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G. D. Carbines
M. P. Beentjes

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G. D. Carbines[1]
M. P. Beentjes[2]

[1]NIWA
P O Box 109695
Newmarket
Auckland

[2]NIWA
P O Box 6414
Dunedin

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EXECUTIVE SUMMARY

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This report describes the results of two relative abundance surveys of blue cod (*Parapercis colias*) carried out using cod pots off Kaikoura in December 2004 and off Motunau in February 2005.

A potting survey was carried out off Kaikoura between 4 and 16 December 2004. Twenty-five stations were successfully surveyed (6 pots per station = 150 pot lifts) from two inshore and two offshore strata. The total blue cod catch was 782 kg, consisting of 1296 fish. During phase 1, 120 pot lifts were completed (80%) with 30 in phase 2. The overall mean catch rate for the survey was 2.45 kg per lift (c.v. 8.7%), but ranged from only 0.60 kg per lift in the inshore stratum south of Kaikoura to 7.97 kg per lift in the offshore Kaikoura Peninsula stratum. Overall mean catch rate and c.v. for fish over 30 cm (minimum legal size) were 1.91 kg per pot per hour and 7.9%

The inshore stratum south of Kaikoura had the smallest fish, followed by the inshore stratum off the Kaikoura Peninsula. Both strata had similar numbers of males and females. Fish from the southern offshore stratum in Kaikoura were slightly larger, and the sex ratio was heavily biased toward males. This contrasted with the Kaikoura Peninsula offshore stratum where fish were about 5 cm longer on average (especially females), and the sex ratio was biased towards females.

A potting survey was carried out off Motunau between 10 and 17 February 2005. Nineteen stations were successfully surveyed (6 pots per station = 114 pot lifts) from three inshore strata. The total blue cod catch was 1308 kg, consisting of 3223 fish. The overall mean catch rate for the survey was 10.19 kg per lift, ranging from 8.74 kg per lift in the central stratum, to 15.37 kg per lift in the northern stratum. Overall mean catch rate and c.v. for fish over 30 cm were 6.0 kg per pot per hour and 9.8%. During phase 1, 90 pot lifts were completed (79%), an additional 24 stations completing phase 2. Although overall catch rates were higher, blue cod from all areas of Motunau were smaller than from Kaikoura and heavily biased towards males.

The results of this survey provide the first abundance index of blue cod around North Canterbury. The overall c.v for all blue cod of 8.7% for Kaikoura and 7.3% for Motunau is reasonable given there were no previous surveys on which to optimise allocation of stations. The mean catch rates varied between strata, but were highest in the two strata off Motunau (although fish were smaller) than in the offshore stratum in Kaikoura. With the notable exception of the inshore stratum south of Kaikoura, catch rates in North Canterbury were considerably higher than those for blue cod surveyed in the Marlborough Sounds, within Dusky Sound, or inshore Banks Peninsula. There was also relatively little bycatch in North Canterbury compared with these other survey areas.

Gonad stages indicate that the timing of spawning off North Canterbury is similar to that off Southland.

1. INTRODUCTION

Blue cod (*Parapercis colias*) is a highly desirable recreational finfish and the species most commonly landed by recreational fishers in the South Island (Bradford 1998, James & Unwin 2000), where it is usually caught by line from small vessels fishing over reef edges, and shingle/gravel, or sandy bottoms, close to rocky outcrops. Blue cod is also an important species for Maori customary fishers, but the catch is unknown. Recreational take in BCO 3 was estimated at 175 t and 245 t in 1994 and 1996. A smaller amount (150–160 t) of blue cod is landed annually by commercial fishers in BCO 3. A number of submissions concerning the Review of Sustainability Measures for 2000–01 provided anecdotal evidence of a decline in blue cod populations off North Canterbury leading to the recent lowering of the blue cod bag limit to 10 per day for the northern area of BCO 3 (from Waimakariri River to Clarence Point). Recreational fishers are also concerned about indications of increasing commercial catch around the Kaikoura area. The reef area off North Canterbury supporting blue cod is relatively discrete and recreational catch is reported to be comparatively low (Carbines 2000). The two main areas in North Canterbury where blue cod are most commonly targeted are Kaikoura (Figure 1) and Motunau (Figure 2). These areas are about 60 km apart.

In the 2000–01 Sustainability Round, the Ministry undertook to work with stakeholders in North Canterbury to monitor blue cod populations in the area. Detailed information on relative abundance and population structure for the blue cod populations off North Canterbury is lacking. This report presents the results of two standardised potting surveys of blue cod relative abundance and population structure for areas off Kaikoura and Motunau. It is envisaged that further surveys will be undertaken, and a time series of relative abundance indices will be developed as a means to monitor the status of blue cod stocks in this area and gauge the effectiveness of the current management regime (Beentjes & Carbines 2005). The results are comparable to those from other standardised potting surveys for Banks Peninsula (Beentjes & Carbines 2003, Beentjes & Carbines 2006), North Otago (Carbines & Beentjes 2006), Dusky Sound (Carbines & Beentjes 2003) and Marlborough Sounds (Blackwell 1997, 1998, 2002).

2. METHODS

2.1 Timing

A potting survey was carried out off North Canterbury between December 2004 and February 2005. December-January was chosen as the optimum time to conduct the survey because weather conditions are generally settled off the east coast of the South Island and also as blue cod probably spawn about this time of year. The Kaikoura and Motunau areas were to be surveyed consecutively, but interruptions caused by a protracted period of southerly winds and vessel availability required the survey to be conducted in two stages. Kaikoura was surveyed between 4 and 16 December 2004, and Motunau between 10 and 17 February 2005.

2.2 Survey area

Because Kaikoura and Motunau, the two main blue cod fisheries in North Canterbury, are about 60 km apart, they were surveyed separately surveys were conducted for each area. The southern and northern boundaries of the two survey areas were based on discussions with local fishers, the Dunedin Ministry of Fisheries, and the South Recreational Advisory Committee. Fishers were then given charts of the area and asked to mark discrete locations where blue cod are most commonly caught within the survey areas. From this information, the survey area off Kaikoura was subdivided into three contiguous strata from Kaikoura Peninsula to Haumuri Bluffs (two strata ranged from the coast to 100 m and one from 100 to 200 m depth) and one discrete offshore strata (Conway Rocks and Bushett Shoal) about 10 km south of Haumuri Bluffs (See Figure 1). Similarly, the survey area off Motunau was divided into three contiguous inshore strata from Double Corner to Sail Rock using the 30 m depth contour as the outer strata boundaries (Figure 2). Each stratum was assumed to contain equal and random distributions of foul and the area (km^2) within each stratum was taken as a measure of available habitat for blue cod.

2.3 Survey design

Both surveys used a two-phase stratified random station design (Francis 1984), adapted to allow for the use of pots. Before the survey, a minimum of 10 stations or sampling sites per stratum were marked on charts as described above, ensuring that they were at least 300 m apart. As no previous data are available for North Canterbury an equal sampling allocation was used initially between strata and five stations per stratum were randomly selected for phase 1.

In phase 1 about three-quarters of the stations were allocated with 25% available for phase 2. Allocation of phase 2 stations was based on the mean catch rate (kg per pot per hour) of all blue cod per stratum and optimised using the "area mean squared" method of Francis (1984). In this way, stations were assigned iteratively to the stratum in which the expected gain is greatest, where expected gain is given by:

$$expected\ gain_i = area_i^{\ 2}\ mean_i^{\ 2} / (n_i(n_i+1))$$

where for the ith stratum $mean_i$ is the mean catch rate of blue cod per pot, $area_i$ is the area of the stratum, and n_i is the number of pots. Pots were always allocated in groups of six which equates to one set.

2.4 Vessel and gear

The Kaikoura survey was conducted from *Mystique* (Registration number 63405), a Kaikoura-based commercial vessel equipped to set and lift rock lobster and blue cod pots. The vessel was chartered by NIWA and skippered by the owner. The vessel specifications are: 12.5 m length, 4.1 m breadth, 8 t, aluminium monohull, powered by a 450 hp Volvo Penta diesel engine with propeller propulsion.

The Motunau survey was conducted from *Navigator* (Registration number 64016), a Motunau-based commercial vessel equipped to set and lift rock lobster and blue cod pots. The vessel was chartered by NIWA and skippered by the owner. The vessel specifications are: 12 m length, 4 m breadth, 9 t, aluminium monohull, powered by twin 370 Yanmar diesel engines with two 74 Hamilton jet units.

