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EXECUTIVE SUMMARY

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This report describes the results of the 2008 blue cod (*Parapercis colias*) potting survey off Banks Peninsula, the third in the time series following surveys in 2002 and 2005. The stated overall objective of the survey was to estimate blue cod relative abundance, age structure, and sex ratio, but data were also collected on size composition, spawning condition, and length-weight. Otoliths were collected and aged for age composition and mortality estimates.

Forty stations were successfully surveyed (6 pots per station = 240 pot lifts) from five inshore strata (contiguous with the coastline) and two offshore strata (Pompeys Rocks and Le Bons Rocks) around Banks Peninsula between 8 April and 5 May 2008. Of the total 689 kg of catch, 579 kg (84%) was blue cod, consisting of 726 fish. Bycatch included 14 fish and 1 octopus species.

Mean catch rates of blue cod (all sizes) ranged from 0.07 kg per pot per hour in stratum 2 (Akaroa Harbour entrance) to 5.80 kg per pot per hour for offshore stratum 6 located over Le Bons Rock. Overall mean catch rate and c.v. were 2.59 kg per pot per hour and 7.7%. For blue cod 30 cm and over (minimum legal size), highest catch rates were also in stratum 6 (5.74 kg per pot per hour) and lowest catch rates in stratum 2 (0.04 kg per pot per hour). Overall mean catch rate and c.v. for blue cod 30 cm and over were 2.30 kg per pot per hour and 8.3%.

The sex ratio for inshore strata (1–5) was 2.4:1 (male:female), for offshore strata (6 and 7) 0.98:1, and overall 1.5:1.

Blue cod from inshore strata ranged in length from 16 to 46 cm with a single modal peak apparent at about 29 cm when data for all inshore strata are combined. Blue cod in the two offshore strata were considerably larger, ranging in length from 10 to 56 cm. Mean lengths of males averaged about 3 cm more than females from all strata combined, and the largest fish, both inshore and offshore, were male. Mean length of males in the offshore strata was nearly 13 cm more than the inshore and for females the difference was 10 cm.

Overall for all strata the proportion of blue cod of minimum legal size (30 cm and over) was 61%.

Otoliths were prepared and read for 173 males and 142 females.

The blue cod examined were not spawning at the time of the survey.

The parameters of the length weight relationship for blue cod from this survey using the derived model $W = aL^b$ were:

males: a = 0.01221, b = 3.0824, and R^2 = 0.99 (N = 179, range 18–56 cm);
females: a = 0.00563, b = 3.3050, and R^2 = 0.99 (N=137, range 10–49 cm).

Overall for all strata combined age ranged from 2 to 30 years with a strong mode from about 3 to 8 years, peaking at 4 years. There is little difference between the male and female age distributions except that mean ages were male 5.7 y and female 6.9 y. For inshore strata, age ranged from 2 to 12 years with a strong mode centred at about 5 years and the mean ages were male 4.7 y and female 4.4 y. In contrast, the offshore had a wide age range from 2 to 30 years with no clear modes, and the average ages were male 13.7 y and female 11.3 y. These results reveal major differences in the population size and age structure inshore and offshore of Banks Peninsula.

Total mortality (Z) was estimated from catch-curve analysis using the Chapman Robson estimator (CR) The combined strata estimates were between 0.20 and 0.25, inshore from 0.58 to 0.74, and offshore from 0.12 to 0.15. Mortality is markedly greater for blue cod inshore than for those offshore. Estimates are consistent with those from 2002 and 2005 surveys.

Strong recruitment in 2002 occurred in both inshore and offshore strata, but was particularly strong inshore. Growth of these recruited fish resulted in much higher catch rates in 2005, an increase in the mean size, and a change in the age distribution consistent with the growth characteristics of blue cod. By 2008 catch rates, size and age structure were similar to 2002, but there was no strong juvenile length mode.

The predominance of males over females for inshore strata and the parity of sex ratio for offshore fish has persisted among all three surveys.

1. INTRODUCTION

This report describes the 2008 potting survey of Banks Peninsula, the third in the time series following surveys in 2002 and 2005 (Beentjes & Carbines 2003, 2006). These surveys provide relative abundance indices as well as information on population size/age structure, mortality estimates, and sex ratio useful in monitoring the blue cod stocks in this area.

The first blue cod potting survey time series was established in the Marlborough Sounds in 1995 and since then there have been four surveys, (1996, 2001, 2004, and 2007) (Blackwell 1997, 1998, 2002, 2006, 2008). Blue cod catch rates (kg per pot per hour) from potting surveys are considered to provide an index of relative abundance and population size/age composition. Indeed trends in size composition and catch rates of blue cod in the Marlborough Sounds indicate that local depletion and overfishing have occurred, particularly from the inner Sounds. As well as the Marlborough Sounds, there are now a number of blue cod potting survey time series throughout the South Island including North Canterbury (2 surveys), (Carbines & Beentjes 2006b, in press), North Otago (2 surveys) (Carbines & Beentjes 2006a, unpublished results), Dusky Sound (2 surveys) (Carbines & Beentjes 2003, unpublished results), and Paterson Inlet (1 survey) (Carbines 2007), with plans for surveys in south Otago and Foveaux Strait. These potting surveys provide a means to assess blue cod stocks throughout the South Island and allow comparison of the populations both spatially and temporally.

The national diary survey of marine recreational fishing from charter vessels in 1997–98 found blue cod (*Parapercis colias*) to be the second most frequently landed finfish species nationally, and the most frequently landed species off the South Island (James & Unwin 2000). Further, a survey of recreational fishing from Akaroa in 1996 found that blue cod was the most common catch outside Akaroa Heads (Bell 1997). It is also an important customary species for Maori, but the catch is unknown (Ministry of Fisheries 2008). In the South Island, recreational blue cod is usually caught by line from small vessels fishing over reef edges and shingle/gravel or sandy bottoms close to rocky outcrops. In BCO 3, which extends from Clarence River to Slope Point, most blue cod is caught from Taieri Mouth, Karitane, Moeraki, and Motunau and the blue cod fishery off Banks Peninsula is small in comparison. While commercial catches of blue cod in BCO 3 are on average about 170 t (TACC 163 t) (Ministry of Fisheries 2008), the catch from the 1999–2000 national diary survey of recreational fishers was estimated at 752 t (range 530–973, cv = 29%) (Boyd & Reilly 2005). The total catch taken exclusively from around Banks Peninsula is unknown, but it is mostly taken by recreational fishers.

There are concerns from both charter boat operators and commercial fishers that blue cod abundance has declined off Banks Peninsula. Submissions included in the Review of Sustainability Measures and other Management Controls for 2000–01 (Anonymous 2000) also provided anecdotal evidence of a decline in abundance of blue cod around Banks Peninsula. Recreational fishers are also concerned that the lowering of the blue cod bag limit in November 2000 to 10 per day for the northern area of BCO 3 (from Waimakariri River to Clarence Point) may have resulted in a transfer of fishing effort to Banks Peninsula blue cod populations.

In this report, together with results and analysis of the 2008 potting survey, we also examine trends in blue cod population size, age, abundance, and mortality among the three surveys.

Overall objective

1 To estimate relative abundance, sex ratio, and age structure of blue cod (*Parapercis colias*) around Banks Peninsula.

Specific objectives

1. To estimate relative abundance, sex ratio and collect otoliths from pre-recruited and recruited blue cod around Banks Peninsula.
2. To determine age structure of blue cod around Banks Peninsula.

2. METHODS

2.1 Survey area and timing

The Banks Peninsula blue cod potting survey was carried out between 8 April and 5 May 2008. The strata used in the current survey were identical to those from the initial 2002 survey (Beentjes & Carbines 2003). The southern and northern boundaries of the survey area off Banks Peninsula were based on discussions with a commercial blue cod fisher in Akaroa and several charter boat operators that regularly fish in this area. These fishers were given charts of the area and asked to mark discrete locations around Banks Peninsula where blue cod are most commonly caught. The survey area selected was between Snuffle Nose in the south and Le Bons Bay in the north, because outside this area water clarity is often poor and considered to reduce catches. The survey area adjacent to the coast was arbitrarily divided into five strata of similar size with boundaries often determined by headlands or bays (Figure 1). The marine reserve extending off Flea Bay was excluded from the survey area. Discussions with fishers also indicated that much of the recreational catch of blue cod is now taken offshore in two large but discrete areas of foul: Pompeys Rocks (20 km southeast of Pompeys Pillar), and Le Bons Rocks (36 km east of Le Bons Bay) (Figure 1). These offshore areas were included by adding two strata to the survey design.

The blue cod habitat adjacent to Banks Peninsula comprises a narrow band of foul extending out from the cliff faces and exposed headland reefs. It was assumed that this habitat band was reasonably constant in width and that the length of the coastline was proportional to the amount of blue cod habitat. Thus the size of the inshore strata was recorded as length of coast rather than in square kilometres.

The area of the two offshore strata (Le Bons Rocks and Pompeys Rocks) could not be quantified in the same manner because they are discrete areas or islands of foul. To make inshore and offshore areas surveyed comparable, the boundaries of both offshore strata were defined by rectangles (roughly equivalent to the size of the area of foul), each subdivided into 12 smaller rectangles (3 wide and 4 long). The effective size of each offshore stratum was taken as three times the length of the longest side of each stratum. In this way the foul was artificially divided into bands analogous to those of inshore strata.

As this is the third survey in a time series, the same area and strata used in 2002 and 2005 were resurveyed, but with fishing sites generated randomly from the possible sites identified in 2002 (Beentjes & Carbines 2003).

2.2 Survey design

The survey 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. These sites were the same as those identified for the 2002 survey. From this list, five stations per stratum were randomly selected for phase 1. In phase 1, 35 stations (35 sets x 6 pots per set = 210 pot lifts) (87%) were allocated with the remaining 5 (30 pot lifts) (13%) allocated in 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 was greatest, where expected gain is given by:

$$expected\ gain_i = A_i^2\ mean_i^2 / (n_i(n_i+1))$$

where for the ith stratum $mean_i$ is the mean weight of blue cod per stratum, and A_i is the area of the stratum (= length of coastline, or equivalent length of offshore strata) and n_i is the number of pots. Pots were always allocated in groups of six.

2.3 Vessel and gear

The survey was again conducted from F.V. *CherilynJ* (registration number 63139), an Akaroa-based commercial vessel equipped to set and lift rock lobster and blue cod pots. The vessel was chartered by NIWA and, as in 2002 and 2005, was skippered by the owner, John Wright. The vessel specifications are: 10.5 m length, 3.8 m breadth, 3.5 t, aluminium monohull, powered by a 230 hp Volvo Penta diesel engine with propeller propulsion. The trip code for survey was CHJ0801.

Six custom designed and built cod pots were used to conduct the survey. Pot specifications were as follows: length 1200 mm, width 900 mm, depth 500 mm, synthetic inner mesh, 30 mm diameter; 50 mm cyclone wire outer mesh, four entrances. Pots were marked with a number from 1 to 6, and baited with paua guts and fish. These are the same pots used for the 2002 and 2005 blue cod surveys of Banks Peninsula and all other South Island surveys with the exception of the Marlborough Sounds.

2.4 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 2002 and 2005. The six pots were set in clusters, separated by about 100 m to avoid pots competing for the same fish. 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 in which strata and stations were surveyed was dependent on the prevailing weather conditions, as exposed offshore strata 6 and 7 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, time of day, and standard trawl survey physical oceanographic data[1], including wind direction, wind force, air temperature, air pressure, cloud cover, sea condition, sea colour, swell height, swell direction, bottom type, bottom contour, sea surface temperature, sea bottom temperature, wind speed, and water visibility (secchi depth). 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 hagfish) to the nearest 20 g using 10 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. Sex and maturity of blue cod 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. Blue cod sagittal otoliths were removed from a representative size range of males and females (up to five otoliths from each sex per 1 cm size class), from which the weight of each fish

[1] This is the first Banks Peninsula blue cod survey to record standard trawl survey physical oceanographic data.

was recorded. Otoliths were rinsed with water, air dried, and stored in paper envelopes.

2.5 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 ith 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 coastline length ($area_i$) divided by the sum of all coastline lengths ($area_{total}$).

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

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 c.v. for the survey was then determined from the overall mean and standard errors to provide a weighted c.v.

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

Unscaled length frequency for blue cod for each sex is presented by individual strata, inshore strata (1–5) and offshore strata (6 and 7). These length frequency data were not scaled because the area fished by a pot is unknown. Mean length for each sex was calculated for individual strata, inshore strata, offshore strata, and overall for all strata combined.

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. Weights of individual blue cod that were not weighed were determined from the length-weight relationship (see results). Individual fish weights were used to determine catch rates of blue cod 30 cm and over (minimum legal size).

2.5.1 Otolith sectioning and reading

Otoliths were embedded in Araldite polymer resin, baked and sectioned to about 0.5 mm thickness along the transverse plane with a diamond-tipped cut-off wheel. The sections were then sanded with 600 grit sandpaper to remove saw marks and polished on a felt pad with 0.3 µm alumina suspension polishing compound. Sections were observed at x40 and x100 magnification under transmitted light with a compound microscope (Carbines 2004b).

Sections exhibit alternating opaque and translucent zones and age estimates were made by counting the number of annuli (opaque zones) from the core to the distal edge of the section, an ageing technique previously validated by Carbines (2004a). Translucent zones were used to define each complete opaque zone, i.e., annuli were counted only if they had a translucent zone on both sides. Otoliths were read independently by two experienced readers (G. Carbines & D. Kater), and where counts differed readers consulted to resolve a final agreed age estimate. Initial independently derived individual reader estimates of age were compared between readers and then with the agreed age class estimates.

2.6 Age composition

Age composition of the Banks Peninsula blue cod population was estimated using the NIWA program Catch-at-age (Bull & Dunn 2002). The program firstly scales the length frequency data to the catch or area of the strata. Secondly, the length-at-age data are converted into an age-length-key comprising the proportion at age across each length, which is then applied to the scaled length frequency data to give an estimate of relative proportions or numbers at age. The length frequency data were scaled to the area of the individual strata and not the catch weight, which would have resulted in a scaling factor of 1, because we measured every fish. The stratum area was taken as the length of coastline and gave a greater weighting to the larger offshore strata (Table 1). This is consistent with the approach used for catch at age analyses of the 2002 and 2005 Banks Peninsula surveys (Beentjes & Carbines 2006). Length weight coefficients (males and females separately) used in the catch at age analyses were estimated from the length-weight relationship of the blue cod that were individually weighed on this survey (see Results). Scaled length frequency and age frequency proportions are presented together with coefficients of variation (c.v.) for each length and age class, and the mean weighted coefficients of variation (MWCV). The c.v. was calculated using 300 bootstraps.

2.7 Total mortality (*Z*) estimates

Total mortality (Z) was estimated from catch-curve analysis using the Chapman Robson estimator (CR) (Chapman & Robson 1960). The catch curve was generated from the scaled to area catch at age data. Details of the methodology are provided in Appendix 1. The CR method has been shown to be less biased than the simple regression catch curve analysis (Dunn et al. 2002). Catch curve analysis assumes that the right hand descending part of the curve declines exponentially and that the slope is equivalent to the total mortality Z ($M + F$). Implicit assumptions are that recruitment and mortality are constant, that all recruited fish are equally vulnerable to capture, and that there are no age-estimation errors.

