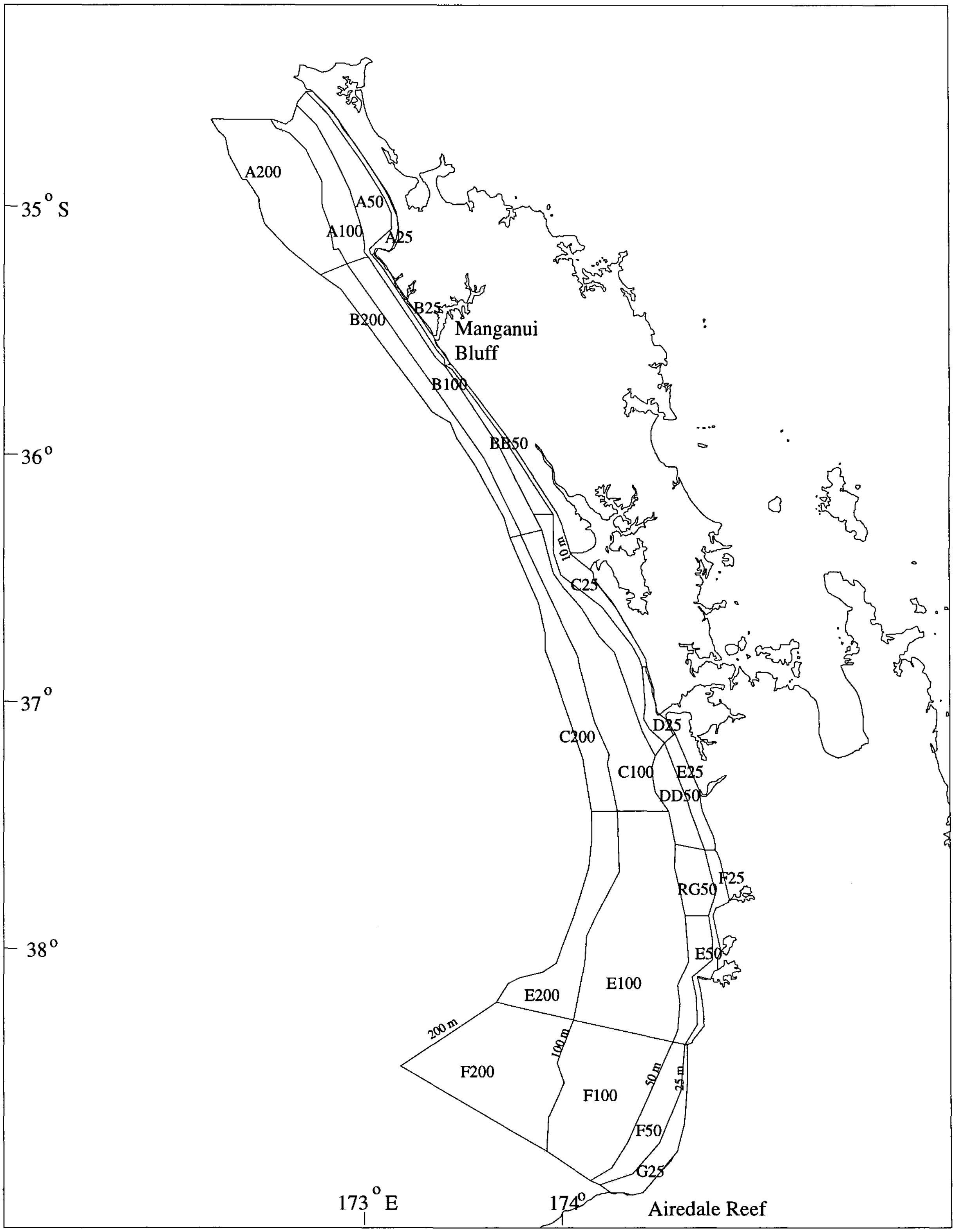

***Figure 3*: Stratum boundaries and numbers for the 1996 west coast North Island trawl survey (KAH9615) (foul ground not shown).**