Six custom designed and built cod pots were used to conduct the survey. Pot specifications are: length 1200 mm, width 900 mm, depth 500 mm, synthetic inner mesh, 30 mm diameter; 50 mm cyclone wire outer mesh, entrances 4. Pots were marked with a number from 1 to 6, and baited with paua guts. These are the same pots used for the blue cod surveys of Banks Peninsula in 2002 and 2005 (Beentjes & Carbines 2003, Beentjes & Carbines 2006), Dusky Sound in 2002 (Carbines & Beentjes 2003), and North Otago in 2005 (Carbines & Beentjes 2006).

2.5 Sampling methods

At each station, six pots were set and left to fish (soak) for 1 h during daylight hours. Soak time was standardised to be consistent with previous potting surveys in the Marlborough Sounds (Blackwell 1997, 1998, 2002), Banks Peninsula (Beentjes & Carbines 2003, Beentjes & Carbines 2006), Fiordland (Carbines & Beentjes 2003), and North Otago (Carbines & Beentjes 2006) The six pots were set in clusters, separated by about 100 m to avoid pots competing for the same fish. Once on station the position of each of the six pots was determined by the skipper using local knowledge and the vessel sounder to locate a suitable area of foul. After a station was completed (six pot lifts) the next closest station in the stratum was fished and no allowance was made for time of day or tides. The order that strata and stations were surveyed was dependent on the prevailing weather conditions, as exposed and tidal offshore strata could be surveyed only during calm weather.

As each pot was set, a record was made on customised forms of pot number, latitude and longitude from GPS, depth and bottom type from the sounder, and time of day. Pots were lifted aboard using the vessel's hydraulic pot lifter, emptied, and the contents sorted by species. Total weight per pot was recorded for each species (except octopus to the nearest 10 g using 5 kg Seaway scales. The number of individuals of each species per pot was also recorded. Total length down to the nearest centimetre, sex, and maturity were recorded for all blue cod, and otoliths were removed from a representative size range of males and females, from which weight of each fish was recorded. Sex and maturity were determined by dissection and macroscopic examination of the gonads (Carbines 1998). Gonads were recorded as one of five stages as follows: 1, immature or resting; 2, maturing (oocytes visible in females); 3, mature (hyaline oocytes in females, milt expressible in males); 4, running ripe (eggs and milt free flowing); 5, spent.

2.6 Data analysis

For each stratum and for all strata combined catch rates for all blue cod and for legal sized blue cod (30 cm and over) were estimated as the mean kilograms per pot per hour. Coefficients of variation (c.v.) for each stratum were determined from:

$$cv_i = se_i / mean_i$$

where for the *i*th stratum se_i is the standard error, and $mean_i$ is the mean catch rate (kg per pot per hour).

The overall weighted mean catch rate for all strata was determined by weighting each stratum mean by the stratum area ($area_i$) divided by the sum of all strata areas ($area_{total}$).

$$mean_{overall} = \Sigma((mean_i * area_i)/area_{total})$$

The overall weighted mean standard error of the means was determined by squaring each standard error times its weighting, summing them, and then taking the square root.

$$se_{overall} = SQRT\ (\Sigma(se_i(area_i/area_{total}))^2)$$

The overall coefficient of variation for the survey was then determined from the overall mean and standard errors providing a weighted c.v.

$$cv_{overall} = se_{overall} / mean_{overall}$$

Length frequency for blue cod for each sex is presented by individual stratum and all strata combined. Length frequency data were not scaled because the area fished by a pot is unknown. Mean length for each sex was calculated for individual stratum and overall for all strata combined.

For blue cod from the Kaikoura survey, the length-weight relationship was determined from the linear regression model ln W = b(ln L) + ln a, where W = weight (g), L = length (cm), and a and b are the regression coefficients. There were insufficient numbers of blue cod weighed from Motunau to calculate a precise length-weight relationship. Weights of individual blue cod from both surveys that were not weighed were calculated from the Kaikoura length-weight relationship (see results). Individual fish weights were used to determine catch rates of blue cod 30 cm and over (minimum legal size).

3. RESULTS

3.1 Kaikoura survey

3.1.1 Stations surveyed

Twenty-five stations (= sets) were surveyed (6 pots per station = 150 pot lifts) from four strata around Kaikoura (Table 1, Figure 1, Appendix 1) between 4 and 16 December 2004. Of the 25 stations, 20 were carried out in phase 1 (5 per stratum) and 5 allocated to stratum 3 in phase 2. Depth ranged from 8 to 123 m.

3.1.2 Catch

A total of 908 kg of catch was taken on the survey, of which 782 kg (86%) was blue cod, consisting of 1296 fish (Table 2). Bycatch included nine fish and one octopus species. The five most common bycatch species by weight were sea perch (*Helicolenus percoides*), octopus (*Octopus cordiformis*), girdled wrasse (*Notolabrus cinctus*), scarlet wrasse (*Pseudolabrus miles*), and banded wrasse (*Notolabus fucicola*).

Mean catch rates of blue cod (all sizes) ranged from 0.61 kg per pot per hour for inshore stratum 2 (Southwest of Kaikoura, coast to 100 m) to 7.97 kg per pot per hour for offshore stratum 4 (offshore of Kaikoura Peninsula, 100 to 200 m). Overall mean catch rate and c.v. were 2.45 kg per pot per hour and 8.7% (Table 3). For blue cod 30 cm and over (minimum legal size), highest and lowest catch rates were also in strata 4 and 2, respectively. Overall mean catch rate and c.v. for fish over 30 cm were 1.91 kg per pot per hour and 7.9% (Table 4). The overall mean catch rates are weighted by the strata areas and are considerably smaller than the average of the four strata catch rates because of the strong weighting effect of stratum 2, the largest stratum with the lowest catch rate.

3.1.3 Biological and length frequency data

Of the 1296 blue cod caught on the survey, all were sexed and measured for length, and otoliths were taken from 891 fish and stored. The sex ratio ranged from 0.3:1 (males: females) (stratum 4) to 3.6:1 (stratum 1), and was 1:1 overall (Table 5). Length frequency distributions for all four strata were unimodal but size varied among the strata (Figure 3). Largest blue cod were from stratum 4 and smallest from stratum 2. Mean lengths of males were larger than females in all strata and overall mean male length was 33.6 cm and female length 31.4 cm. The proportion of blue cod caught on the survey of legal minimum size (30 cm and over) was 68%.

Of 1296 blue cod examined, most were in the maturing phase, but both sexes had gonad stages indicative of spawning with 2% of females and 6% of males in the running ripe stage (stage 4) (Table 6). There were few fish with spent gonad stages (stage 5).

Before calculating the length-weight relationship for blue cod, the data were examined for outliers, which were excluded from the analysis leaving 297 females (range 19–50 cm) and 253 males (range 21–53 cm). Using the derived model $W = aL^b$, the length-weight parameters are as follows:
males – a = 0.00985, b = 3.1394, and $R^2 = 0.97$; females – a = 0.00891, b = 3.161, and $R^2 = 0.95$.

3.2 Motunau survey

3.2.1 Stations surveyed

Nineteen stations (= sets) were surveyed (6 pots per station = 114 pot lifts) from three inshore strata around Motunau (Table 7, Figure 2, Appendix 2) between 10 and 17 February 2005. Of the 19 stations, 15 were carried out in phase 1 (5 per stratum) and 2 allocated to stratum 1, and 2 to stratum 3 in phase 2. Depth ranged from 3 to 33 m.

3.2.2 Catch

A total of 1337 kg of catch was taken on the survey, of which 1308 kg (98%) was blue cod, consisting of 3223 fish (Table 8). Bycatch included seven fish species. The three most common bycatch species by weight were girdled wrasse (*Notolabrus cinctus*), scarlet wrasse (*Pseudolabrus miles*), and banded wrasse (*Notolabus fucicola*).

Mean catch rates of blue cod (all sizes) ranged from 8.7 kg per pot per hour for stratum 2 (off and north of Motunau), to 15.4 kg per pot per hour for stratum 1 (north of Motunau off Sail Rock). Overall mean catch rate and c.v. were 10.2 kg per pot per hour and 7.3% (Table 9). For blue cod 30 cm and over (minimum legal size), highest and lowest catch rates were also in strata 1 and 2, respectively. Overall mean catch rate and c.v. for fish over 30 cm were 6.0 kg per pot per hour and 9.8% (Table 10).

3.2.3 Biological and length frequency data

Of the 3223 blue cod caught on the survey, all were sexed and measured for length, and otoliths were taken from 102 fish and stored. The sex ratio ranged from 2.4:1 (males: females) (strata 1 and 2) to 4.7:1 (stratum 3), and was 2.8:1 overall (Table 11). Length frequency distributions for all three strata were unimodal, but size varied slightly among the strata (Figure 4). Largest blue cod were from stratum 3 and smallest from stratum 2. Mean lengths of males were larger than females in all strata; overall mean male length was 29.4 cm and mean female length 25.8 cm. The proportion of blue cod caught on the survey of legal minimum size (30 cm and over) was 36%.