We used the method of Dunn et al. (2002) to estimate the variance (95% confidence intervals) associated with Z under three different parameters of recruitment, ageing error, and Z estimate error (Appendix 1).

We estimated Z and 95% confidence intervals for each age at full recruitment from 5 to 8 years for both sexes combined, for inshore strata (1–5), offshore strata (6 and 7), and all strata combined.

3. RESULTS

3.1 Stations surveyed

Forty stations (= sets) were surveyed (6 pots per station = 240 pot lifts) from five inshore strata and two offshore strata around Banks Peninsula (Table 1, Figure 1). Of the 40 stations (240 pot lifts), 35 were carried out in phase 1 (5 per stratum) with 3 allocated to stratum 6 and 2 to stratum 7 in phase 2. Depth ranged from about 6 to 40 m inshore (strata 1–5), and 74 to 87 m for offshore strata 6 and 7. Catch data by individual pot are given in Appendix 2 and standard trawl survey physical oceanographic data by station are given in Appendix 3.

3.2 Catch

A total of 689 kg of catch was taken on the survey, of which 579 kg (84%) was blue cod, consisting of 726 fish (Table 2). Bycatch included 14 fish and 1 octopus species. The five most common bycatch species by number were banded wrasse (*Notolabrus fucicola*), scarlet wrasse (*Pseudolabrus miles*), spotty (*Notolabrus celidontus*), sea perch (*Helicolenus percoides*), and girdled wrasse (*Notolabrus cinctus)*.

Mean catch rates of blue cod (all sizes) ranged from 0.07 kg per pot per hour in stratum 2 (Akaroa Harbour entrance), to 5.80 kg per pot per hour for the offshore stratum 6 located over Le Bons Rock (Figure 1, Table 3). Overall mean catch rate and c.v. were 2.59 kg per pot per hour and 7.7%. For blue cod 30 cm and over (minimum legal size), highest catch rates were also in stratum 6 (5.74 kg per pot per hour) and lowest catch rates in stratum 2 (0.04 kg per pot per hour) (Table 4). Overall mean catch rate and c.v. for blue cod 30 cm and over were 2.30 kg per pot per hour and 8.3%.

3.3 Biological and length frequency data

Of the 726 blue cod caught on the survey, all were sexed and measured for length, and of those, otoliths were taken from 173 males and 142 females. The sex ratio for inshore strata (1–5) was 2.4:1 (male:female), for offshore strata (6 and 7) 0.98:1, and overall 1.5:1.

Unscaled length frequency distributions for the five inshore strata were generally similar but small sample sizes preclude any conclusion on the shape of the distributions from each strata; blue cod from inshore strata ranged in length from 16 to 46 cm with a single modal peak apparent at about 29 cm when data for all inshore strata are combined (Figure 2). Blue cod in the two offshore strata were considerably larger, ranging in length from 10 to 56 cm. It is difficult to assign modes to offshore strata, but it appears that fish were overall larger in stratum 6 than in stratum 7 (Figure 2). Mean lengths of males averaged about 3 cm more than females from all strata combined, and the largest fish, both inshore and offshore, were male (Table 5). Mean length of males in the offshore strata was nearly 13 cm more than the inshore and for females the difference was 10 cm.

The proportion of blue cod of legal size (30 cm and over) was 61%.

Of 726 blue cod examined, nearly all males (94%) had maturing (stage 2) stage gonads (Table 6). Females were mostly maturing (69%) with nearly a quarter (23%) mature (stage 3). This indicates that these blue cod were not spawning at the time of the survey.

The parameters of the length weight relationship for blue cod from this survey using the derived model $W = aL^b$ were:

males: a = 0.01221, b = 3.0824, and R^2 = 0.99 (N = 179, range 18–56 cm);
females: a = 0.00563, b = 3.3050, and R^2 = 0.99 (N=137, range 10–49 cm).

3.4 Ageing (between reader analyses)

From 330 otolith collected during the survey and sectioned, 15 were rejected as unreadable or damaged, leaving 315 readable otoliths (173 males 18–56 cm, 142 females 10–49 cm). Initial independently derived reader estimates of age class are compared in Appendix 4 and show only 36% agreement between the two readers, with reader 2 consistently estimating lower age classes than reader 1. When the differences between age class estimates were resolved by agreement between the readers it was apparent that the more experienced reader 1 was 87% consistent with the agreed age class estimates compared to the less experienced reader 2 who was only 38% consistent with the agreed age classes (Appendix 5). The tendency of reader 2 to under estimate the agreed age class worsens with increasing age class (Figure 3).

3.5 Age composition

The scaled length frequency and age distributions of blue cod from Banks Peninsula sampled during the 2008 survey are shown as histograms and as cumulative frequency line plots for males, females, and both sexes combined (Figure 4). This is also presented separately for inshore, offshore, and for all strata combined. The age length key is shown in Appendix 6. Overall for all strata combined age ranges from 2 to 30 years with a strong mode from about 3 to 8 years, peaking at 4 years. There were, however, few fish older than 8 years. There is little difference between the male and female age distributions except that mean age of males is slightly less than that of females (male = 5.7, females = 6.9 years). The age range for the inshore strata is 2 to 12 years with a strong mode centred at about 5 years and the mean age of males is slightly greater than that of females (male = 4.7, female = 4.4 years). In contrast, the offshore strata have a wide age range from 2 to 30 years with no clear modes, and the average age is considerably greater (male = 13.7, female = 11.3 years). Offshore, males are about 3.5 years older on average than females. These results reveal major differences in the population size and age structure of inshore and offshore Banks Peninsula.

3.6 Total mortality (*Z*) estimates

Total mortality estimates (*Z*) and 95% confidence intervals for the 2008 survey for inshore, offshore and all strata combined are given in Table 7, together with estimates from the 2002 and 2005 surveys (Carbines et al. 2008). The combined strata estimates were between 0.20 and 0.25, inshore from 0.58 to 0.74, and offshore from 0.12 to 0.15. Mortality is markedly greater for blue cod inshore compared to those offshore. Estimates are consistent with those from 2002 and 2005 surveys.

4. DISCUSSION

The 2008 potting survey provides the third index in the time series of abundance and population structure of blue cod off Banks Peninsula. Survey sampling methods and strata were identical to those in the 2002 and 2005 surveys and results are directly comparable. However, there is a slight difference in timing as the 2002 survey was split between January and April (due to poor water visibility), whereas the 2005 and 2008 surveys took place in April–May. The overall 2008 c.v. of 8% for all blue cod indicates that the estimates of abundance (= standardised catch rates) are reasonably precise, and similar to those estimates in 2005 (6%) and 2002 (11%).

The weather during the survey was generally fine and there was only one episode of reduced water clarity, which may have affected some catch rates in stratum 2, directly off the harbour entrance (see Figure 1). Reduced water clarity or a tendency for the water to become milky in colour is often a feature of the inshore waters off Banks Peninsula during persistent southerly swell. Advice from fishers, together with the results from stations sampled during poor water clarity in 2002 (Beentjes & Carbines 2003, 2006) and 2008 (i.e., stations 34 & 35 in stratum 2, see Appendices 2 & 3), suggest that blue cod have reduced catchability in these conditions and that sampling should take place only when water clarity is above a threshold of at least 2 m visibility. 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). While it was not logistically possible to standardise for time of day or tides, each stratum was surveyed throughout the day which collectively gave all stations roughly equal exposure to daily tidal and time regimes. However, we cannot rule out the possibility that some catch rates may have been affected, although compared to areas such as Foveaux Strait, tidal flow around Banks Peninsula is low. For all future blue cod potting surveys, including Banks Peninsula, catch rates will be standardised using environmental data collected during the surveys such as depth, current velocity and direction, water temperature, water clarity, etc (Appendix 3).

The mean catch rates varied among strata and were substantially higher in offshore strata where they were between about 3 to 6 kg per pot per hour for all blue cod compared with about 0.05 to 2 kg per pot per hour from inshore strata. Similarly, there was a marked contrast in both the size and sex structure of blue cod between inshore and offshore strata; male blue cod average length was about 12 cm and females 10 cm longer offshore than inshore, and males outnumbered females about 2.5:1 in inshore strata, but the ratio was about 1:1 offshore.

Results of the ageing and mortality analyses have also shown some contrasting results between inshore and offshore waters off Banks Peninsula. Inshore the population is truncated with no fish older than 12 years and total mortality (Z) is relatively high between about 0.6 and 0.7. Offshore there is a wide range of ages from 2 to 30 years and total mortality is substantially lower at between 0.12 and 0.15.

Blue cod are protogynous hermaphrodites with some (but not all) females changing into males as they grow (Carbines 2004b). The finding that males were on average about 3 cm longer than females and that the largest fish were males is consistent with sex structure in protogynous hermaphrodites. The skewed sex ratios in the inshore Banks Peninsula strata are contrary to an expected dominance of females resulting from selective removal of the larger final sex fish (males). Beentjes & Carbines (2005) suggested that the shift towards a higher proportion of males in heavily fished blue cod populations such as inshore Banks Peninsula, may be caused by removal of the inhibitory effect of large males, and a consequent higher rate (and possibly earlier onset) of sex inversion by primary females. This concept is supported by the predominance of males in the two Motunau surveys where the size distributions are very similar to inshore Banks Peninsula (Carbines & Beentjes 2006b, unpublished results).

It seems likely that the difference between relative abundance, size and age structure, total mortality and possibly sex ratios of these populations is a result of greater 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). There are, however, other possible explanations for the difference between relative abundance (= standardised catch rates) and size/age structure between inshore and offshore Banks Peninsula blue cod populations. These include potential inshore/offshore migration, and/or that deeper offshore reefs provide a more productive environment. However, these would not explain the numerical dominance of males inshore. Further, tagging studies of open coast blue cod populations in Foveaux Strait have shown that 91% of blue cod travel less than 10 km (Carbines 2004b). In Banks Peninsula, the offshore strata 6 and 7 are 36 and 20 km respectively east of Banks Peninsula. It therefore seems more plausible that the population structure difference between on and offshore Banks Peninsula are mainly a result of greater fishing pressure on the more accessible inshore reefs.

Previous potting surveys indicate that December–January is the peak spawning period for blue cod on the east coast South Island, but the timing probably varies seasonally and regionally (Carbines 2004b). The absence of spawning gonad conditions in April-May 2008 is consistent with the 2002 and 2005 surveys.

4.1 Time series comparison

4.1.1 Catch rates

The catch rates of the 2002 and 2008 surveys are similar across the inshore and offshore strata (Figure 5). In contrast, the 2005 catch rates (all strata combined) were about double that of 2002 and 2008. The differences were greatest for the inshore strata in which the 2005 catch rates were almost three-fold greater for both pre-recruited and recruited fish. Confidence intervals surrounding the catch rates suggest that these differences are statistically significant.

4.1.2 Size and age composition

The scaled length and age frequency distributions for 2002, 2005, and 2008 are plotted for comparison (Figures 6–8). Good recruitment, particularly inshore in 2002, is shown by a very strong modal peak centred around 26 cm – the age composition plots indicate that the bulk of these fish were between 4 and 6 years old. By 2005 this mode had progressed with large numbers of fish from about 30 to 45 cm in length, and there was a substantial increase in mean size of about 5 cm overall. Between 2002 and 2005 the increase in the average size of fish resulted in the proportion of fish of MLS (30 cm and over) increasing from 38% to 68%. By 2008 there were no clear modes and the distribution is flat, overall mean size was similar to that of 2002, and the proportion of fish of MLS was 61%. Comparison of the length frequency distributions from inshore and offshore indicates that the strong recruitment in 2002 occurred in both inshore and offshore strata, but was particularly strong inshore. The shapes of the cumulative scaled length and age frequency distributions for the 2002, 2005, and 2008 surveys, show clearly that there were differences in both size and age among the surveys (Figures 9 and 10).

Comparison of the age composition among the three surveys indicates that the modal progression of the strong length mode from 2002 to 2005 is reflected in the age composition data (Figures 6–8). In 2005 there were relatively more fish in the 6 to 13 year age range than in 2002, which is consistent with the expected growth rate of blue cod. The age distribution in 2008 is similar to that of 2002 (see Figures 6–8).

Assuming that there were no major catchability differences among these surveys, the large increase in catch rates in 2005 resulted from a strong recruitment pulse in 2002 progressing through the fishery. The progression is consistent with the growth characteristics of blue cod (Carbines 2004b). The relatively modest catch rates of 2008 suggest that there was no strong recruitment pulse equivalent to 2002.

Given that the Banks Peninsula survey comprises an inshore and an offshore survey with major differences in size, age, and sex ratio it is recommended that when collecting otoliths on future surveys that a separate otolith collection be taken from both the inshore and offshore strata to ensure sufficient numbers are taken from all the size classes from each of these areas. The high MWCV reflects a low sample size of otoliths for both inshore and offshore areas when a single otolith collection is subdivided in this way.

4.1.3 Mortality

Estimates of total mortality (Z) in 2008 are consistent with those from the 2002 and 2005 surveys and Z is markedly greater for blue cod inshore (range over three surveys from 0.43 to 0.94) than offshore (range 0.12 to 0.19) (Table 7).

4.1.4 Sex ratios

The predominance of males over females for inshore strata and the parity of sex ratio for offshore fish has persisted among the three surveys.

5. ACKNOWLEDGMENTS

This research was carried out by NIWA and Stock Monitoring Services (SMS) under contract to the Ministry of Fisheries (MFish Project BCO200701). We thank John Wright for providing his vessel and crew to undertake the survey. Thanks also to NIWA staff Derek Kater for otolith preparation and reading, Evan Baddock for graphics assistance, and Mike Beardsell for editorial comments.

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

Stratum	Length of coastline (km)	Number of sets Phase 1	Phase 2	Number of pot lifts	Depth (m) Mean	Range
1	7.96	5		30	23.5	18–30
2	9.44	5		30	27.9	20–38
3	7.96	5		30	25.9	20–35
4	7.78	5		30	21.4	6–40
5	8.15	5		30	17.2	7–31
6	16.67	5	3	48	82.5	77–87
7	16.67	5	2	42	76.5	74–82
Total	74.63	35	5	240	44.4	6–87

Table 2: Catch weights and/or numbers of blue cod and bycatch species caught on the survey and percentage of total weight.