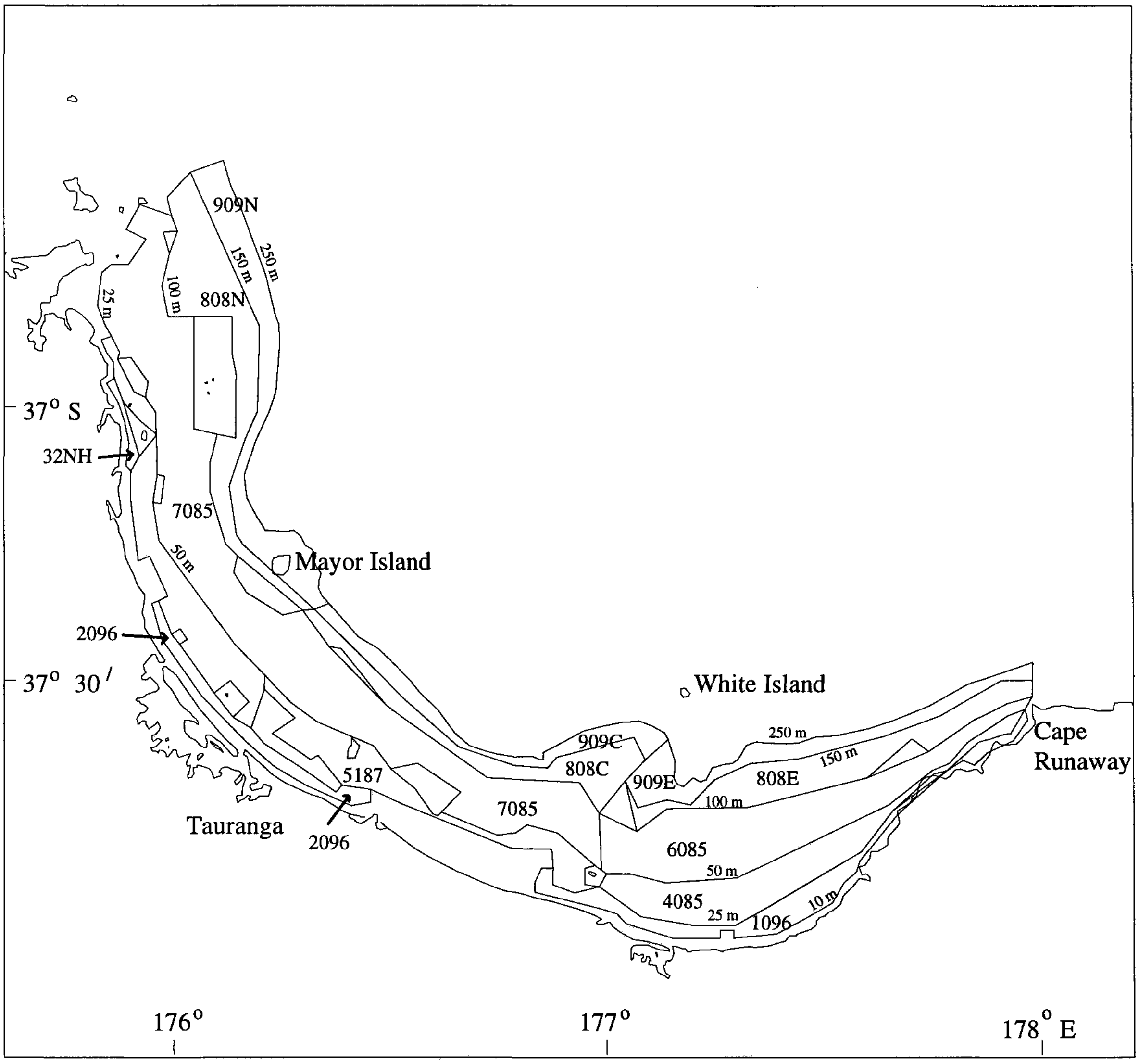

***Figure 4*: Stratum boundaries and numbers from the 1996 Bay of Plenty trawl survey (KAH9601) (foul ground not shown).**