Of 3223 blue cod examined, 98% of both males and females had maturing stage gonads (Table 12).

4. DISCUSSION

The results of this survey provide the first abundance index of blue cod around North Canterbury. The overall c.v for all blue cod of 8.7% for Kaikoura and 7.3% for Motunau is reasonable given there were no previous surveys on which to optimise allocation of stations. The mean catch rates varied between strata, but were higher in all strata off Motunau (although fish were smaller), followed by offshore stratum 4 in Kaikoura. With the notable exception of stratum 2 inshore south of Kaikoura, catch rates in North Canterbury were considerably higher than those for blue cod surveyed in the Marlborough Sounds (Blackwell 1997, 1998, 2002), within Dusky Sound (Carbines & Beentjes 2003), or inshore Banks Peninsula (Beentjes & Carbines 2003, 2005, 2006). There was also relatively little bycatch in North Canterbury compared with other survey areas.

The division of the surveys into two parts separated by a month was unavoidable. We assume that blue cod catch rates were not affected by the timing of the survey because blue cod in BCO 5 are caught commercially all year round (Warren et al. 1997), and tagging studies in other areas have shown that blue cod populations are temporally stable (Mace & Johnston 1983, Carbines & McKenzie 2001, 2004, Carbines 2004a).

Blue cod catches do not appear to be affected by time of day, but can be influenced by the state of the tide in areas where tidal flow is high, such as in Foveaux Strait (Warren et al. 1997). In our sampling design it was not practical to allow for the effect that tide might have on catch rates, and we cannot rule out the possibility that some catch rates may have been affected, although compared to Foveaux Strait, tidal flow around North Canterbury is low. However, high tidal flows off the Kaikoura Peninsula (stratum 4) following southerly fronts arrested fishing in this area for several days.

Blue cod from the inshore stratum south of Kaikoura had the smallest fish followed by the inshore stratum off the Kaikoura Peninsula; both had similar numbers of males and females. Fish from the southern offshore stratum in Kaikoura were slightly larger, but the sex ratio was heavily biased toward males. This contrasts with fish from the Kaikoura Peninsula offshore stratum, which were about 5 cm longer on average with larger fish (especially females) and more females than males (See Table 5 and Figure 3). Although overall catch rates were higher, blue cod from all areas of Motunau were smaller than at Kaikoura (and other areas) and heavily biased towards males (See Table 11and Figure 4). It is possible that the difference between relative abundance, size structure, and possibly sex ratios of these populations is a result of fishing pressure on the more accessible inshore stocks. Similar conclusions were reached for blue cod in the Marlborough Sounds, where catch rates appear to be inversely proportional to recreational fishing effort (Blackwell 1998, 2002). However, the quality of benthic habitat and the protection afforded by strong currents in offshore areas may also be contributing factors.

Southland blue cod spawn mainly between September and November, but continue through to January (Carbines 1998). Of 1296 blue cod examined in Kaikoura, most were in the maturing phase, but both sexes had gonad stages indicative of spawning with 2% of females and 6% of males in the running ripe stage. There were few fish with spent gonad stages indicating that the timing of the survey (December) was just before the peak spawning period. Of 3223 blue cod examined in Motunau, 98% of both males and females had maturing stage gonads, indicating that these blue cod were not spawning at the time of the survey (February). These results suggest that the timing of spawning off North Canterbury is similar to that off Southland.

Changes in abundance should be reflected in the age structure of the surveyed catch. Otoliths were therefore collected in order to monitor age structure (Carbines 2004a, 2004b), but also to estimate growth and mortality for stock assessment purposes. Ageing and stock assessment will be handled in a separate project (BCO200504).

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Table 1: Kaikoura stratum coastline area, number of phase 1 and 2 stations, pot lifts, and depth.

	Area of strata	Number of sets		Number of	Depth (m)	
Stratum	(km^2)	Phase 1	Phase 2	pot lifts	Mean	Range
1	2.9	5		30	28	23–35
2	96.0	5		30	40	8–99
3	24.8	5	5	60	65	25–95
4	15.7	5		30	110	66–123
Total	139.43	20	5	150	62	8–123

Table 2: Catch weights and/or numbers of blue cod and bycatch species caught on the Kaikoura survey and percentage of total weight. *Estimated weight using average weight of 6.5 kg for octopus (the mean of 2 weighed octopus from north Otago survey (Carbines and Beentjes 2006)).

Common name	Scientific name	Catch (kg)	Number	Percent of total catch
Blue cod	*Parapercis colias*	782.0	1296	86.1
Sea perch	*Helicolenus percoides*	44.6	75	4.9
Octopus	*Octopus cordiformis**	39.0	6	4.3
Girdled wrasse	*Notolabrus cinctus*	22.6	82	2.5
Scarlet wrasse	*Pseudolabrus miles*	10.4	30	1.1
Banded wrasse	*Notolabrus fucicola*	4.0	8	0.4
Red cod	*Pseudophycis bachus*	2.2	2	0.2
Spotty	*Notolabrus celidotus*	1.9	5	0.2
Swollen head conger	*Bassanago bulbiceps*	0.7	1	0.1
Dwarf scorpion fish	*Scorpaena papillosus*	0.6	3	0.1
Tarakihi	*Nemadactylus macropterus*	0.3	1	0.0
Total		908.3		

Table 3: Kaikoura mean blue cod catch rate, standard error, and c.v. per stratum and overall for all blue cod.

Stratum	Pot lifts (N)	Mean (kg/lift)	s.e.	c.v. (%)
1	30	6.11	0.94	15.45
2	30	0.60	0.22	36.78
3	60	5.70	0.60	10.50
4	30	7.97	0.90	11.31
Overall	150	2.45	0.21	8.66

Table 4: Kaikoura mean blue cod catch rate, standard error, and c.v. per stratum and overall for blue cod 30 cm and over.

Stratum	Pot lifts (N)	Mean (kg/lift)	s.e.	c.v. (%)
1	30	5.10	0.81	15.85
2	30	0.25	0.10	40.73
3	60	4.36	0.50	11.43
4	30	7.54	0.87	11.57
Overall	150	1.91	0.151	7.90

Table 5: Kaikoura mean lengths of blue cod by strata and sex.

Strata	Sex	N	Mean length (cm)
1	m	230	33.8
	f	64	28.5
2	m	25	29.4
	f	25	25.7
3	m	342	32.8
	f	298	29.7
4	m	68	38.4
	f	244	34.9
Overall	m	665	33.6
	f	631	31.4

Table 6: Kaikoura gonad stages of blue cod. 1, immature or resting; 2, maturing (oocytes visible in females); 3, mature (hyaline oocytes in females, milt expressible in males); 4, running ripe (eggs and milt free flowing); 5, spent.

	Gonad stage (%)					
	1	2	3	4	5	N
Males	3.2	71.1	19.5	6.0	0.2	665
Females	4.6	64.3	28.7	2.2	0.2	631

Table 7: Motunau stratum coastline length, number of phase 1 and 2 stations, pot lifts, and depth.

	Area of strata	Number of sets		Number of	Depth (m)	
Stratum	(km^2)	Phase 1	Phase 2	pot lifts	Mean	Range
1	41.3	5	2	42	28	19–33
2	66.9	5		30	20	3–25
3	176.1	5	2	42	19	12–28
Total	284.3	15	4	114	23	3–33

Table 8: Catch weights and/or numbers of blue cod and bycatch species caught on the Motunau survey and percentage of total weight. *Estimated weight using average weight of 6.5 kg for octopus (the mean of 2 weighed octopus from north Otago survey (Carbines and Beentjes 2006)).

Common name	Scientific name	Catch (kg)	Number	Percent of total catch
Blue cod	*Parapercis colias*	1307.8	3223	97.8
Girdled wrasse	*Notolabrus cinctus*	9.7	26	0.7
Scarlet wrasse	*Pseudolabrus miles*	10.8	28	0.8
Banded wrasse	*Notolabrus fucicola*	4.6	11	0.3
Spotty	*Notolabrus celidotus*	1.7	14	0.1
Leatherjacket	*Parika scaber*	1.2	–	0.1
Dwarf scorpion fish	*Scorpaena papillosus*	0.7	2	0.1
Tarakihi	*Nemadactylus macropterus*	0.7	4	0.1
Total		1337.3		

Table 9: Motunau mean blue cod catch rate, standard error, and c.v. per strata and overall for all blue cod.