Common name	Scientific name	Catch (kg)	Number	Percent of total catch
Blue cod	*Parapercis colias*	578.9	726	84.04
Banded wrasse	*Notolabrus fucicola*	53.27	91	7.73
Sea perch	*Helicolenus percoides*	15.14	25	2.20
Scarlet wrasse	*Pseudolabrus miles*	12.54	35	1.82
Common conger	*Conger verreauxi*	10.63	1	1.54
Spotty	*Notolabrus celidotus*	6.48	35	0.94
Girdled wrasse	*Notolabrus cinctus*	3.19	15	0.46
Tarakihi	*Nemadactylus macropterus*	3.01	11	0.44
Southern bastard cod	*Pseudophycis barbata*	2.25	6	0.33
Trumpeter	*Latris lineata*	1.75	1	0.25
Blue moki	*Latridopsis ciliaris*	0.7	2	0.10
Red cod	*Pseudophycis bachus*	0.62	2	0.09
Leatherjacket	*Parika scaber*	0.29	1	0.04
Redbanded perch	*Hypoplectrodes huntii*	0.07	1	0.01
Octopus	*Octopus cordiformis*	0.01	1	0.00
Hagfish	*Eptatretus cirrhatus*	–	1	–
Total		688.85	954	100

Table 3: 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	1.03	0.17	16.28
2	30	0.07	0.04	58.58
3	30	1.08	0.25	23.55
4	30	2.30	0.53	22.81
5	30	1.15	0.41	35.40
6	48	5.80	0.62	10.65
7	42	3.13	0.55	17.47
Overall	240	2.59	0.20	7.71

Table 4: 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	0.69	0.17	25.10
2	30	0.04	0.03	71.80
3	30	0.51	0.13	25.47
4	30	1.63	0.42	25.60
5	30	0.79	0.32	40.24
6	48	5.74	0.62	10.73
7	42	2.81	0.53	19.01
Overall	240	2.30	0.19	8.35

Table 5: Mean lengths of blue cod by stratum and sex.

Strata	Sex	N	Mean length (cm)
1	m	49	29.4
	f	24	22.9
2	m	6	26.5
	f	0	–
3	m	56	27.2
	f	37	26.2
4	m	103	31.3
	f	31	26.8
5	m	48	31.7
	f	18	27.0
6	m	104	45.4
	f	110	37.5
7	m	71	38.4
	f	69	33.9
1–5	m	262	30.0
	f	110	25.8
6 and 7	m	175	42.6
	f	179	36.1
Overall	m	437	35.1
	f	289	32.2

Table 6: 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	3.4	94.3	2.3	0	0	437
Females	7.6	68.9	22.8	0.3	0.3	289

Table 7: Total mortality estimates (*Z*) and 95% confidence intervals of blue cod from the 2002, 2005, and 2008 Banks Peninsula potting surveys using Chapman Robson method described in Appendix 1. The cv is the mean weighted cv from the scaled age frequency distribution.

				Low		Medium		High	
Area Year	AgeR	*Z*	cv	Lower	Upper	Lower	Upper	Lower	Upper
Banks inshore 2002									
	5	0.81	0.35	0.49	1.26	0.49	1.25	0.45	1.25
	6	0.94	0.35	0.56	1.45	0.56	1.43	0.55	1.46
	7	0.53	0.35	0.36	0.74	0.35	0.74	0.33	0.80
	8	0.53	0.35	0.37	0.72	0.36	0.73	0.34	0.78
Banks offshore 2002									
	5	0.14	0.48	0.11	0.18	0.10	0.19	0.10	0.20
	6	0.14	0.48	0.11	0.17	0.10	0.18	0.09	0.19
	7	0.15	0.48	0.11	0.18	0.11	0.19	0.10	0.21
	8	0.15	0.48	0.11	0.18	0.11	0.19	0.10	0.20
Banks combined 2002									
	5	0.36	0.33	0.25	0.49	0.24	0.49	0.22	0.53
	6	0.28	0.33	0.21	0.35	0.19	0.38	0.18	0.41
	7	0.20	0.33	0.16	0.25	0.15	0.27	0.14	0.29
	8	0.18	0.33	0.14	0.23	0.14	0.23	0.12	0.25
Banks inshore 2005									
	5	0.43	0.27	0.31	0.58	0.30	0.61	0.27	0.65
	6	0.47	0.27	0.33	0.62	0.31	0.65	0.29	0.71
	7	0.50	0.27	0.36	0.66	0.34	0.69	0.32	0.71
	8	0.56	0.27	0.40	0.75	0.39	0.77	0.37	0.82
Banks offshore 2005									
	5	0.14	0.44	0.11	0.18	0.11	0.19	0.10	0.21
	6	0.16	0.44	0.12	0.20	0.12	0.21	0.11	0.23
	7	0.18	0.44	0.13	0.23	0.13	0.23	0.12	0.25
	8	0.19	0.44	0.14	0.24	0.14	0.25	0.13	0.27
Banks combined 2005									
	5	0.27	0.26	0.20	0.34	0.19	0.36	0.17	0.39
	6	0.27	0.26	0.21	0.34	0.20	0.36	0.18	0.40
	7	0.27	0.26	0.21	0.34	0.20	0.35	0.19	0.38
	8	0.28	0.26	0.21	0.35	0.20	0.36	0.19	0.39
Banks inshore 2008									
	5	0.57	0.32	0.37	0.80	0.36	0.80	0.34	0.87
	6	0.58	0.32	0.38	0.82	0.37	0.82	0.36	0.85
	7	0.73	0.32	0.48	1.02	0.46	1.07	0.45	1.06
	8	0.74	0.32	0.50	1.02	0.49	1.05	0.49	1.07
Banks offshore 2008									
	5	0.12	0.47	0.09	0.15	0.09	0.16	0.08	0.17
	6	0.14	0.47	0.11	0.17	0.10	0.18	0.09	0.20
	7	0.14	0.47	0.11	0.18	0.11	0.18	0.10	0.20
	8	0.15	0.47	0.12	0.19	0.11	0.20	0.10	0.21
Banks combined 2008									
	5	0.25	0.31	0.19	0.33	0.18	0.34	0.16	0.37
	6	0.22	0.31	0.17	0.28	0.17	0.30	0.15	0.32
	7	0.22	0.31	0.17	0.28	0.17	0.29	0.15	0.32
	8	0.2	0.31	0.16	0.25	0.15	0.25	0.13	0.28

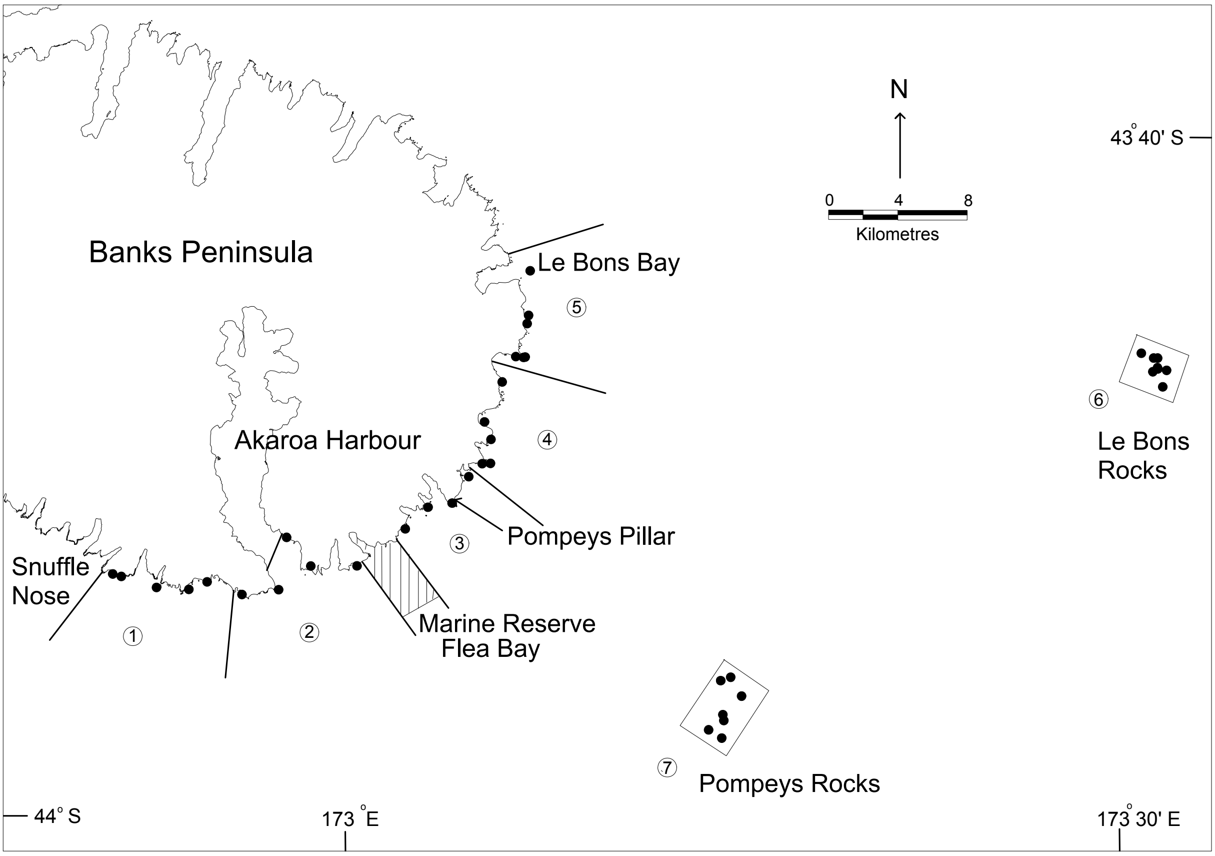

Figure 1: Map of Banks Peninsula showing strata (1–7) and stations surveyed (black dots) in 2008.

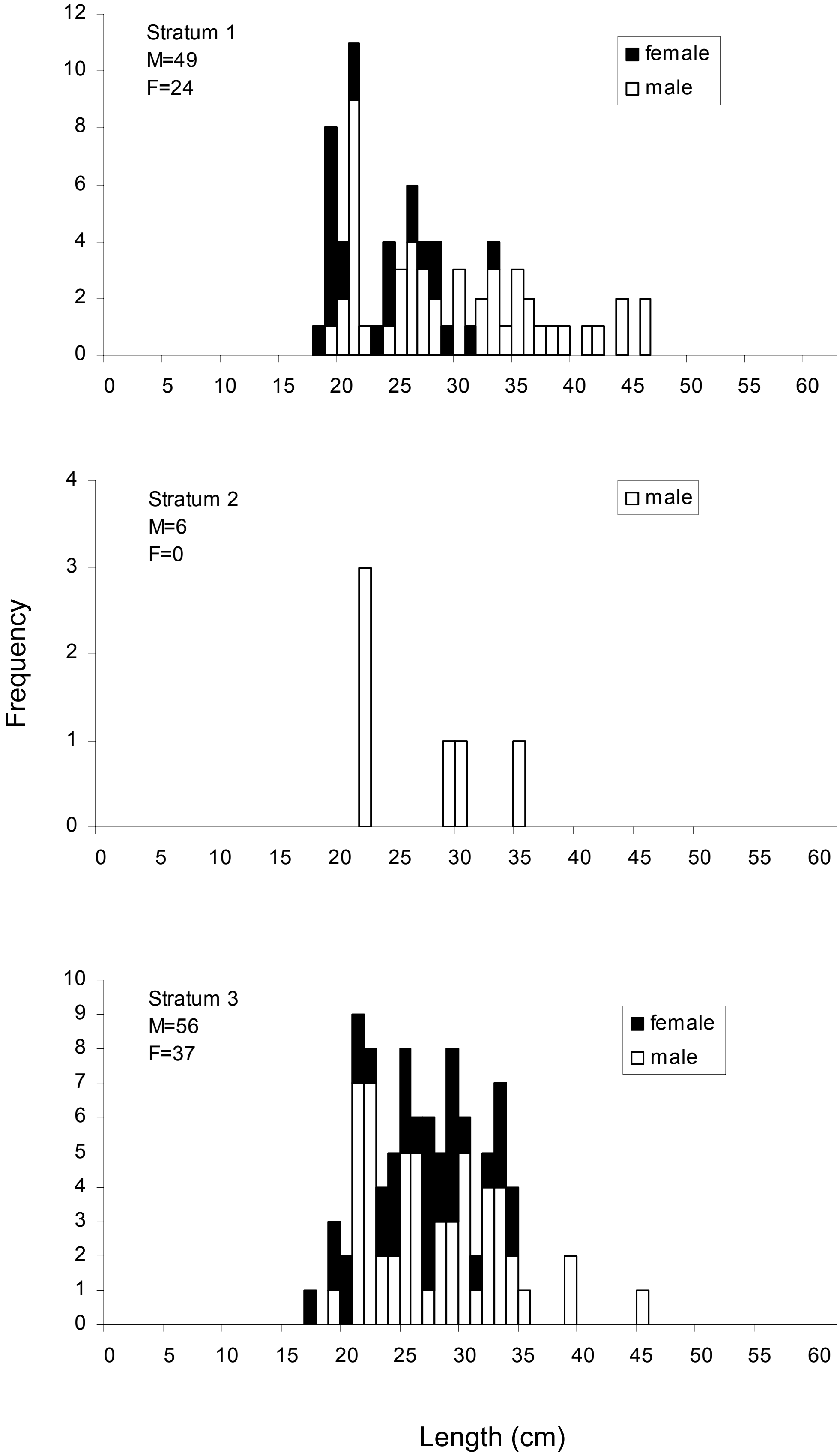

Figure 2: Length frequency distributions (not scaled) of blue cod for each stratum (1–7), for inshore strata combined (1–5), offshore strata combined (6 & 7), and all strata combined for the 2008 Banks Peninsula survey.