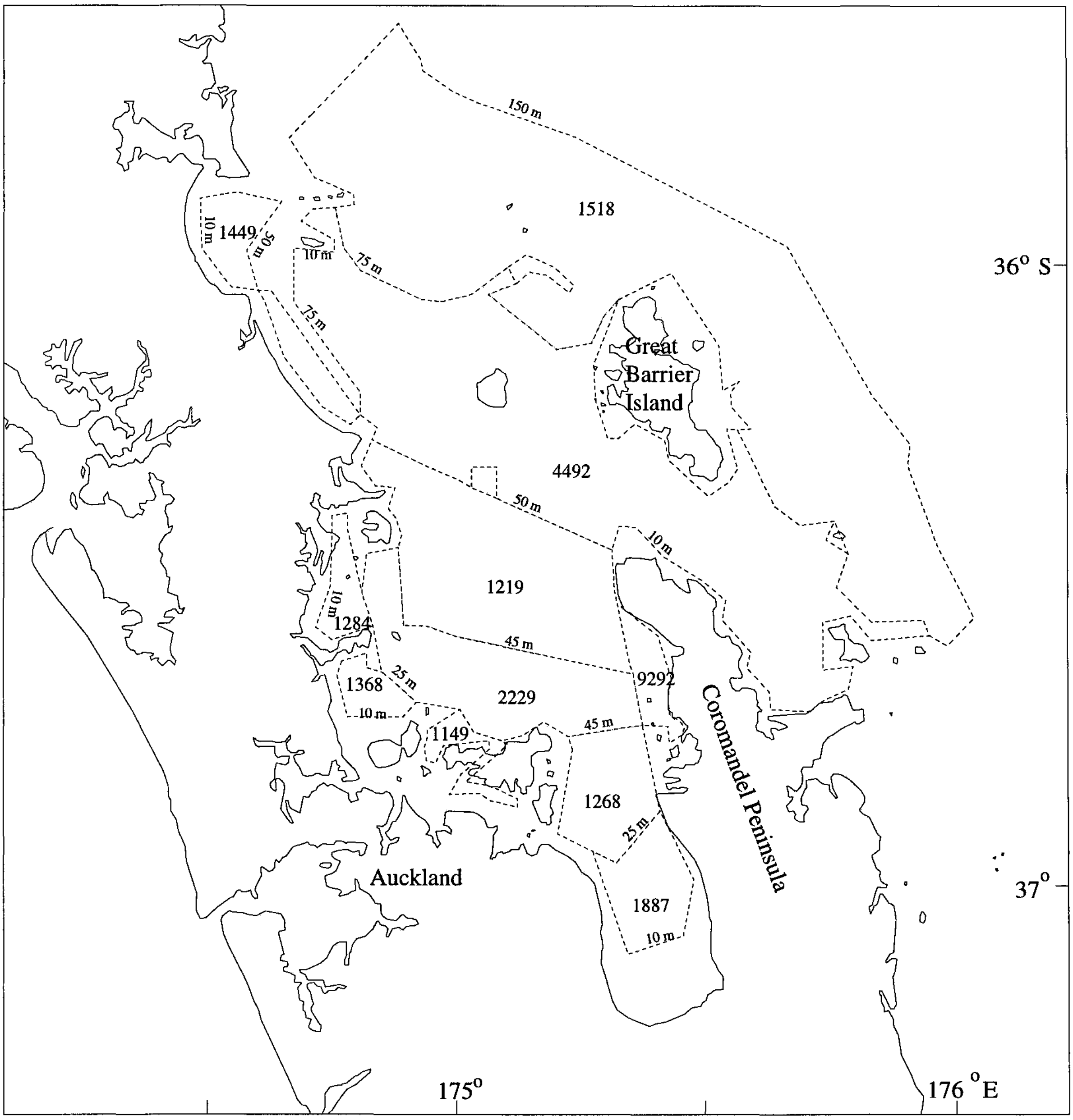

***Figure 5*: Stratum boundaries and numbers for 1994 Hauraki Gulf trawl survey (KAH9411) (foul ground not shown).**

Appendix 1: List of ITQ and commercially important non-ITQ species to be sampled. Priority values are: H= high, M= moderate, L = low)