Stratum	Pot lifts (N)	Mean (kg/lift)	s.e.	c.v. (%)
1	42	15.37	1.97	12.84
2	30	8.74	1.14	13.09
3	42	9.53	1.01	10.64
Overall	114	10.19	0.74	7.27

Table 10: Motunau Mean blue cod catch rate, standard error, and c.v. per strata and overall for blue cod 30 cm and over.

Stratum	Pot lifts (N)	Mean (kg/lift)	s.e.	c.v. (%)
1	42	7.49	1.32	17.68
2	30	3.22	0.61	18.89
3	42	6.66	0.86	12.90
Overall	114	5.97	0.58	9.80

Table 11: Motunau mean lengths of blue cod by strata and sex.

Strata	Sex	N	Mean length (cm)
1	m	1144	29.1
	f	475	25.9
2	m	552	27.8
	f	225	25.0
3	m	681	31.0
	f	146	26.8
Overall	m	2377	29.4
	f	846	25.8

Table 12: Gonad stages of Motunau blue cod. 1, immature or resting; 2, maturing (oocytes visible in females); 3, mature (hyaline oocytes in females, milt expressible in males); 4, running ripe (eggs and milt free flowing); 5, spent.

	Gonad stage (%)					
	1	2	3	4	5	N
Males	0.1	98.2	1.4	0.2	0.0	2376
Females	1.7	98.1	0.2	0.0	0.0	846

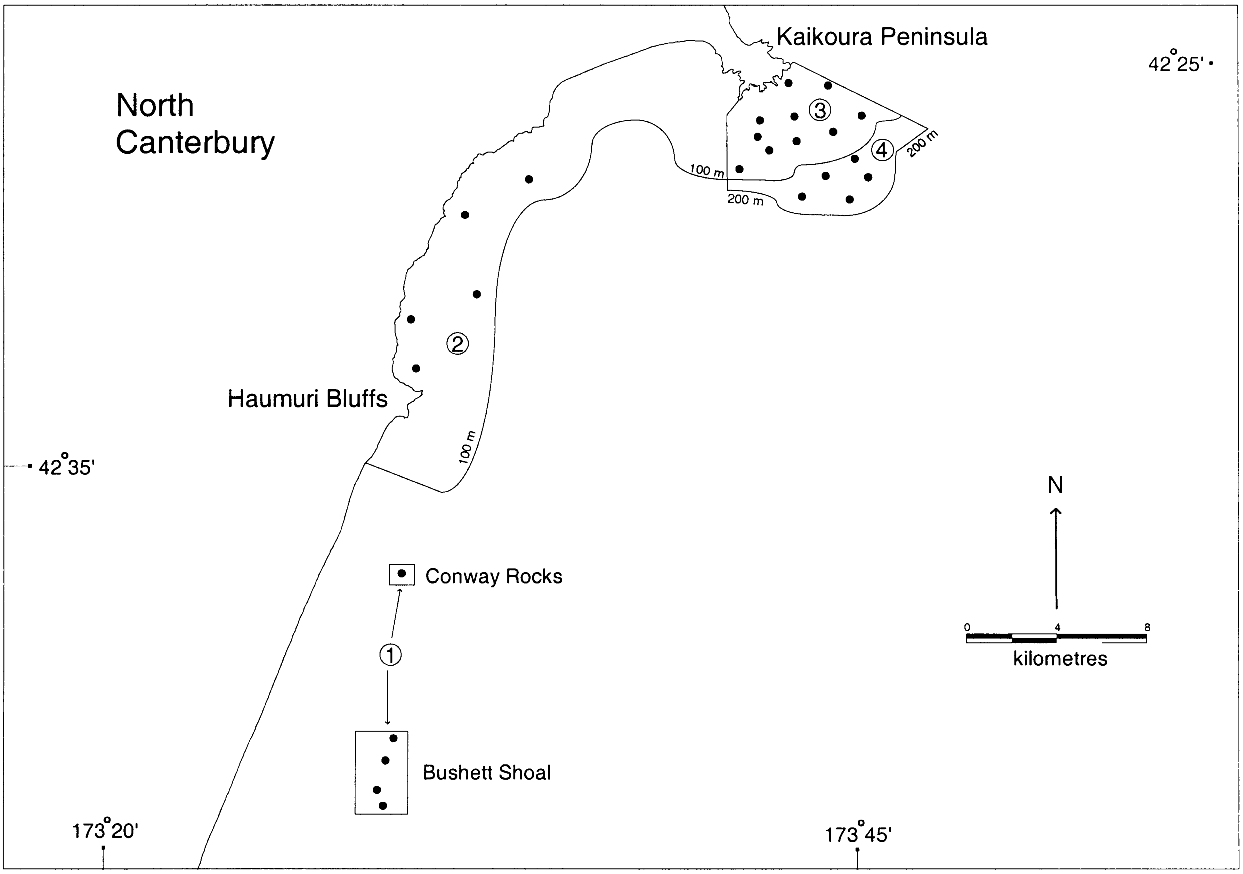

Figure 1: Map of north Canterbury coast and Kaikoura Peninsula showing strata (1–4) and stations surveyed.

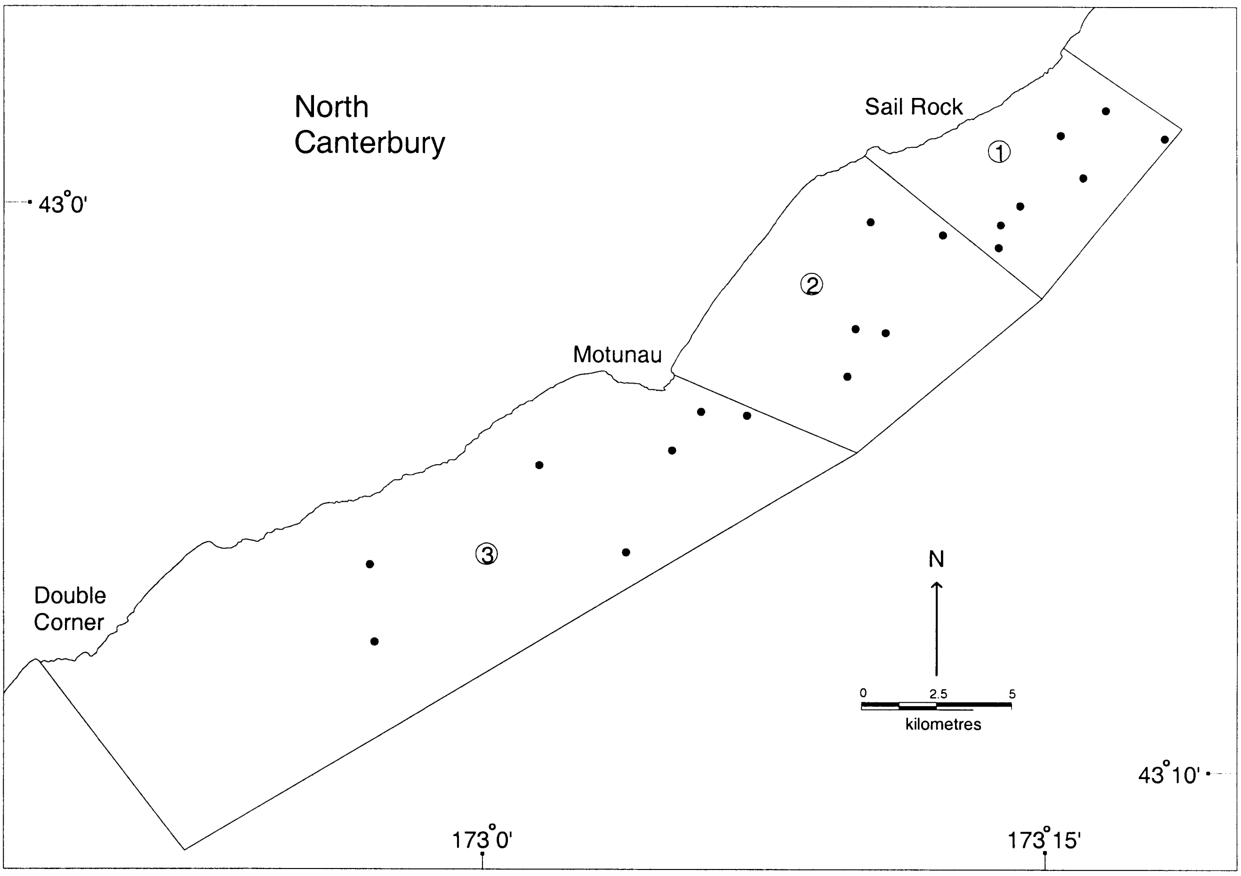

Figure 2: Map of north Canterbury coast around Motunau showing strata (1–3) and stations surveyed.