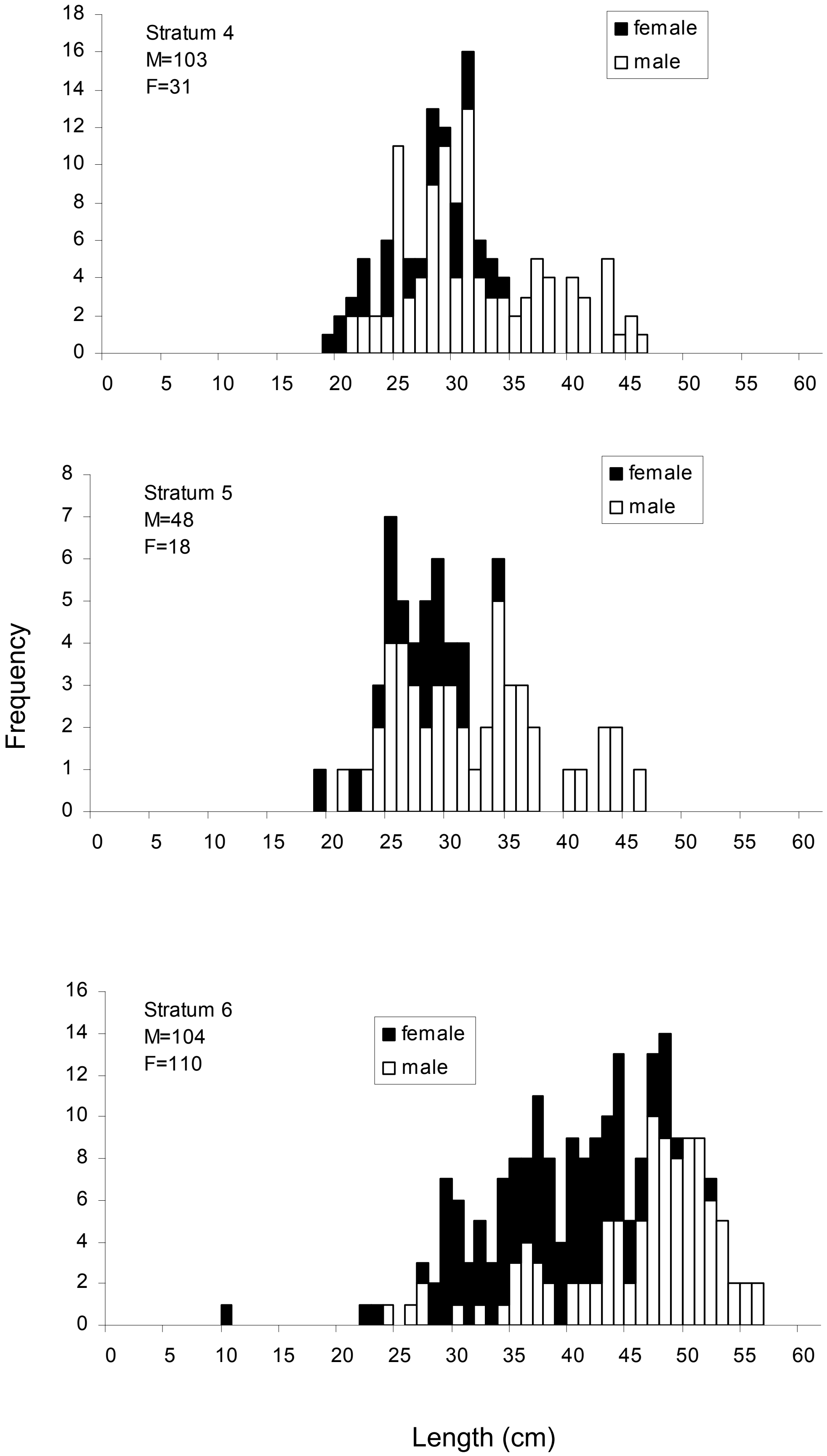

Figure 2 – ***continued***

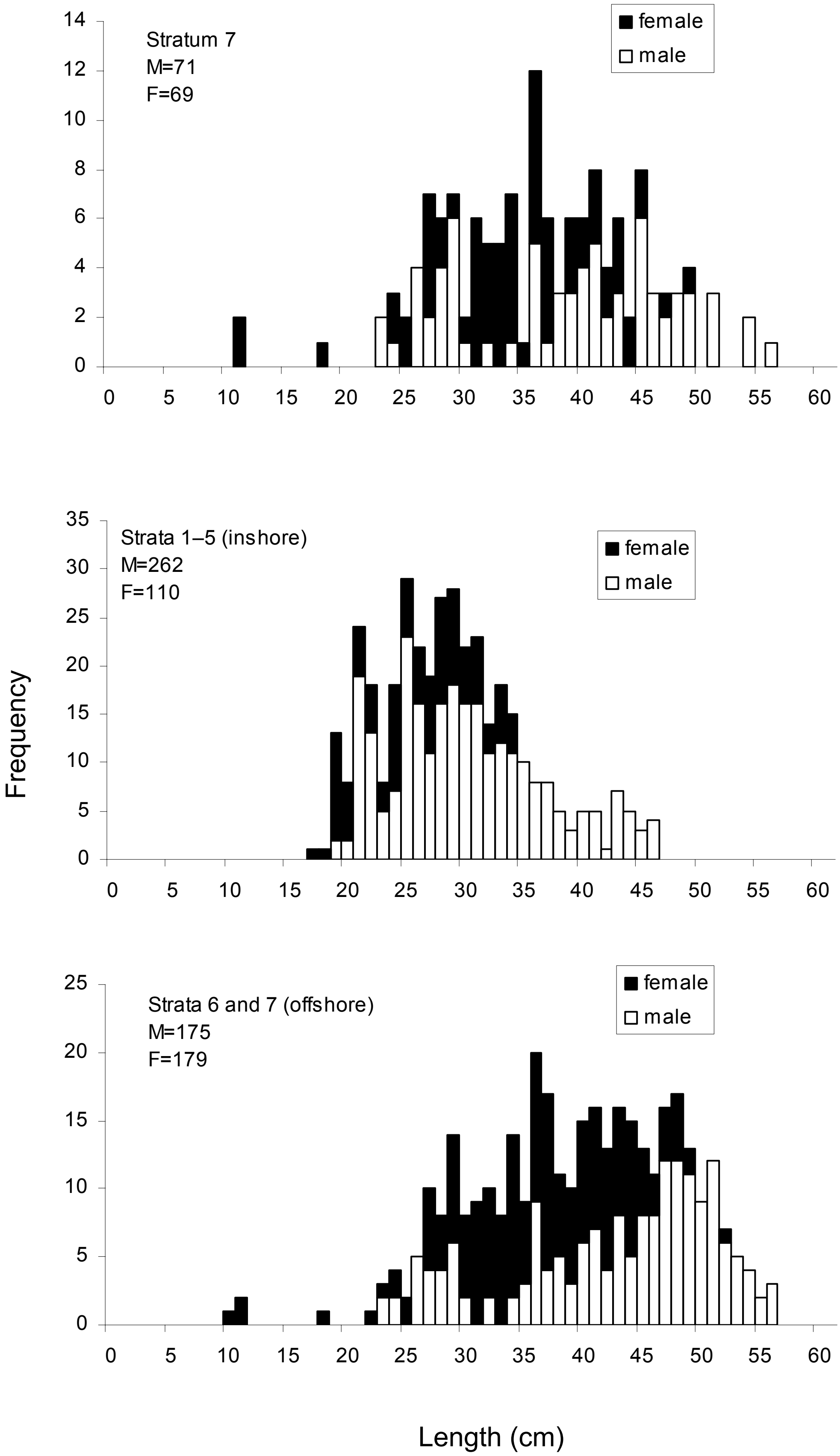

Figure 2 – ***continued***

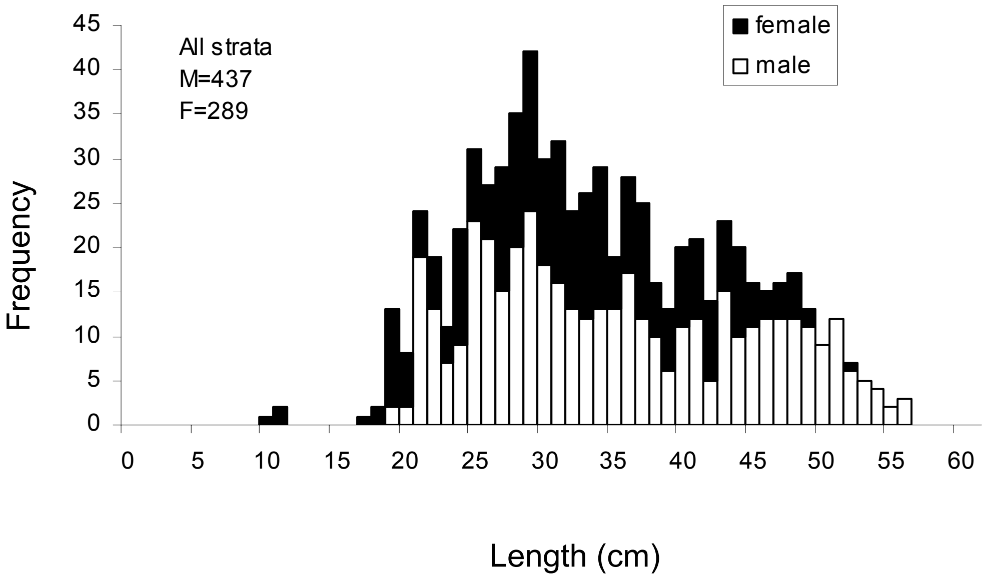

Figure 2 – ***continued***

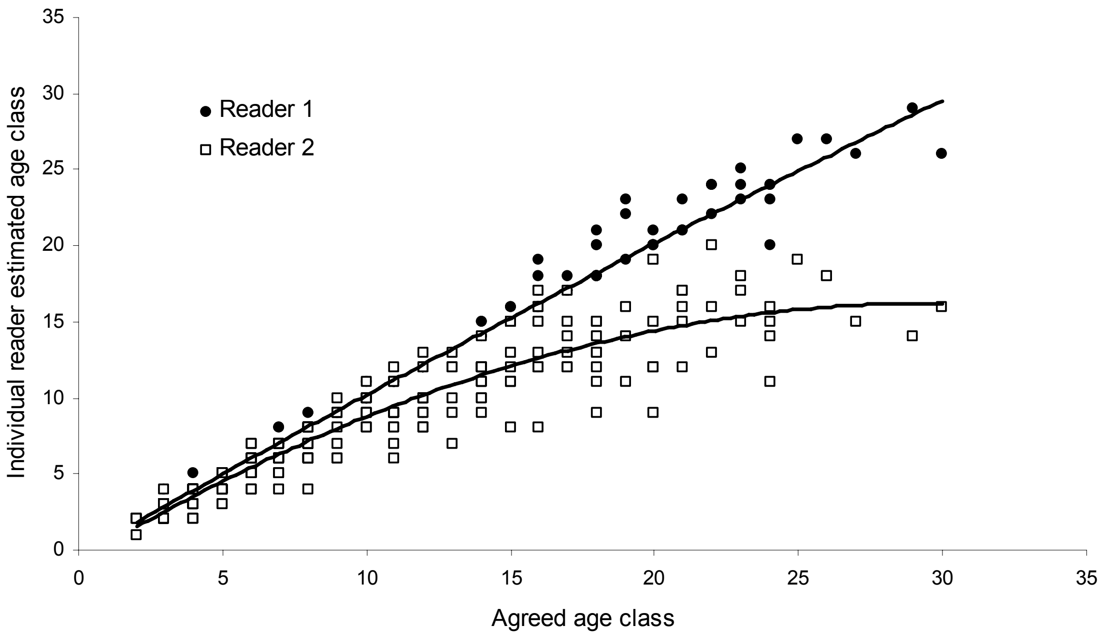

Figure 3: Comparison of individual reader age class estimates from the 2008 Banks Peninsula survey otoliths plotted against the agreed age class estimates (N = 315). Polynomial trend lines are fitted to the individual age class estimates of each reader.

All strata

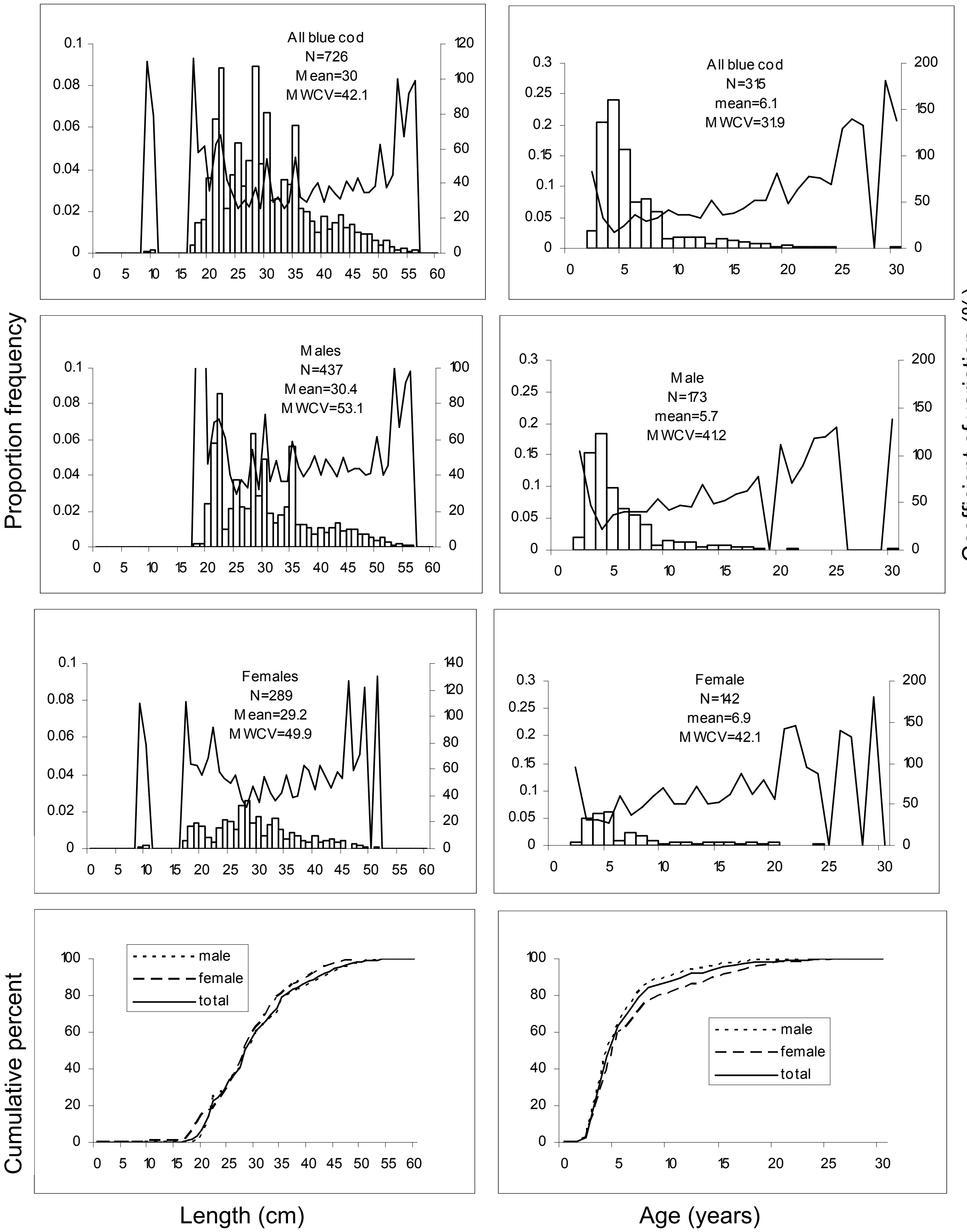

Figure 4: Scaled length frequency, age frequency, and cumulative distributions for total, male, and female blue cod for all strata (1–7), inshore strata (1–5), and offshore strata (6 and 7) for the 2008 Banks Peninsula survey. N, Sample size; MWCV, mean weighted coefficient of variation.