Species	Code	North Island Length frequency	North Island Biologicals	South Island Length frequency	South Island Biologicals
Alfonsino (*Beryx decadactylus)*	BYD	H	L	H	M
Alfonsino (*B. splendens)*	BYS	H	L	H	M
Arrow squid (*N. sloanii*)	NOS	H	L	H	L
Arrow squid (*N. gouldi*)	NOG	H	L	H	L
Barracouta	BAR	H	M	H	M
Blue cod	BCO	H	M	H	M
Blue mackerel	EMA	H	L	H	L
Bluenose	BNS	H	M	H	M
Blue shark	BWS	L	L	L	L
Blue warehou	WAR	H	M	H	M
Brill	BRI	H	L	H	L
Butterfish	BUT	H	L	H	L
Conger eels	CON	L	L	L	L
Dark ghost shark	GSH	H	L	H	M
Elephantfish	ELE	H	M	H	H
Frostfish	FRO	M	L	M	L
Gemfish	SKI	H	M	H	M
Giant stargazer	STA	H	L	H	H
Greenback flounder	GBF	H	L	H	M
Hagfish	HAG	L	L	L	L
Hake	HAK	H	M	H	M
Hapuku (groper)	HAP	H	M	H	M
Hoki	HOK	H	L	H	L
Jack mackerel					
Trachurus declivis	JMD	H	L	H	L
T. murphyi	JMM	H	L	H	L
T. novaezelandiae	JMN	H	L	H	L
John dory	JDO	H	M	H	M
Kahawai	KAH	H	M	H	M
Kingfish	KIN	H	M	H	M
Leatherjacket	LEA	M	L	M	L
Lemon sole	LSO	H	L	H	M
Ling	LIN	H	L	H	M
Lookdown dory	LDO	M	L	M	L
Moki, blue	MOK	H	M	H	L
NZ sole (common)	ESO	H	M	H	M
Northern spiny dogfish	NSD	H	L	H	L
Pale ghost shark	GSP	H	L	H	L
Ray's bream	RBM	H	L	H	L
Red cod	RCO	H	M	H	H
Red gurnard	GUR	H	H	H	H
Rig	SPO	H	M	H	M
Rough skate	RSK	M	L	M	M
Rubyfish	RBY	H	M	H	L
Sand flounder	SFL	H	M	H	M
Scampi	SCI	L	L	L	L

Appendix 1—*continued*

Species	Code	North Island: Length frequency	North Island: Biologicals	South Island: Length frequency	South Island: Biologicals
Schoolshark	SCH	H	M	H	M
Sea perch	SPE	H	L	H	M
Seal shark	BSH	M	L	M	L
Silverside	SSI	L	L	L	L
Silver warehou	SWA	H	M	H	M
Smooth skate	SSK	M	L	H	M
Snapper	SNA	H	H	H	M
Southern blue whiting	SBW	H	L	H	L
Spiny dogfish	SPD	H	L	H	L
Spotted stargazer	SPZ	L	L	L	L
Tarakihi	TAR	H	M	H	H
Thresher shark	THR	M	L	M	L
Trevally	TRE	H	M	H	M
Trumpeter	TRU	H	L	H	L
Turbot	TUR	H	M	H	M
Warty squid (*M. ingens*)	MIQ	M	L	M	L
Warty squid (*M. robsoni*)	MRQ	M	L	M	L
White warehou	WWA	H	M	H	L
Witch	WIT	M	L	M	L
Yelloweyed mullet	YEM	M	L	M	L