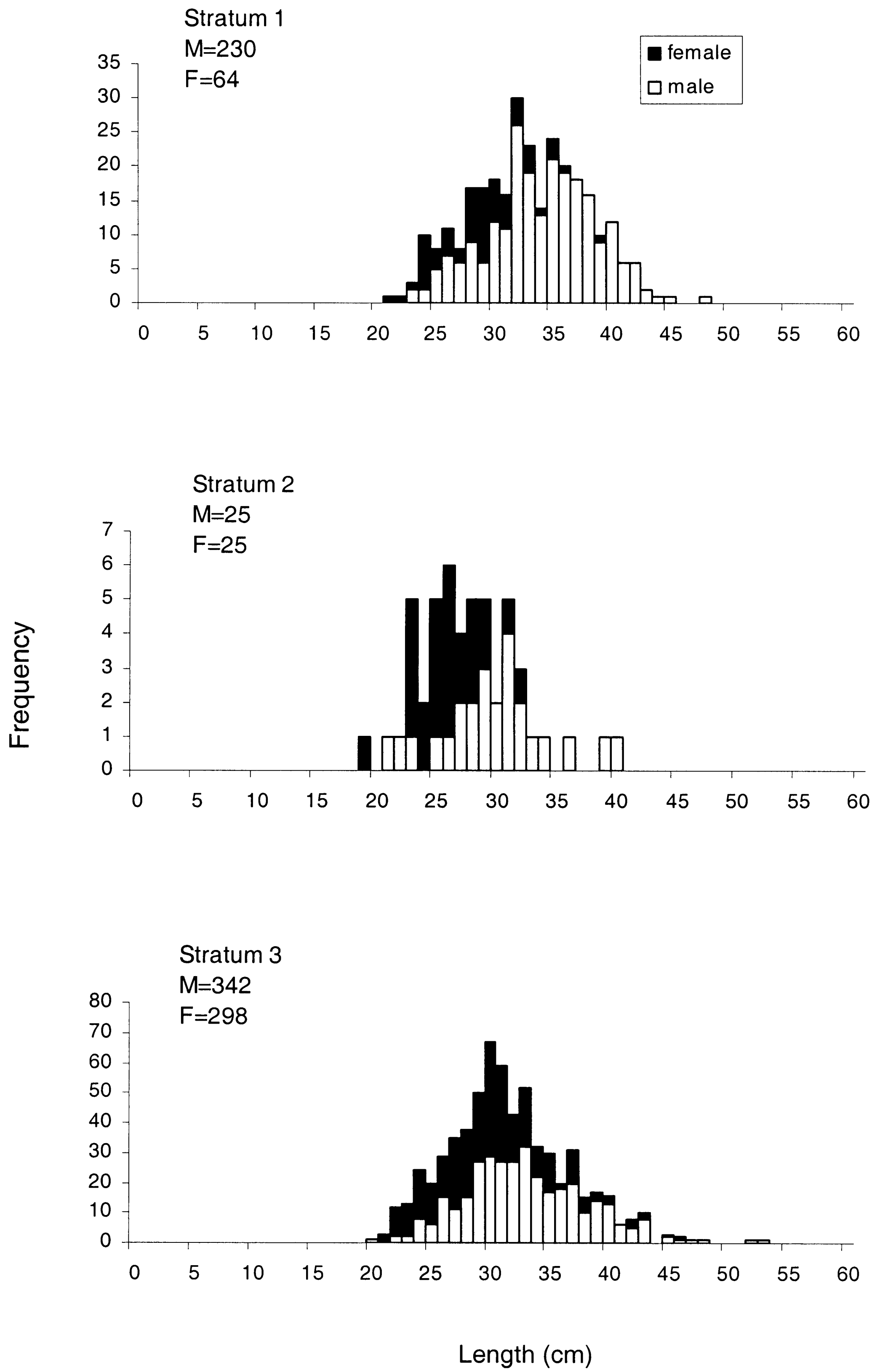

Figure 3: Length frequency distributions of blue cod for each stratum (1–4) and all strata combined for the Kaikoura survey.