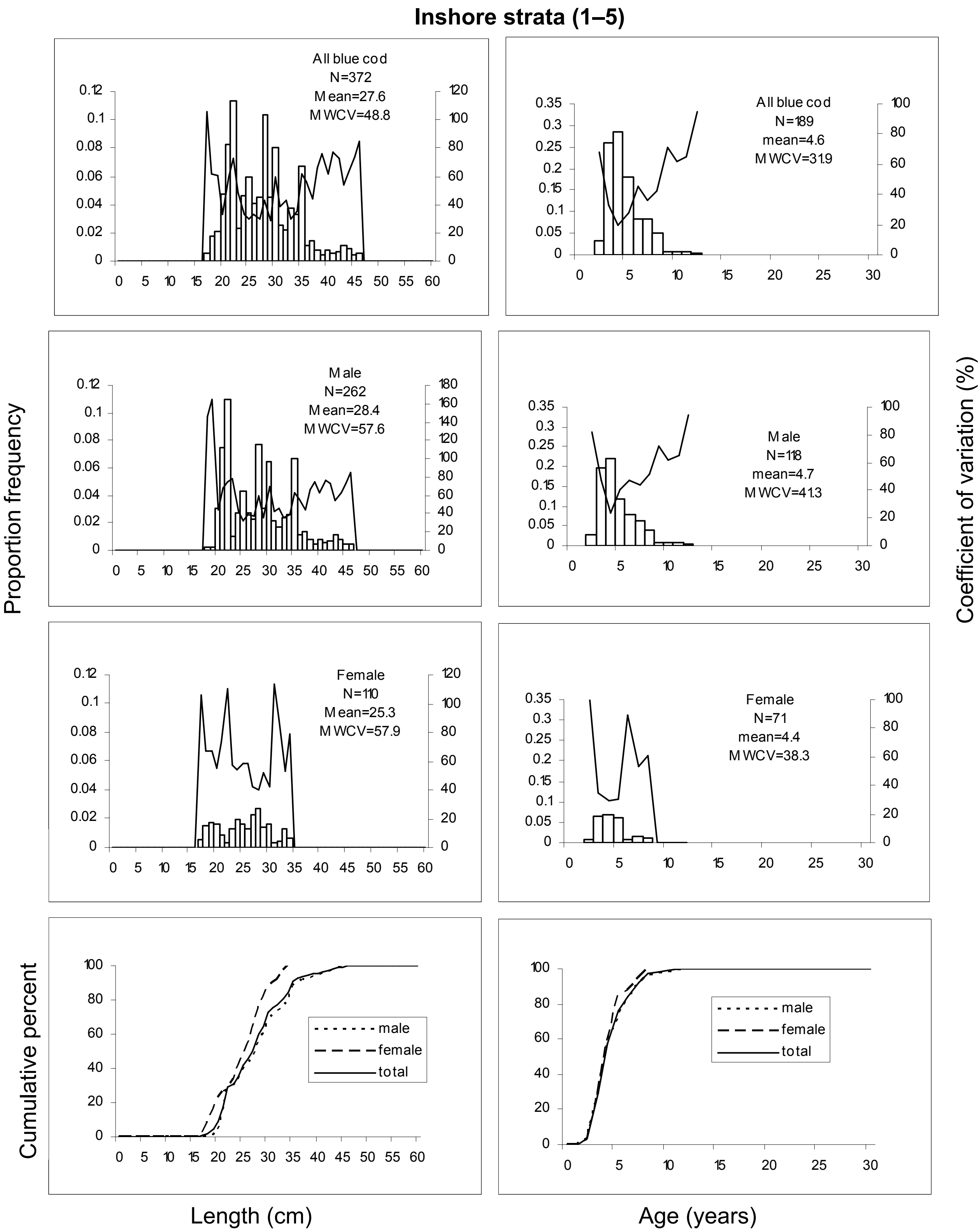

Figure 4–*continued*

Offshore strata (6 and 7)

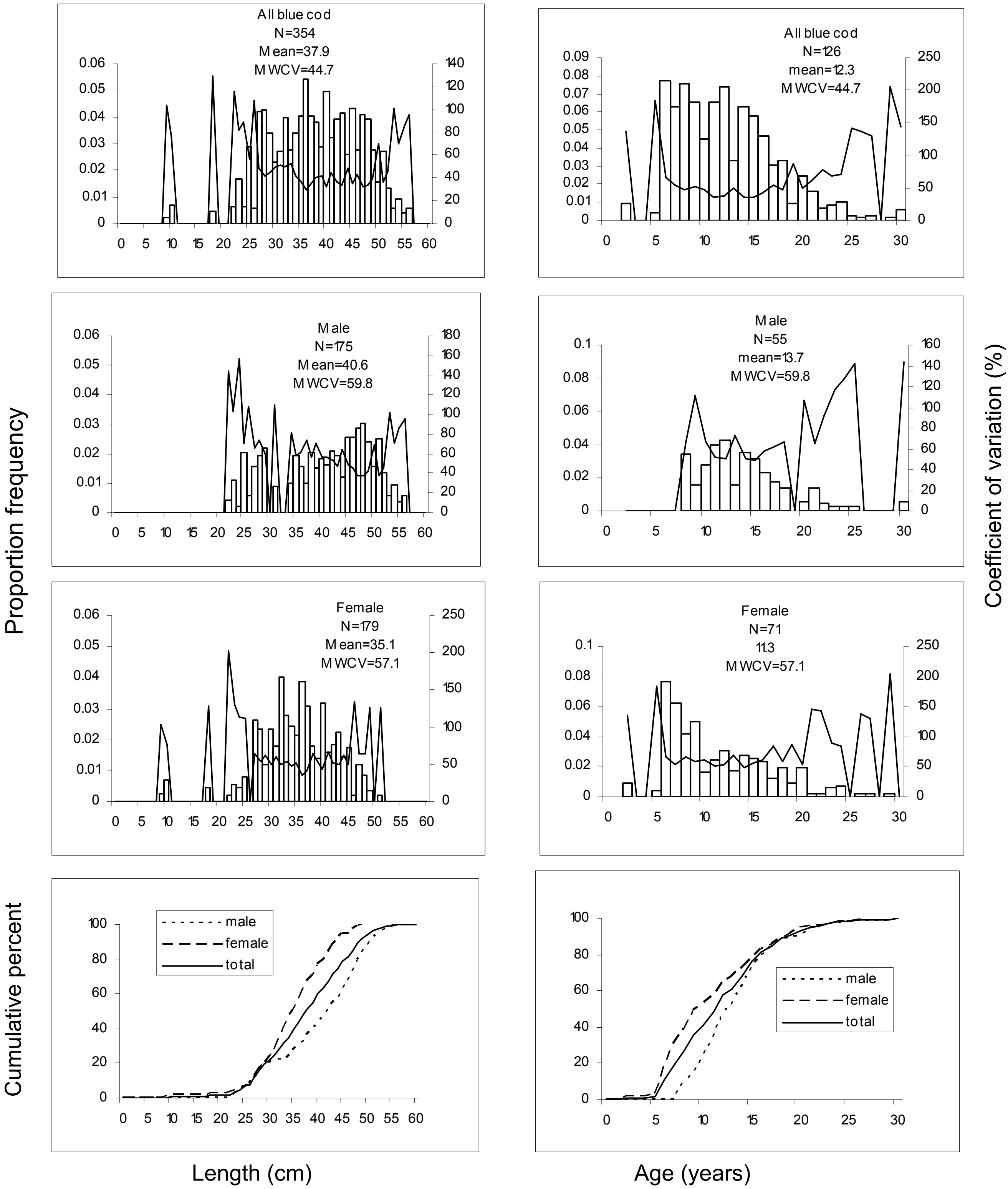

Figure 4–*continued*

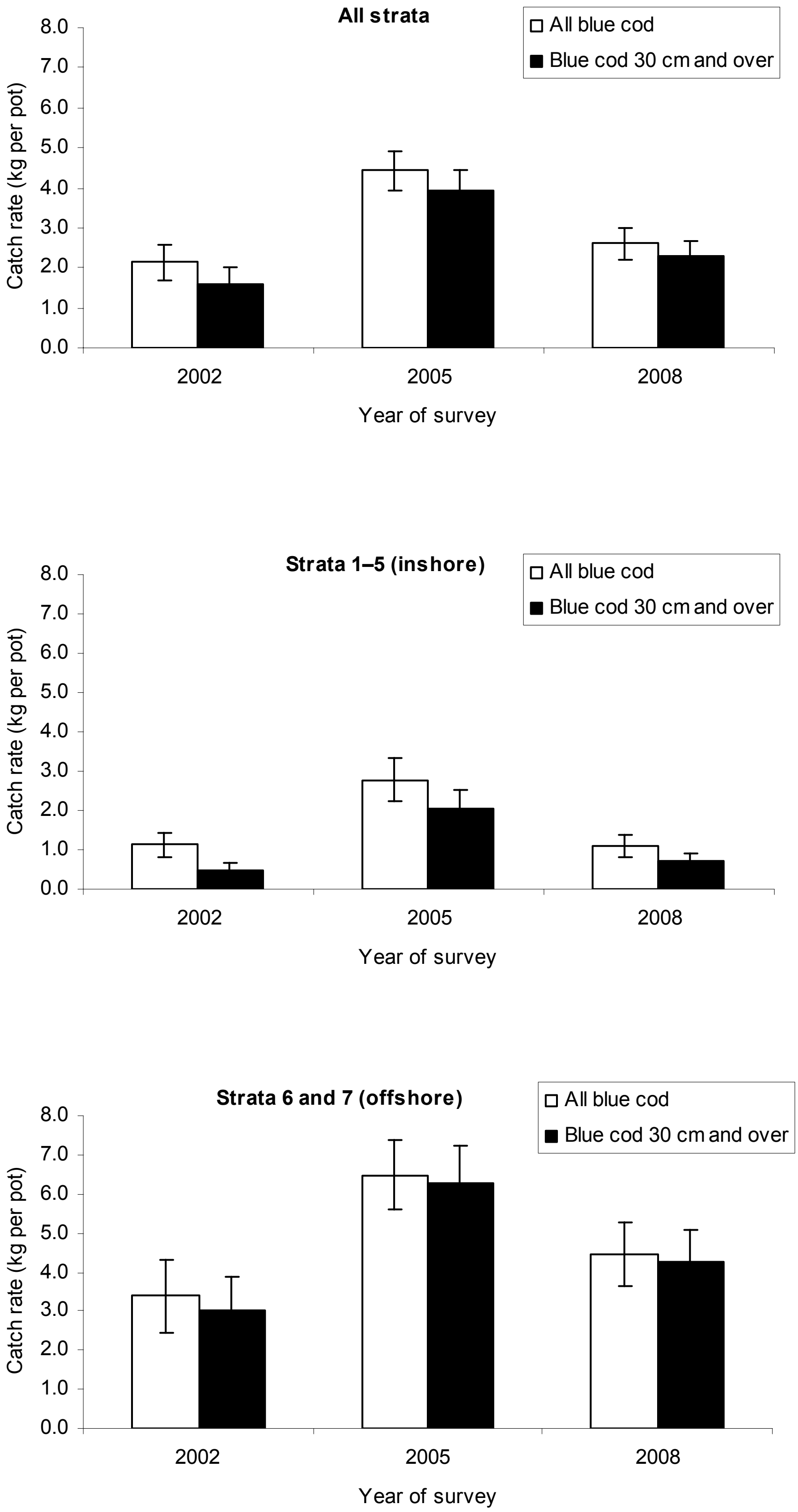

Figure 5: Catch rates for Banks Peninsula blue cod potting surveys for 2002, 2005, and 2008 for all strata, inshore strata (1–5), and offshore strata (6 and 7).

2002 survey

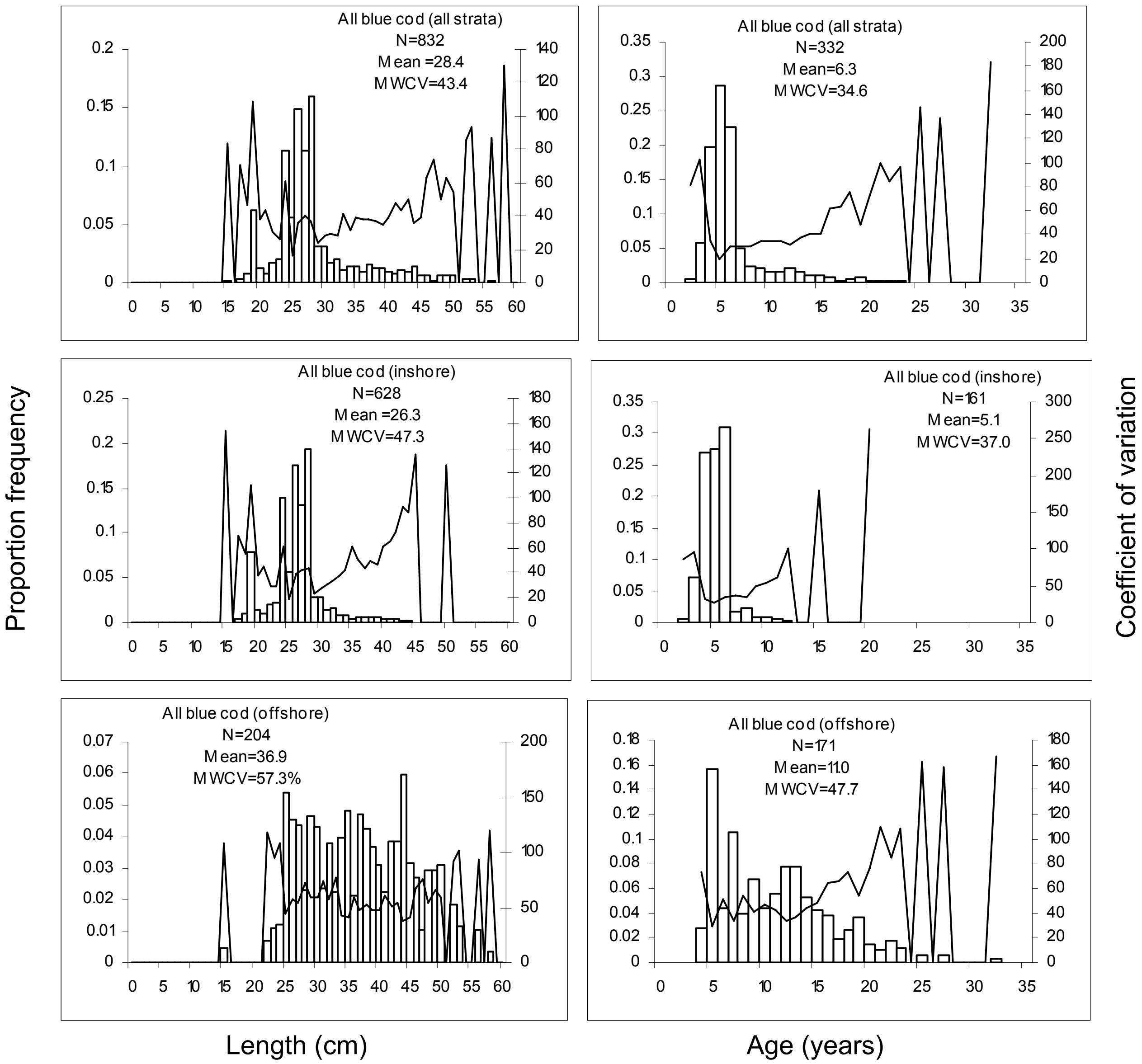

Figure 6: Scaled length and age frequency distributions for blue cod (males and females combined) for all strata (1–7), inshore strata (1–5), and offshore strata (6 and 7) for the 2002 Banks Peninsula survey. N, Sample size; MWCV, mean weighted coefficient of variation. See Carbines et al. (2008) for details.