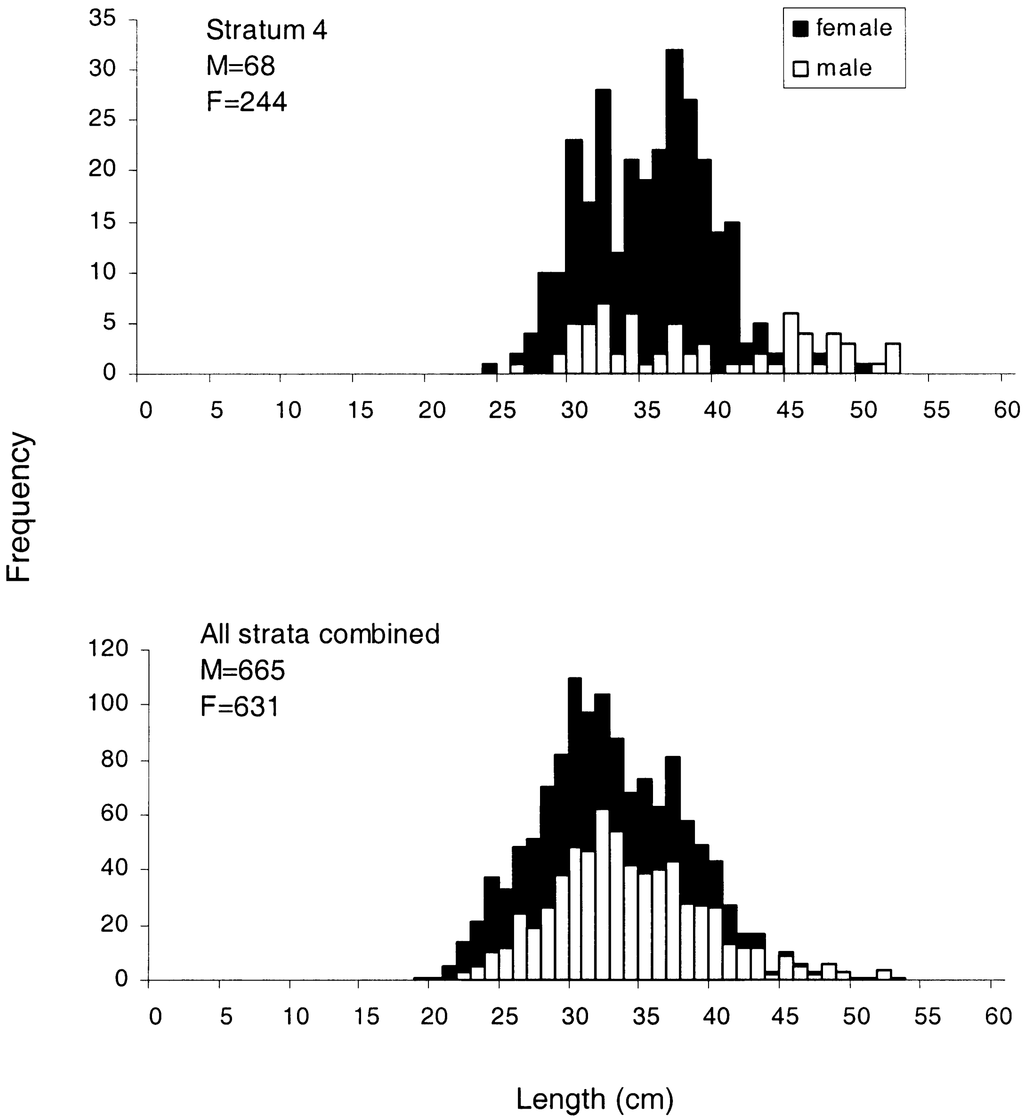

Figure 3 – ***continued***

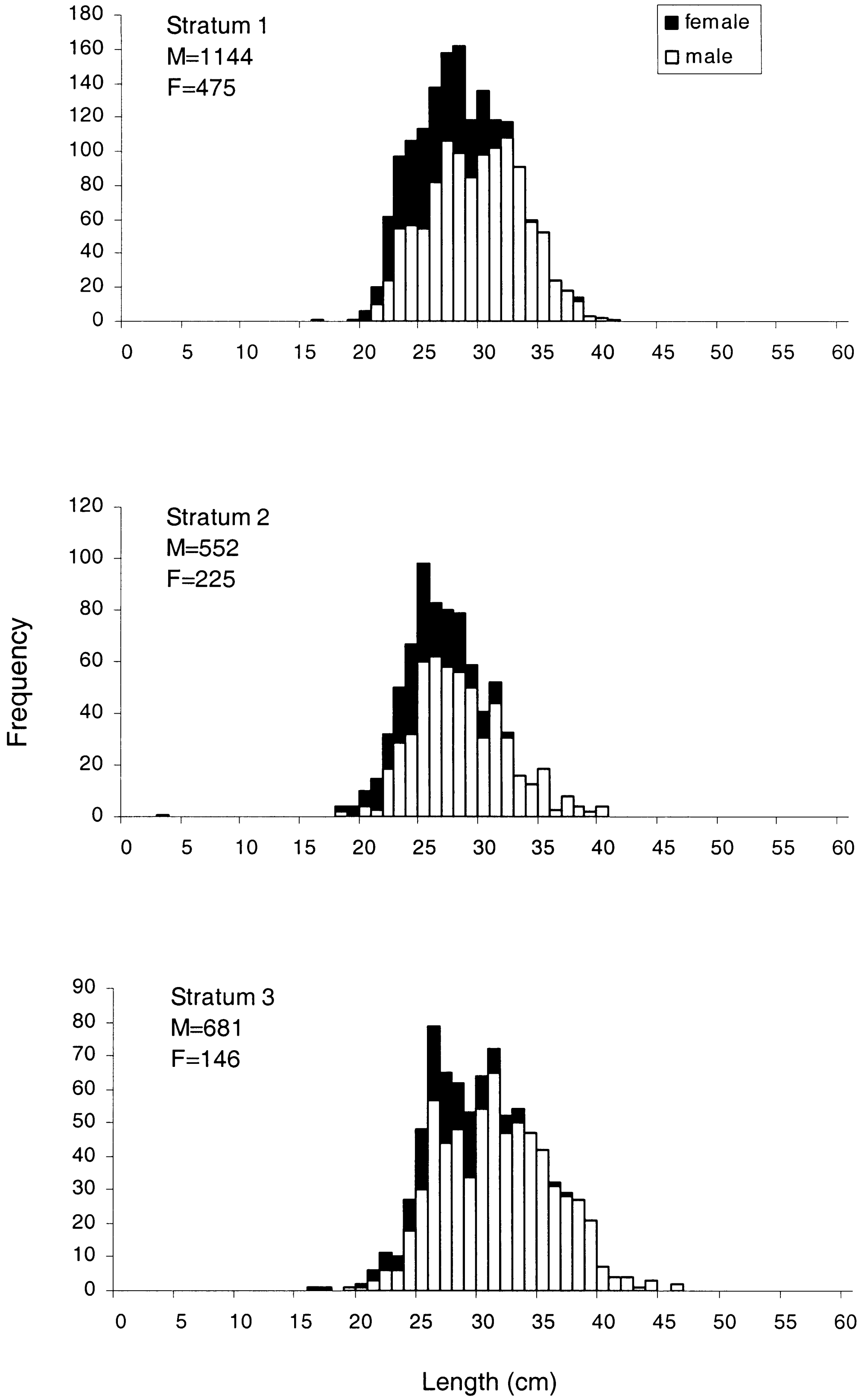

Figure 4: Length frequency distributions of blue cod for each stratum (1–3) and all strata combined for the Motunau survey.

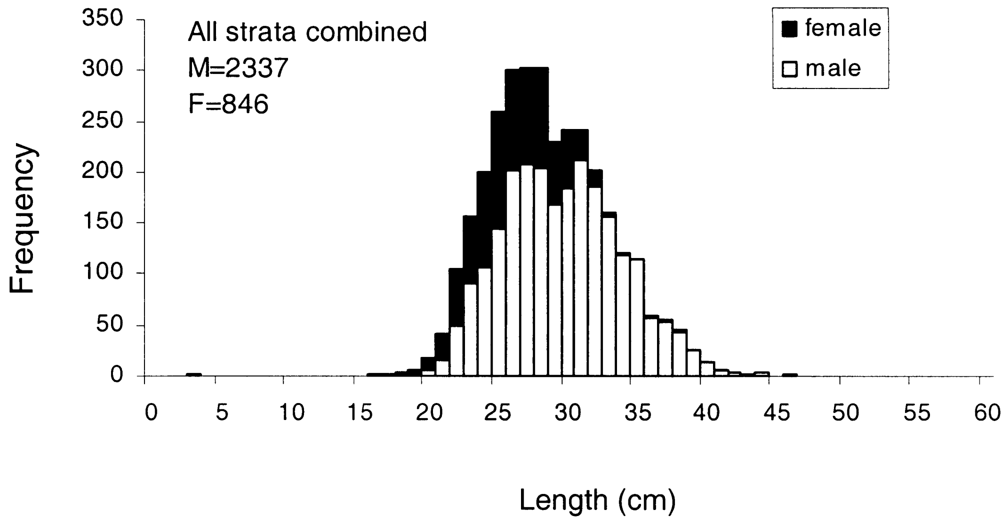

Figure 4 – ***continued***

Appendix 1: Summary of survey pot lift station data, Kaikoura 2004.

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
1	4-Dec-04	1	2	2B	13.4	0607	3	0.3	1
1	4-Dec-04	1	2	2B	9.5	0613	2	0.3	1
1	4-Dec-04	1	2	2B	18.3	0553	6	0.0	0
1	4-Dec-04	1	2	2B	15.5	0602	1	0.5	1
1	4-Dec-04	1	2	2B	8.8	0618	4	0.0	0
1	4-Dec-04	1	2	2B	14.4	0625	5	0.0	0
2	4-Dec-04	1	2	2C	10.6	0735	5	0.6	2
2	4-Dec-04	1	2	2C	8.2	0738	4	0.3	1
2	4-Dec-04	1	2	2C	8.4	0739	2	1.5	2
2	4-Dec-04	1	2	2C	11.4	0747	1	0.0	0
2	4-Dec-04	1	2	2C	20.1	0748	6	2.2	7
2	4-Dec-04	1	2	2C	14.2	0742	3	0.8	2
3	4-Dec-04	1	2	2F	73.3	0906	6	0.0	0
3	4-Dec-04	1	2	2F	71.3	0911	1	0.0	
3	4-Dec-04	1	2	2F	34.2	0914	3	0.6	3
3	4-Dec-04	1	2	2F	20.1	0918	2	2.3	9
3	4-Dec-04	1	2	2F	22.3	0925	4	0.0	0
3	4-Dec-04	1	2	2F	30.1	0928	5	5.9	15
4	4-Dec-04	1	2	2E	?	1046	5	1.1	4
4	4-Dec-04	1	2	2E	?	1052	4	0.0	0
4	4-Dec-04	1	2	2E	53	1058	2	0.0	0
4	4-Dec-04	1	2	2E	86.9	1105	3	0.0	0
4	4-Dec-04	1	2	2E	99	1108	1	0.0	0
4	4-Dec-04	1	2	2E	91.5	1114	6	0.0	0
5	4-Dec-04	1	2	2I	69.5	1235	6	0.0	0
5	4-Dec-04	1	2	2I	54.1	1240	1	1.7	2
5	4-Dec-04	1	2	2I	67.7	1245	3	0.0	0
5	4-Dec-04	1	2	2I	73.2	1247	2	0.0	0
5	4-Dec-04	1	2	2I	54.9	1250	4	0.0	0
5	4-Dec-04	1	2	2I	58.5	1354	5	0.0	0
6	8-Dec-04	1	4	4G	114.7	0625	5	3.4	6
6	8-Dec-04	1	4	4G	70.9	0631	4	0.0	0
6	8-Dec-04	1	4	4G	70	0637	2	1.5	2
6	8-Dec-04	1	4	4G	66.2	0642	3	4.3	5
6	8-Dec-04	1	4	4G	116	0647	1	0.5	1
6	8-Dec-04	1	4	4G	112.5	0653	6	5.8	4
7	8-Dec-04	1	4	4H	122.7	0929	6	14.6	18
7	8-Dec-04	1	4	4H	121.6	0932	1	10.6	11
7	8-Dec-04	1	4	4H	121.6	0935	3	2.6	4
7	8-Dec-04	1	4	4H	117.6	0937	2	9.4	14
7	8-Dec-04	1	4	4H	116.9	0940	4	8.4	14
7	8-Dec-04	1	4	4H	119.8	0942	5	10.2	11
8	8-Dec-04	1	4	4I	119.8	1106	5	9.2	12
8	8-Dec-04	1	4	4I	117.1	1111	4	9.3	11
8	8-Dec-04	1	4	4I	120.7	1117	2	18.3	21
8	8-Dec-04	1	4	4I	115.8	1124	3	6.1	8
8	8-Dec-04	1	4	4I	117.3	1130	1	8.5	10

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
8	8-Dec-04	1	4	4I	117.2	1136	6	4.5	7
9	8-Dec-04	1	4	4D	112.3	1312	6	10.1	14
9	8-Dec-04	1	4	4D	110.5	1322	1	9.6	13
9	8-Dec-04	1	4	4D	108.8	1322	3	9.4	10
9	8-Dec-04	1	4	4D	102.6	1342	2	8.3	13
9	8-Dec-04	1	4	4D	106.3	1353	4	17.8	26
9	8-Dec-04	1	4	4D	110.3	1402	5	11.9	20
10	10-Dec-04	1	4	4C	116.7	0521	5	0.0	0
10	10-Dec-04	1	4	4C	114.9	0536	4	4.5	6
10	10-Dec-04	1	4	4C	109.2	0550	2	7.1	9
10	10-Dec-04	1	4	4C	105.9	0558	3	6.7	9
10	10-Dec-04	1	4	4C	102.4	0608	1	8.9	12
10	10-Dec-04	1	4	4C	109.9	0616	6	17.6	21
11	10-Dec-04	1	3	3F	80.5	0735	6	18.2	30
11	10-Dec-04	1	3	3F	76.8	0745	1	12.4	29
11	10-Dec-04	1	3	3F	71.3	0752	3	6.0	10
11	10-Dec-04	1	3	3F	73.3	0758	2	11.5	27
11	10-Dec-04	1	3	3F	74.1	0805	4	18.8	29
11	10-Dec-04	1	3	3F	78.5	0815	5	8.4	26
12	12-Dec-04	1	1	1K	28.5	0614	1	1.5	5
12	12-Dec-04	1	1	1K	28.5	0619	2	0.0	0
12	12-Dec-04	1	1	1K	29.5	0623	3	0.0	0
12	12-Dec-04	1	1	1K	30	0627	4	0.0	0
12	12-Dec-04	1	1	1K	27.5	0637	6	2.0	5
12	12-Dec-04	1	1	1K	22.6	0632	5	0.7	2
13	12-Dec-04	1	1	IH	23	0800	6	4.6	6
13	12-Dec-04	1	1	IH	23.6	0803	5	1.7	2
13	12-Dec-04	1	1	IH	29	0805	1	11.4	15
13	12-Dec-04	1	1	IH	28.2	0810	2	9.9	16
13	12-Dec-04	1	1	IH	23.3	0805	4	3.7	6
13	12-Dec-04	1	1	IH	24.4	0807	3	11.7	18
14	12-Dec-04	1	1	1A	30	0927	1	0.3	1
14	12-Dec-04	1	1	1A	29	0930	2	2.2	3
14	12-Dec-04	1	1	1A	29	0932	3	4.7	6
14	12-Dec-04	1	1	1A	30	0935	4	5.3	9
14	12-Dec-04	1	1	1A	30	0937	5	12.9	21
14	12-Dec-04	1	1	1A	30	0940	6	19.0	37
15	12-Dec-04	1	1	1D	27	1108	2	5.8	10
15	12-Dec-04	1	1	1D	28	1110	1	4.3	7
15	12-Dec-04	1	1	1D	35	1105	4	4.7	8
15	12-Dec-04	1	1	1D	27	1107	3	6.1	10
15	12-Dec-04	1	1	1D	32	1100	6	2.6	4
15	12-Dec-04	1	1	1D	34	1103	5	16.1	25
16	12-Dec-04	1	1	1F	32	1237	5	11.2	19
16	12-Dec-04	1	1	1F	24	1240	6	9.6	15
16	12-Dec-04	1	1	1F	26	1228	1	2.0	3
16	12-Dec-04	1	1	1F	27	1230	2	8.0	11
16	12-Dec-04	1	1	1F	26.5	1233	3	8.4	11

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
16	12-Dec-04	1	1	1F	29	1235	4	13.2	19
17	15-Dec-04	1	3	3I	87.8	0538	3	4.4	6
17	15-Dec-04	1	3	3I	78.6	0548	6	2.3	3
17	15-Dec-04	1	3	3I	76.8	0558	4	4.1	5
17	15-Dec-04	1	3	3I	78.6	0607	1	4.7	6
17	15-Dec-04	1	3	3I	84.1	0620	5	3.9	7
17	15-Dec-04	1	3	3I	90.5	0628	2	3.7	2
18	15-Dec-04	1	3	3J	86	0737	2	3.1	4
18	15-Dec-04	1	3	3J	88.7	0742	5	3.7	5
18	15-Dec-04	1	3	3J	80.5	0748	1	3.6	5
18	15-Dec-04	1	3	3J	76.8	0756	4	0.4	1
18	15-Dec-04	1	3	3J	81.4	0800	6	3.4	5
18	15-Dec-04	1	3	3J	87.8	0803	3	9.3	13
19	15-Dec-04	1	3	3E	58.5	0918	3	5.8	12
19	15-Dec-04	1	3	3E	49.1	0923	6	2.1	8
19	15-Dec-04	1	3	3E	45.7	0926	4	8.4	31
19	15-Dec-04	1	3	3E	41.1	0930	1	0.4	3
19	15-Dec-04	1	3	3E	36.6	0934	5	0.5	1
19	15-Dec-04	1	3	3E	25.6	0942	2	0.2	1
20	15-Dec-04	1	3	3D	25.6	1058	2	4.8	15
20	15-Dec-04	1	3	3D	36.6	1102	5	1.6	7
20	15-Dec-04	1	3	3D	64	1115	6	12.1	20
20	15-Dec-04	1	3	3D	65.8	1119	3	15.4	19
20	15-Dec-04	1	3	3D	45.7	1107	1	6.3	14
20	15-Dec-04	1	3	3D	57.6	1110	4	7.9	18
21	15-Dec-04	2	3	3C	65.5	1300	3	16.8	24
21	15-Dec-04	2	3	3C	53.2	1308	6	4.8	9
21	15-Dec-04	2	3	3C	40.4	1315	4	0.0	0
21	15-Dec-04	2	3	3C	41.1	1320	1	0.4	2
21	15-Dec-04	2	3	3C	29.2	1326	5	0.2	1
21	15-Dec-04	2	3	3C	25	1330	2	7.3	19
22	15-Dec-04	2	3	3B	26.5	1442	2	3.0	10
22	15-Dec-04	2	3	3B	40.6	1446	5	2.3	4
22	15-Dec-04	2	3	3B	47.9	1451	1	4.2	6
22	15-Dec-04	2	3	3B	56.9	1456	4	8.2	16
22	15-Dec-04	2	3	3B	62.2	1500	6	10.0	15
22	15-Dec-04	2	3	3B	66.7	1506	3	10.6	16
23	15-Dec-04	2	3	3A	65.8	1616	3	7.7	14
23	15-Dec-04	2	3	3A	64	1621	6	14.4	25
23	15-Dec-04	2	3	3A	53.9	1626	4	6.4	13
23	15-Dec-04	2	3	3A	51.9	1632	1	2.8	8
23	15-Dec-04	2	3	3A	47.2	1635	5	1.3	5
23	15-Dec-04	2	3	3A	33.3	1640	2	1.1	3
24	16-Dec-04	2	3	3G	76.6	0534	2	4.3	7
24	16-Dec-04	2	3	3G	80.5	0540	5	6.1	8
24	16-Dec-04	2	3	3G	89.1	0545	1	6.2	8
24	16-Dec-04	2	3	3G	91.5	0550	4	1.0	2
24	16-Dec-04	2	3	3G	89.4	0555	6	3.8	5

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
24	16-Dec-04	2	3	3G	82.3	0600	3	2.1	4
25	16-Dec-04	2	3	3H	84.1	0712	3	4.4	8
25	16-Dec-04	2	3	3H	88.5	0718	6	10.9	21
25	16-Dec-04	2	3	3H	95.5	0721	4	3.3	5
25	16-Dec-04	2	3	3H	91.5	0727	1	5.4	8
25	16-Dec-04	2	3	3H	85.6	0731	5	2.1	4
25	16-Dec-04	2	3	3H	83.4	0738	2	4.1	8

Appendix 2: Summary of survey pot lift station data, Motunau 2005.