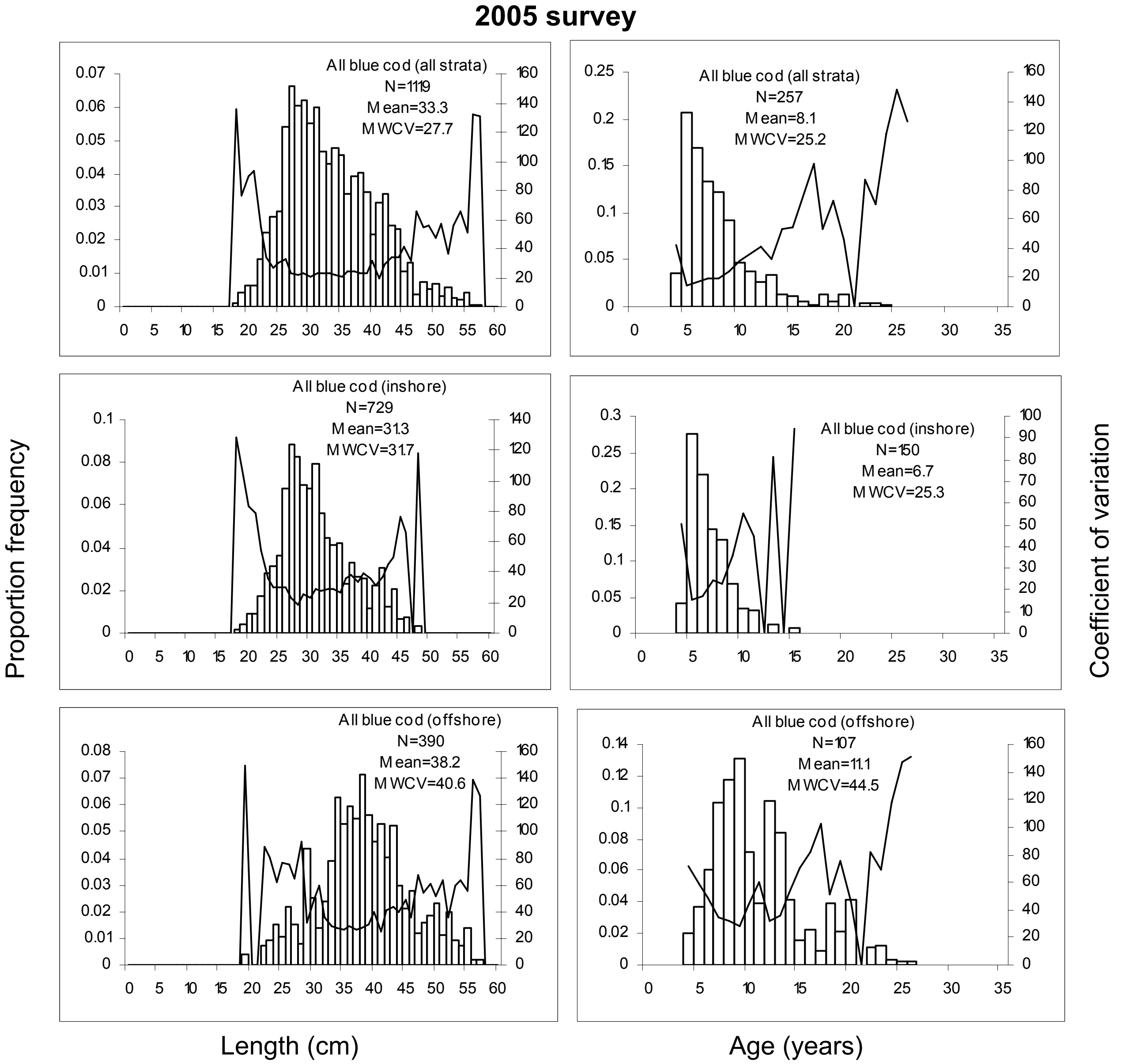

Figure 7: Scaled length and age frequency distributions for blue cod (males and females combined) for all strata (1–7), inshore strata (1–5), and offshore strata (6 and 7) for the 2005 Banks Peninsula survey. N, Sample size; MWCV, mean weighted coefficient of variation. See Carbines et al. (2008) for details.

2008 survey

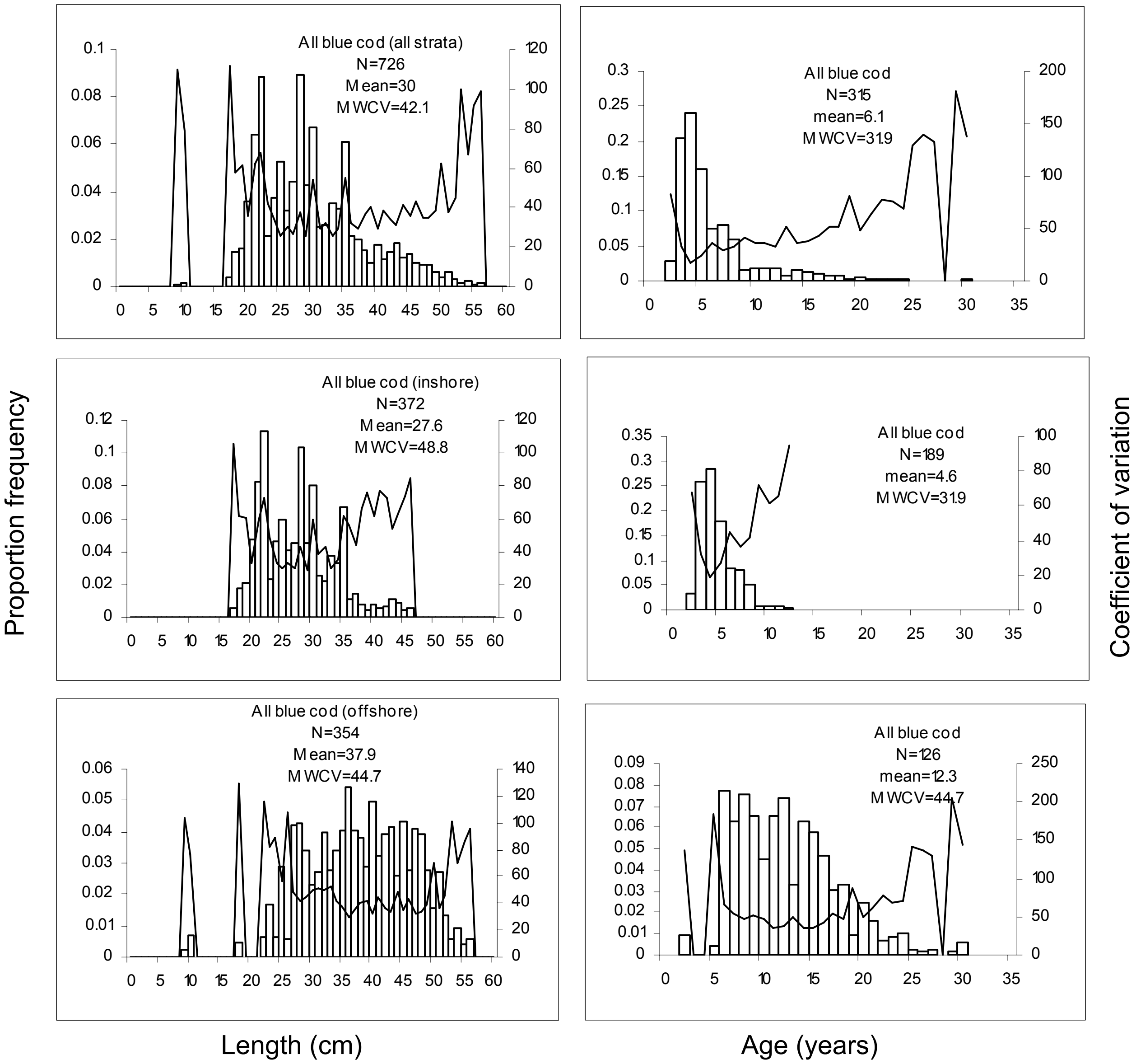

Figure 8: Scaled length and age frequency distributions for blue cod (males and females combined) for all strata (1–7), inshore strata (1–5), and offshore strata (6 and 7) for the 2008 Banks Peninsula survey. N, Sample size; MWCV, mean weighted coefficient of variation.

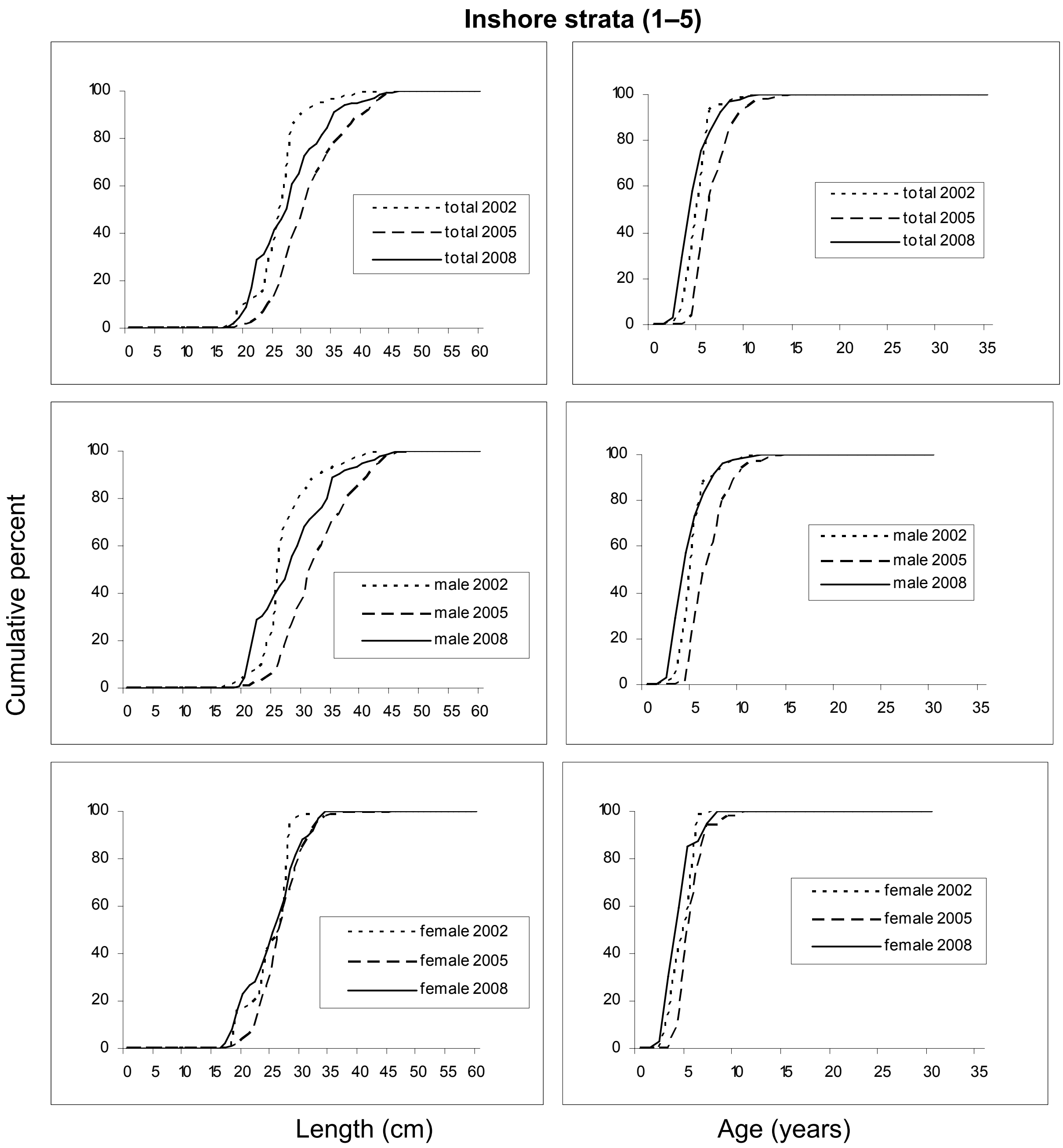

Figure 9: Scaled length and age cumulative frequency distributions of blue cod for the inshore strata (1–5) of the Banks Peninsula blue cod potting surveys in 2002, 2005, and 2008.

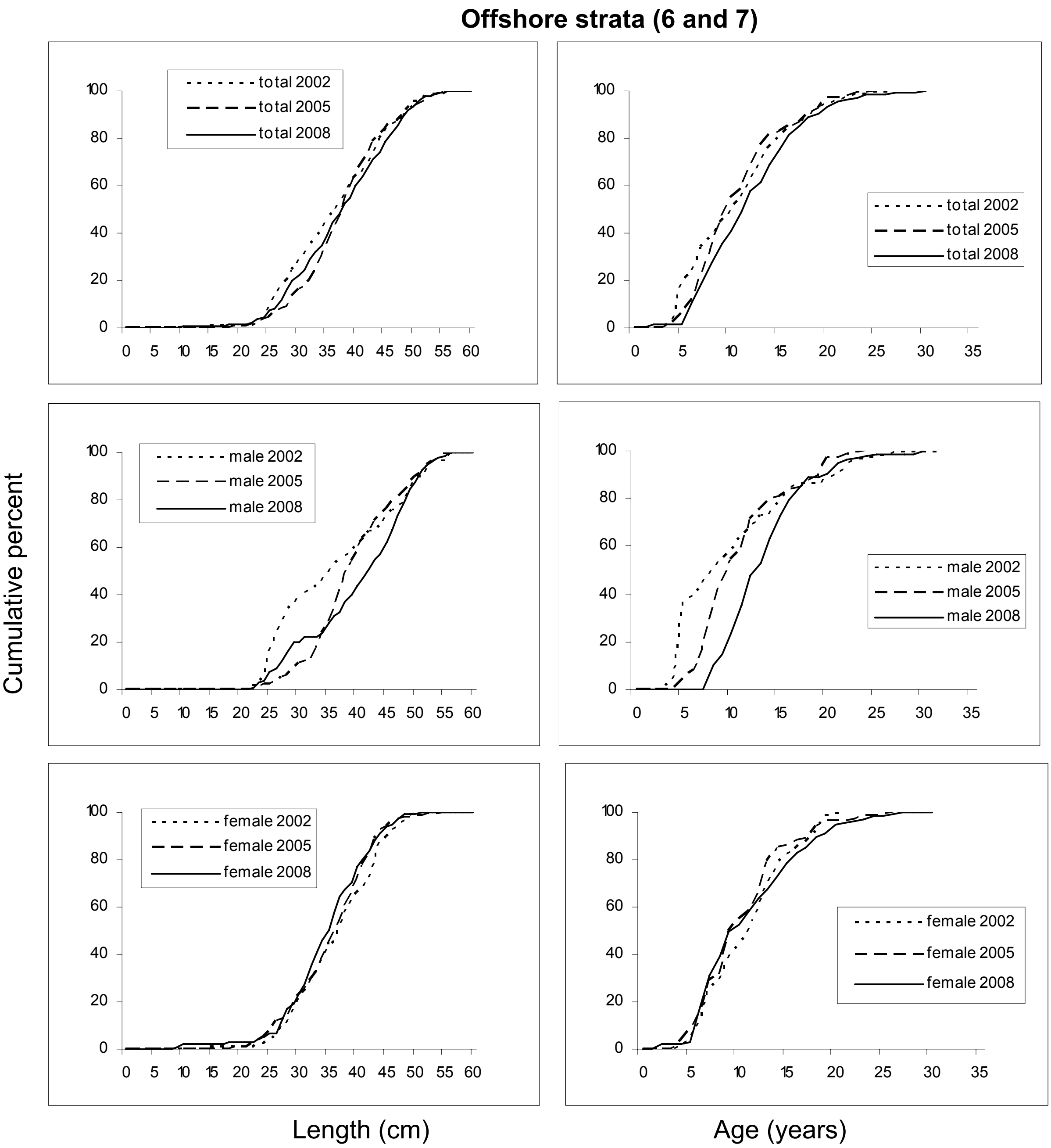

Figure 10: Scaled length and age cumulative frequency distributions of blue cod for the offshore strata (6 and 7) of the Banks Peninsula blue cod potting surveys in 2002, 2005, and 2008.