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
1	10-Feb-05	1	1	1C	31.5	0753	A	28.42	70
1	10-Feb-05	1	1	1C	32.0	0755	B	28.69	68
1	10-Feb-05	1	1	1C	32.0	0758	C	36.88	96
1	10-Feb-05	1	1	1C	30.2	0802	D	20.56	50
1	10-Feb-05	1	1	1C	32.0	0804	E	20.31	55
1	10-Feb-05	1	1	1C	30.0	0807	F	14.42	45
2	10-Feb-05	1	1	1E	25.0	0918	F	57.56	96
2	10-Feb-05	1	1	1E	25.5	0920	E	16.84	52
2	10-Feb-05	1	1	1E	21.0	0921	D	15.67	41
2	10-Feb-05	1	1	1E	21.5	0922	C	9.46	34
2	10-Feb-05	1	1	1E	28.0	0930	B	2.13	6
2	10-Feb-05	1	1	1E	28.0	0935	A	8.06	19
3	10-Feb-05	1	1	1G	19.0	1210	A	5.58	26
3	10-Feb-05	1	1	1G	22.2	1212	B	16.59	25
3	10-Feb-05	1	1	1G	21.0	1214	C	40.22	83
3	10-Feb-05	1	1	1G	25.0	1218	D	4.88	19
3	10-Feb-05	1	1	1G	26.0	1222	E	8.17	33
3	10-Feb-05	1	1	1G	24.6	1226	F	6.29	26
4	10-Feb-05	1	1	1H	25.0	1336	F	8.06	22
4	10-Feb-05	1	1	1H	22.0	1339	E	19.08	33
4	10-Feb-05	1	1	1H	22.7	1340	D	17.98	39
4	10-Feb-05	1	1	1H	23.0	1344	C	16.94	44
4	10-Feb-05	1	1	1H	25.4	1344	B	5.64	23
4	10-Feb-05	1	1	1H	25.0	1348	A	3.65	12
5	11-Feb-05	1	1	1K	26.0	0740	A	13.9	31
5	11-Feb-05	1	1	1K	27.0	0743	B	6.32	12
5	11-Feb-05	1	1	1K	30.0	0745	C	12.23	30
5	11-Feb-05	1	1	1K	31.5	0748	D	0.67	5
5	11-Feb-05	1	1	1K	30.0	0750	E	1.28	9
5	11-Feb-05	1	1	1K	32.0	0751	F	5.7	27
6	11-Feb-05	1	2	2A	25.0	0901	D	5.75	17
6	11-Feb-05	1	2	2A	25.0	0902	E	12.07	37
6	11-Feb-05	1	2	2A	22.1	0903	F	11.34	40

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
6	11-Feb-05	1	2	2A	23.0	0904	A	7.04	18
6	11-Feb-05	1	2	2A	24.0	0905	B	10.17	26
6	11-Feb-05	1	2	2A	24.0	0906	C	5.23	18
7	11-Feb-05	1	2	2D	15.0	1027	F	0	0
7	11-Feb-05	1	2	2D	8.0	1028	E	4.86	12
7	11-Feb-05	1	2	2D	15.0	1029	D	0	0
7	11-Feb-05	1	2	2D	15.0	1030	C	3.16	9
7	11-Feb-05	1	2	2D	14.0	1031	B	0	0
7	11-Feb-05	1	2	2D	14.0	1034	A	0	0
8	11-Feb-05	1	2	2G	21.6	1228	A	16.64	43
8	11-Feb-05	1	2	2G	21.0	1232	B	8.66	32
8	11-Feb-05	1	2	2G	21.9	1230	C	18.52	46
8	11-Feb-05	1	2	2G	23.0	1232	D	6.87	20
8	11-Feb-05	1	2	2G	22.0	1235	E	9.21	33
8	11-Feb-05	1	2	2G	24.0	1240	F	10.83	30
9	11-Feb-05	1	2	2J	18.0	1340	F	20.5	67
9	11-Feb-05	1	2	2J	21.7	1342	E	4.28	23
9	11-Feb-05	1	2	2J	22.0	1343	D	11.29	42
9	11-Feb-05	1	2	2J	21.0	1344	C	21.2	55
9	11-Feb-05	1	2	2J	19.0	1345	B	11.88	35
9	11-Feb-05	1	2	2J	21.8	1347	A	5.3	25
10	14-Feb-05	1	2	2L	23.0	0733	A	5.17	19
10	14-Feb-05	1	2	2L	24.0	0736	B	15.21	28
10	14-Feb-05	1	2	2L	24.0	0738	C	11.02	29
10	14-Feb-05	1	2	2L	23.4	0740	D	3.61	16
10	14-Feb-05	1	2	2L	19.4	0743	E	19.43	43
10	14-Feb-05	1	2	2L	2.9	0746	F	2.87	14
11	14/2/2005	1	3	3A	19.0	0855	F	14.45	19
11	14-Feb-05	1	3	3A	19.0	0858	E	1.2	6
11	14-Feb-05	1	3	3A	16.0	0859	D	7.45	18
11	14-Feb-05	1	3	3A	14.0	0901	C	5.8	13
11	14-Feb-05	1	3	3A	15.0	0902	B	8.52	25
11	14-Feb-05	1	3	3A	15.0	0902	A	7.88	18
12	14-Feb-05	1	3	3F	18.0	1022	A	14.51	42
12	14-Feb-05	1	3	3F	20.0	1024	B	10.17	25
12	14-Feb-05	1	3	3F	17.0	1026	C	5.41	18
12	14-Feb-05	1	3	3F	16.0	1028	D	9.29	22
12	14-Feb-05	1	3	3F	17.0	1030	E	16	37
12	14-Feb-05	1	3	3F	21.0	1033	F	24.74	56
13	15-Feb-05	1	3	3K	20.4	0810	F	2.13	6
13	15-Feb-05	1	3	3K	23.6	0812	E	5.54	20
13	15-Feb-05	1	3	3K	24.0	0813	D	6.79	13
13	15-Feb-05	1	3	3K	25.1	0815	C	2.65	12
13	15-Feb-05	1	3	3K	24.5	0817	B	7.7	13
13	15-Feb-05	1	3	3K	26.5	0820	A	2.91	5
14	15-Feb-05	1	3	3P	14.0	0930	A	3.44	7
14	15-Feb-05	1	3	3P	15.0	0931	B	5.8	7
14	15-Feb-05	1	3	3P	16.0	0932	C	13.77	28

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod (kg)	Number of fish
14	15-Feb-05	1	3	3P	15.0	0933	D	4.8	13
14	15-Feb-05	1	3	3P	12.0	0935	E	3.49	9
14	15-Feb-05	1	3	3P	17.0	0936	F	9.54	19
15	15-Feb-05	1	3	28	28.0	1055	F	10.69	26
15	15-Feb-05	1	3	28	27.0	1057	E	1.46	3
15	15-Feb-05	1	3	28	26.0	1058	C	17.84	39
15	15-Feb-05	1	3	28	22.0	1100	D	14.74	25
15	15-Feb-05	1	3	28	27.5	1103	B	17.68	37
15	15-Feb-05	1	3	28	28.0	1105	A	30.6	47
16	16-Feb-05	2	3	30	19.0	0916	A	10.79	13
16	16-Feb-05	2	3	30	18.0	0918	B	6.73	12
16	16-Feb-05	2	3	30	18.0	0920	C	18.82	35
16	16-Feb-05	2	3	30	20.0	0927	D	8.02	12
16	16-Feb-05	2	3	30	21.4	0923	E	20.67	26
16	16-Feb-05	2	3	30	20.0	0925	F	11.15	23
17	16-Feb-05	2	3	36	15.0	1042	F	6.91	13
17	16-Feb-05	2	3	36	19.0	1045	E	7.42	13
17	16-Feb-05	2	3	36	17.0	1046	D	7.12	14
17	16-Feb-05	2	3	36	14.0	1048	C	11.65	29
17	16-Feb-05	2	3	36	20.0	1050	B	0	0
17	16-Feb-05	2	3	36	19.0	1051	A	4.02	9
18	17-Feb-05	2	1	A	33.0	0913	A	11.71	39
18	17-Feb-05	2	1	A	32.0	0916	B	50.32	93
18	17-Feb-05	2	1	A	30.0	0918	C	29.91	76
18	17-Feb-05	2	1	A	32.5	0920	D	11.81	34
18	17-Feb-05	2	1	A	31.0	0923	E	15.11	44
18	17-Feb-05	2	1	A	33.0	0925	F	21.03	68
19	17-Feb-05	2	1	M	30.0	1031	F	15.44	35
19	17-Feb-05	2	1	M	26.0	1032	E	12.24	27
19	17-Feb-05	2	1	M	28.0	1033	D	14.87	37
19	17-Feb-05	2	1	M	32.0	1034	C	6.33	19
19	17-Feb-05	2	1	M	33.0	1035	B	1.61	5
19	17-Feb-05	2	1	M	30.0	1037	A	2.82	11