Appendix 1: Methodology for estimating total mortality (*Z*).

ESTIMATES OF TOTAL MORTALITY (*Z*)

The term "catch-curve" has commonly been used to describe an age frequency distribution from a catch (or sample) of a population, and has been widely used in fisheries research in the estimation of total mortality (Z) (i.e., the sum of natural mortality M and fishing mortality F). The assumption is that this curve declines exponentially on its right hand limb and the rate of exponential decline is Z.

A common method for estimating Z from catch–curve data is the Chapman Robson estimator (CR) (Chapman & Robson 1960). Their estimator is based on a minimum variance unbiased estimator for the related survival parameter, $S\ \left(=e^{-Z}\right)$, and is defined as

$$\mathrm{CR} = \log_e\left(\frac{1+\bar{a}-1/n}{\bar{a}}\right) \qquad [1]$$

Where $\bar{a}$ is the mean age (above the recruitment age) and n is the sample size.

Chapman & Robson (1960) also showed that

$$\mathrm{Bias(CR)} \approx \frac{\left(1-e^{-Z}\right)^2}{ne^{-Z}} \approx \mathrm{Variance(CR)} \qquad [2]$$

However, both the estimates and variance of Z assumes that the population sampled has a stable age structure, "steady-state" (i.e., that recruitment and mortality are constant), that fish of age greater than some known age (the recruitment age) are equally vulnerable to sampling, and that there are no age–estimation errors (Ricker 1975).

We used the simulation model developed by Dunn et al. (2002) to estimate the variance of Z, and hence attempt to evaluate the variance of these estimates when the steady state assumptions are relaxed. An approximate simulated 95% confidence interval for the estimates of $\hat{Z}$ was calculated from the 2008 blue cod potting survey sample (males and females combined) using the simulation models of Dunn et al. (2002). Here, we simulated 1000 age distributions with a known value of $\hat{Z}$ (the 'true' estimate), that included annual variation in Z (described by a normal distribution with c.v. σ_Z), error in sampling (described as a lognormally distributed error with a constant c.v., cv_{sampling}), ageing error (normally distributed errors described by a constant c.v., cv_{ageing}), and variability in recruitment (described by lognormally distributed recruitment deviations with standard deviation σ_R, and autocorrelation φ). Then, for each simulated age distribution, we estimated the CR estimate of Z, and hence evaluated the 95% empirical confidence intervals for the estimate of $\hat{Z}$.

However, as the CR estimator is biased, we adjusted the empirical 95% intervals by (i) estimating a scaling factor to adjust the mean empirical estimate to the 'true' estimate, and (ii) applied this scaling factor to the 95% intervals to estimate bias corrected intervals for $\hat{Z}$.

THE NATURE AND MAGNITUDE OF THE INTRODUCED STOCHASTIC ERROR

In simulating age distributions for catch curve derived estimates of mortality (Z), we attempted to approximate the values of parameters that could be found in typical blue cod populations. The parameters (and symbols used to describe each) and values that have been used in the simulation model are shown below:

Parameter		Low	Medium	High
Ageing error (coefficient of variation)	cv_a	0.10	0.15	0.20
Error in Z (coefficient of variation)	cv_Z	0.00	0.10	0.20
Error in recruitment	σ_R	0.50	0.70	1.00

Ageing error is a likely source of bias, but the scale of ageing error can be difficult to estimate (Dunn et al. 2002). We assumed that ageing error is normally distributed with a c.v. of $cv_a = 0.15$, but also consider $cv_a = 0.1$ (low) and $cv_a = 0.2$ (high).

Stochastic variation in Z has considerable impact on the shape of an empirical catch-curve, but no data are available to describe the type or magnitude of stochastic variation. We assume either that there was no variation in Z (low) and variation defined as lognormally distributed, uncorrelated, and without trend, with error described by a cumulative variance of $cv_Z = 0.1$ (medium) and $cv_Z = 0.2$ (high).

We assume errors in log recruitment to be normally distributed with standard deviation σ_R,. We based the values chosen for the simulations on data given by Myers et al. (1995). This details the standard deviation and first order autocorrelation of estimated recruitment for a wide variety of international fisheries. Lower, mid, and upper quartiles were derived from this table (using those series with more than 10 years data) selected from the orders Aulopiformes, Clupeiformes, Gadiformes, Lophiiformes, Ophidiiformes, Perciformes (except Percidae), Pleuronectiformes, and Scorpaeniformes. The lower, mid, and upper quartiles from these data were σ_R, = 0.48, σ_R, = 0.67, and σ_R, = 1.00. We assume variation in recruitment based on the median values ($\sigma_R = 0.7$), and also consider low ($\sigma_R = 0.5$) and high levels ($\sigma_R = 1.0$) based on the lower and upper quartiles.

Appendix 2: Summary of 2008 Banks Peninsula survey pot lift station data. *, lost pot 6 so used pot 2; **, a new pot 6 replacement was used.

				Pot lift			Pot	Catch of blue cod	
Set	Date	Phase	Stratum	station	Depth (m)	Time set	number	Weight (kg)	Number of fish
1	8-Apr-08	1	1	1E	26	07:20	1	1.45	3
1	8-Apr-08	1	1	1E	24	07:25	2	2.73	3
1	8-Apr-08	1	1	1E	28	07:30	5	0.85	3
1	8-Apr-08	1	1	1E	26	07:35	4	0.00	0
1	8-Apr-08	1	1	1E	24	07:40	3	0.00	0
1	8-Apr-08	1	1	1E	26	07:45	6	0.00	0
2	8-Apr-08	1	1	1C	19	09:23	6	0.00	0
2	8-Apr-08	1	1	1C	19	09:27	3	2.12	7
2	8-Apr-08	1	1	1C	19	09:30	4	0.93	2
2	8-Apr-08	1	1	1C	20	09:33	5	1.01	3
2	8-Apr-08	1	1	1C	18	09:37	2	0.14	1
2	8-Apr-08	1	1	1C	20	09:43	1	1.09	2
3	8-Apr-08	1	1	1A	21	11:20	1	2.25	4
3	8-Apr-08	1	1	1A	18	11:25	2	1.20	4
3	8-Apr-08	1	1	1A	20	11:28	5	0.19	2
3	8-Apr-08	1	1	1A	28	11:30	4	3.81	4
3	8-Apr-08	1	1	1A	30	11:38	3	1.15	5
3	8-Apr-08	1	1	1A	28	11:44	6	0.76	3
4	8-Apr-08	1	1	1G	29	13:30	6	0.00	0
4	8-Apr-08	1	1	1G	28	13:33	3	1.94	3
4	8-Apr-08	1	1	1G	25	13:35	5	1.06	1
4	8-Apr-08	1	1	1G	30	13:40	4	0.83	2
4	8-Apr-08	1	1	1G	24	13:45	2	0.82	1
4	8-Apr-08	1	1	1G	23	13:48	1	1.42	4
5	9-Apr-08	1	2	2C	30	07:22	1	0.00	0
5	9-Apr-08	1	2	2C	26	07:27	2	0.00	0
5	9-Apr-08	1	2	2C	25	07:32	4	0.00	0
5	9-Apr-08	1	2	2C	24	07:38	5	0.00	0
5	9-Apr-08	1	2	2C	24	07:42	3	0.00	0
5	9-Apr-08	1	2	2C	22	07:48	6	0.00	0
6	9-Apr-08	1	2	2E	21	09:04	6	0.00	0
6	9-Apr-08	1	2	2E	22	09:07	3	0.00	0
6	9-Apr-08	1	2	2E	23	09:12	5	0.00	0
6	9-Apr-08	1	2	2E	20	09:16	4	0.00	0
6	9-Apr-08	1	2	2E	22	09:04	2	0.00	0
6	9-Apr-08	1	2	2E	22	09:25	1	0.00	0
7	10-Apr-08	1	5	5H	19	07:46	1	0.00	0
7	10-Apr-08	1	5	5H	15	07:50	2	0.00	0
7	10-Apr-08	1	5	5H	20	07:55	4	0.00	0
7	10-Apr-08	1	5	5H	20	08:00	5	0.00	0
7	10-Apr-08	1	5	5H	12	08:05	3	0.00	0
7	10-Apr-08	1	5	5H	7	08:10	6	0.00	0
8	10-Apr-08	1	5	5G	13	09:18	6	0.28	1
8	10-Apr-08	1	5	5G	11	09:22	3	0.00	0
8	10-Apr-08	1	5	5G	13	09:27	5	0.00	0
8	10-Apr-08	1	5	5G	14	09:30	4	0.00	0

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod Weight (kg)	Number of fish
8	10-Apr-08	1	5	5G	13	09:33	2	1.40	4
8	10-Apr-08	1	5	5G	15	09:36	1	0.82	1
9	10-Apr-08	1	5	5B	14	10:48	1	0.77	1
9	10-Apr-08	1	5	5B	13	10:52	2	0.00	0
9	10-Apr-08	1	5	5B	18	10:55	4	0.00	0
9	10-Apr-08	1	5	5B	13	10:59	5	0.00	0
9	10-Apr-08	1	5	5B	11	11:03	3	1.21	1
9	10-Apr-08	1	5	5B	14	11:07	6	5.44	7
10	10-Apr-08	1	5	5C	28	12:18	6	0.00	0
10	10-Apr-08	1	5	5C	29	12:23	3	0.00	0
10	10-Apr-08	1	5	5C	31	12:26	5	0.00	0
10	10-Apr-08	1	5	5C	25	12:30	4	0.00	0
10	10-Apr-08	1	5	5C	23	12:33	2	0.00	0
10	10-Apr-08	1	5	5C	21	12:37	1	9.90	14
11	10-Apr-08	1	5	5E	21	13:46	1	1.70	3
11	10-Apr-08	1	5	5E	19	13:50	2	5.60	12
11	10-Apr-08	1	5	5E	18	13:52	4	3.26	10
11	10-Apr-08	1	5	5E	14	13:56	5	0.72	3
11	10-Apr-08	1	5	5E	15	13:59	3	1.47	4
11	10-Apr-08	1	5	5E	16	14:04	6	1.90	5
12	11-Apr-08	1	4	4I	23	07:42	6	4.57	13
12	11-Apr-08	1	4	4I	19	07:47	3	4.89	6
12	11-Apr-08	1	4	4I	22	07:52	5	0.27	2
12	11-Apr-08	1	4	4I	14	07:58	4	0.24	1
12	11-Apr-08	1	4	4I	13	08:05	2	0.41	1
12	11-Apr-08	1	4	4I	14	08:08	1	0.73	1
13	11-Apr-08	1	4	4H	6	09:58	1	0.00	0
13	11-Apr-08	1	4	4H	11	10:03	2	0.83	2
13	11-Apr-08	1	4	4H	13	10:05	4	2.26	5
13	11-Apr-08	1	4	4H	13	10:10	5	1.24	2
13	11-Apr-08	1	4	4H	15	10:15	3	0.00	0
13	11-Apr-08	1	4	4H	20	10:19	6	0.00	0
14	11-Apr-08	1	4	4F	20	11:27	6	7.20	12
14	11-Apr-08	1	4	4F	17	11:31	3	1.11	1
14	11-Apr-08	1	4	4F	19	11:34	5	12.03	18
14	11-Apr-08	1	4	4F	19	11:37	4	5.21	7
14	11-Apr-08	1	4	4F	17	11:40	2	1.43	5
14	11-Apr-08	1	4	4F	16	11:44	1	5.12	6
15	11-Apr-08	1	4	4C	34	13:39	1	0.00	0
15	11-Apr-08	1	4	4C	30	13:43	2	0.31	1
15	11-Apr-08	1	4	4C	25	13:45	4	0.00	0
15	11-Apr-08	1	4	4C	22	13:18	5	4.24	8
15	11-Apr-08	1	4	4C	20	13:52	3	5.95	13
15	11-Apr-08	1	4	4C	17	13:56	6	1.27	4
16	13-Apr-08	1	3	3K	26	07:25	6	0.00	0
16	13-Apr-08	1	3	3K	27	07:31	3	0.00	0
16	13-Apr-08	1	3	3K	24	07:35	5	0.00	0
16	13-Apr-08	1	3	3K	24	07:38	4	0.00	0

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod Weight (kg)	Number of fish
16	13-Apr-08	1	3	3K	25	07:43	2	0.00	0
16	13-Apr-08	1	3	3K	24	07:47	1	0.00	0
17	13-Apr-08	1	4	4B	28	08:55	1	5.69	13
17	13-Apr-08	1	4	4B	29	08:58	2	1.39	7
17	13-Apr-08	1	4	4B	36	09:02	4	0.00	0
17	13-Apr-08	1	4	4B	40	09:07	5	0.00	0
17	13-Apr-08	1	4	4B	37	09:11	3	0.93	2
17	13-Apr-08	1	4	4B	32	09:15	6	1.82	4
18	13-Apr-08	1	3	3H	27	11:16	6	0.00	0
18	13-Apr-08	1	3	3H	28	10:51	3	0.00	0
18	13-Apr-08	1	3	3H	26	10:55	5	0.71	4
18	13-Apr-08	1	3	3H	31	10:59	4	0.00	0
18	13-Apr-08	1	3	3H	33	11:00	2	3.71	14
18	13-Apr-08	1	3	3H	35	11:04	1	0.00	0
19	13-Apr-08	1	3	3E	27	12:28	1	0.61	1
19	13-Apr-08	1	3	3E	26	12:32	2	0.77	4
19	13-Apr-08	1	3	3E	26	12:35	4	1.21	3
19	13-Apr-08	1	3	3E	28	12:38	5	1.45	4
19	13-Apr-08	1	3	3E	24	12:42	3	0.84	3
19	13-Apr-08	1	3	3E	22	12:46	6	1.34	2
20	14-Apr-08	1	3	3C	20	07:10	6	0.00	0
20	14-Apr-08	1	3	3C	23	07:13	3	2.80	9
20	14-Apr-08	1	3	3C	22	07:15	5	2.57	10
20	14-Apr-08	1	3	3C	23	07:19	2	5.45	14
20	14-Apr-08	1	3	3C	24	07:24	4	3.77	9
20	14-Apr-08	1	3	3C	22	07:29	1	1.04	2
21	14-Apr-08	1	3	3B	25	09:10	1	2.03	3
21	14-Apr-08	1	3	3B	25	09:13	4	0.00	0
21	14-Apr-08	1	3	3B	26	09:16	2	0.39	1
21	14-Apr-08	1	3	3B	24	09:20	5	2.38	6
21	14-Apr-08	1	3	3B	27	09:24	3	0.80	2
21	14-Apr-08	1	3	3B	33	09:28	6	0.60	2
22	14-Apr-08	1	1	1J	25	11:28	6	0.00	0
22	14-Apr-08	1	1	1J	23	11:33	3	0.47	2
22	14-Apr-08	1	1	1J	21	11:36	5	1.31	6
22	14-Apr-08	1	1	1J	21	11:39	2	1.37	4
22	14-Apr-08	1	1	1J	20	11:44	4	0.17	1
22	14-Apr-08	1	1	1J	23	11:47	1	1.72	3
23	14-Apr-08	1	2	2A	28	12:57	1	0.38	1
23	14-Apr-08	1	2	2A	30	13:00	4	0.00	0
23	14-Apr-08	1	2	2A	28	13:03	2	0.73	1
23	14-Apr-08	1	2	2A	30	13:06	5	0.86	4
23	14-Apr-08	1	2	2A	31	13:10	3	0.00	0
23	14-Apr-08	1	2	2A	33	13:13	6	0.00	0
24	16-Apr-08	1	7	7L	76	08:22	1	5.27	8
24	16-Apr-08	1	7	7L	74	08:27	2	10.84	12
24	16-Apr-08	1	7	7L	76	08:32	3	2.79	3
24	16-Apr-08	1	7	7L	75	08:37	4	1.39	4

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod Weight (kg)	Number of fish
24	16-Apr-08	1	7	7L	76	08:43	5	1.17	1
24	16-Apr-08	1	7	7L	77	08:50	6	6.81	6
25	16-Apr-08	1	7	7I	81	10:33	6	7.04	6
25	16-Apr-08	1	7	7I	82	10:36	5	4.15	6
25	16-Apr-08	1	7	7I	81	10:40	4	7.27	8
25	16-Apr-08	1	7	7I	79	10:43	3	2.40	3
25	16-Apr-08	1	7	7I	78	10:47	2	1.75	2
25	16-Apr-08	1	7	7I	78	10:54	1	0.37	1
26	16-Apr-08	1	7	7G	77	12:06	1	0.00	0
26	16-Apr-08	1	7	7G	78	12:10	2	0.00	0
26	16-Apr-08	1	7	7G	77	12:15	3	0.00	0
26	16-Apr-08	1	7	7G	77	12:19	4	0.01	1
26	16-Apr-08	1	7	7G	78	12:23	5	0.00	0
26	16-Apr-08	1	7	7G	78	12:28	6	0.00	0
27	16-Apr-08	1	7	7D	75	13:40	6	4.16	6
27	16-Apr-08	1	7	7D	76	13:44	5	11.95	7
27	16-Apr-08	1	7	7D	76	13:48	4	4.21	5
27	16-Apr-08	1	7	7D	74	13:52	3	6.47	4
27	16-Apr-08	1	7	7D	75	13:56	2	13.60	8
27	16-Apr-08	1	7	7D	77	14:03	1	5.27	4
28	16-Apr-08	1	7	7B	75	15:25	3	0.00	0
28	16-Apr-08	1	7	7B	75	15:30	4	0.00	0
28	16-Apr-08	1	7	7B	74	15:15	1	0.32	2
28	16-Apr-08	1	7	7B	75	15:20	2	0.00	0
28	16-Apr-08	1	7	7B	75	15:35	5	0.00	0
28	16-Apr-08	1	7	7B	75	15:40	6	3.75	4
29	17-Apr-08	1	6	6K	85	08:25	4	15.70	13
29	17-Apr-08	1	6	6K	83	08:30	6	7.05	4
29	17-Apr-08	1	6	6K	82	08:35	5	11.22	7
29	17-Apr-08	1	6	6K	81	08:40	3	2.83	2
29	17-Apr-08	1	6	6K	81	08:45	2	3.69	2
29	17-Apr-08	1	6	6K	81	08:50	1	8.52	5
30	17-Apr-08	1	6	6I	85	10:35	1	3.68	4
30	17-Apr-08	1	6	6I	87	10:40	2	12.69	10
30	17-Apr-08	1	6	6I	86	10:45	3	2.71	3
30	17-Apr-08	1	6	6I	86	10:50	5	5.75	6
30	17-Apr-08	1	6	6I	84	10:55	6	7.72	6
30	17-Apr-08	1	6	6I	84	11:00	4	8.69	6
31	17-Apr-08	1	6	6E	83	12:55	4	0.00	0
31	17-Apr-08	1	6	6E	83	13:00	6	8.31	6
31	17-Apr-08	1	6	6E	84	13:05	5	0.40	1
31	17-Apr-08	1	6	6E	83	13:10	3	3.64	2
31	17-Apr-08	1	6	6E	79	13:15	2	9.64	5
31	17-Apr-08	1	6	6E	77	13:20	1	8.14	5
32	17-Apr-08	1	6	6D	78	14:30	1	4.32	4
32	17-Apr-08	1	6	6D	78	14:35	2	12.19	11
32	17-Apr-08	1	6	6D	78	14:40	3	0.00	0
32	17-Apr-08	1	6	6D	80	14:45	5	3.25	3

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod Weight (kg)	Number of fish
32	17-Apr-08	1	6	6D	83	14:50	6	7.19	9
32	17-Apr-08	1	6	6D	84	14:55	4	17.05	10
33	17-Apr-08	1	6	6B	84	16:05	4	4.38	2
33	17-Apr-08	1	6	6B	83	16:10	6	2.10	1
33	17-Apr-08	1	6	6B	83	16:15	5	5.55	6
33	17-Apr-08	1	6	6B	82	16:20	3	3.51	2
33	17-Apr-08	1	6	6B	83	16:25	2	1.72	1
33	17-Apr-08	1	6	6B	85	16:25	1	0.00	0
34	22-Apr-08	1	2	2L	35	07:32	3	0.00	0
34	22-Apr-08	1	2	2L	37	07:37	1	0.00	0
34	22-Apr-08	1	2	2L	38	07:40	5	0.00	0
34	22-Apr-08	1	2	2L	38	07:45	4	0.00	0
34	22-Apr-08	1	2	2L	37	07:50	6	0.00	0
34	22-Apr-08	1	2	2L	38	07:55	2	0.00	0
35	23-Apr-08	1	2	2K	25	07:40	2	0.00	0
35	23-Apr-08	1	2	2K	26	07:45	6	0.00	0
35	23-Apr-08	1	2	2K	26	07:50	4	0.00	0
35	23-Apr-08	1	2	2K	25	07:55	5	0.00	0
35	23-Apr-08	1	2	2K	26	08:00	1	0.00	0
35	23-Apr-08	1	2	2K	26	08:05	3	0.00	0
36	25-Apr-08	2	7	7J	77	09:16	2	0.93	3
36	25-Apr-08	2	7	7J	75	09:21	4	1.57	2
36	25-Apr-08	2	7	7J	76	09:25	6	4.46	5
36	25-Apr-08	2	7	7J	78	09:32	3	4.60	7
36	25-Apr-08	2	7	7J	74	09:38	5	3.30	4
36	25-Apr-08	2	7	7J	77	09:45	1	7.83	8
37	25-Apr-08	2	7	7F	78	11:35	1	0.00	0
37	25-Apr-08	2	7	7F	76	11:40	5	0.01	1
37	25-Apr-08	2	7	7F	75	11:44	3	0.00	0
37	25-Apr-08	2	7	7F	76	12:54	*2B	0.00	0
37	25-Apr-08	2	7	7F	77	11:55	4	2.85	4
37	25-Apr-08	2	7	7F	74	11:58	2	5.03	5
38	5-May-08	2	6	6J	84	09:25	4	0.01	1
38	5-May-08	2	6	6J	82	09:32	**6	0.00	0
38	5-May-08	2	6	6J	78	09:41	3	2.92	4
38	5-May-08	2	6	6J	79	09:47	5	10.59	7
38	5-May-08	2	6	6J	81	09:56	2	3.84	3
38	5-May-08	2	6	6J	82	10:02	1	1.07	1
39	5-May-08	2	6	6F	84	11:05	1	9.67	7
39	5-May-08	2	6	6F	81	11:10	2	3.05	4
39	5-May-08	2	6	6F	81	11:15	5	9.13	6
39	5-May-08	2	6	6F	80	11:20	3	9.07	9
39	5-May-08	2	6	6F	81	11:25	**6	3.60	2
39	5-May-08	2	6	6F	84	11:30	4	9.60	9
40	5-May-08	2	6	6C	84	12:40	4	4.12	4
40	5-May-08	2	6	6C	85	12:45	**6	10.86	7
40	5-May-08	2	6	6C	86	12:50	3	5.64	5
40	5-May-08	2	6	6C	86	12:55	5	8.96	3

Set	Date	Phase	Stratum	Pot lift station	Depth (m)	Time set	Pot number	Catch of blue cod Weight (kg)	Number of fish
40	5-May-08	2	6	6C	82	12:55	2	4.69	6
40	5-May-08	2	6	6C	83	12:59	1	0.00	0
	TOTALS							578	726

Appendix 3: Summary of 2008 Banks Peninsula survey oceanographic environmental station data recorded in the format of MFish trawl data base. Depths are measured in metres, directions in compass degrees (999 = nil), wind force in the Beaufort scale, temperatures in degrees celsius, air pressure in millibars, cloud cover in oktas, sea condition in the Douglas scale, sea colour in a categorical scale from 1 (deep blue) to 8 (yellow green), swell height in the Douglas classification 1 (low) to 3 (heavy), bottom type in a categorical scale from 1 (mud or ooze) to 9 (stone), bottom contour in a categorical scale from 1 (smooth/flat) to 5 (very rugged), and wind speed in metres per second.

Set	Average depth	Wind direction	Wind force	Air temp	Air pressure	Cloud cover	Sea condition	Sea colour	Swell height	Swell direction	Bottom type	Bottom contour	Surface temp	Bottom temp	Wind speed	Secchi depth
1	25.7	255	0	15.5	1011	8	2	03	0.50	135	7	3	15.0	14.5	1.5	4.8
2	19.2	255	2	16.8	1015	7	2	03	0.50	135	7	3	15.0	14.5	7.0	4.5
3	24.2	255	0	18.8	1018	7	2	03	0.50	135	7	3	15.0	15.0	0.0	5.1
4	26.5	220	2	14.5	1018	7	2	03	1.00	135	7	4	15.0	15.0	9.5	4.8
5	25.2	180	3	13.9	1018	7	4	03	2.00	180	7	3	14.8	14.7	17.6	2.5
6	21.7	180	2	15.6	1018	7	4	03	2.00	180	7	2	15.0	15.0	3.6	2.8
7	15.5	165	1	17.5	1019	3	2	08	1.50	180	7	2	14.8	14.5	4.6	1.3
8	13.2	000	1	17.5	1019	4	2	08	1.50	180	7	2	15.0	14.5	7.5	2.2
9	13.8	000	2	18.7	1019	3	3	07	2.00	180	7	4	15.0	14.8	8.5	1.4
10	26.2	000	2	19.5	1020	3	3	08	2.00	180	7	5	15.0	14.5	10.2	1.2
11	17.2	090	2	22.5	1020	4	3	07	2.00	180	7	2	15.0	14.5	12.0	2.4
12	17.5	180	1	14.1	1018	8	4	06	1.50	180	7	2	15.0	14.7	2.5	2.3
13	13.0	180	1	15.0	1018	8	3	06	1.00	180	7	3	15.0	14.7	3.5	2.5
14	18.0	180	2	15.9	1014	8	3	06	1.50	180	7	3	15.0	14.7	11.5	2.7
15	24.7	180	1	17.4	1013	8	3	03	1.50	235	7	5	14.9	14.7	4.1	2.6
16	25.0	330	1	15.1	1021	3	3	06	2.00	180	7	2	14.5	14.0	8.0	2.8
17	33.7	030	3	17.1	1021	2	2	06	2.00	180	7	4	14.5	14.0	16.0	2.8
18	30.0	025	4	20.0	1021	2	2	06	1.50	180	7	3	14.5	14.3	21.4	2.3
19	25.5	025	3	22.1	1020	2	3	07	2.00	180	7	3	14.5	14.2	13.5	2.2
20	22.3	045	3	13.8	1016	3	2	06	1.50	090	7	3	14.5	14.2	13.5	2.8
21	26.7	075	3	18.1	1016	3	3	03	1.50	135	7	4	14.7	14.3	16.5	2.5
22	22.2	070	2	21.3	1013	2	2	03	1.25	135	7	2	15.0	14.5	8.5	3.5
23	30.0	070	3	20.7	1011	2	2	05	1.50	135	7	3	14.5	14.5	17.5	2.8
24	75.7	225	3	14.3	1009	8	3	06	2.00	045	7	2	14.6	14.4	14.0	7.4
25	79.8	225	3	15.4	1009	8	3	06	2.00	045	7	2	14.6	14.4	19.5	7.2
26	77.5	225	3	15.6	1009	8	3	06	2.00	045	7	2	14.5	14.4	13.0	7.0
27	75.5	225	3	15.4	1008	8	3	06	1.50	045	7	2	14.6	14.3	13.5	7.3

Appendix 3–*continued*

Set	Average depth	Wind direction	Wind force	Air temp	Air pressure	Cloud cover	Sea condition	Sea colour	Swell height	Swell direction	Bottom type	Bottom contour	Surface temp	Bottom temp	Wind speed	Secchi depth
28	74.8	225	1	15.5	1008	8	3	06	1.50	045	7	2	14.5	14.4	5.6	7.8
29	82.2	180	3	14.5	1003	3	3	01	1.00	045	7	4	14.4	14.2	13.2	10.2
30	85.3	180	3	15.7	1002	7	3	01	1.00	045	7	4	14.5	14.2	17.9	9.5
31	81.5	180	3	17.5	1000	7	3	01	1.00	045	7	4	14.5	14.2	15.3	8.5
32	80.2	180	4	16.4	0999	8	3	01	1.00	045	7	4	14.5	14.2	20.4	9.7
33	83.3	180	2	16.0	0998	8	3	01	1.00	045	7	4	14.5	14.2	8.0	9.2
34	37.2	180	4	11.7	0998	8	5	08	4.00	180	7	3	14.5	14.2	26.4	1.3
35	25.7	180	3	10.9	0995	8	5	08	4.00	180	7	3	14.2	14.0	15.5	0.8
36	76.2	135	1	14.1	1010	8	4	06	4.00	180	7	2	13.2	13.0	2.1	7.4
37	76.0	135	1	15.4	1010	8	4	06	4.00	180	7	2	13.2	13.0	5.4	7.8
38	81.0	180	2	11.5	1030	3	3	01	3.00	180	7	4	12.5	12.0	11.2	8.2
39	81.8	180	2	13.6	1029	3	3	01	3.00	180	7	4	12.5	12.1	12.3	9.6
40	84.3	180	1	17.1	1028	1	3	01	3.50	180	7	4	12.6	12.3	2.5	9.3

Appendix 4: Between-reader comparisons (using first readings only) for otolith data collected in the 2008 Banks Peninsula survey.

Reader two															Age class (reader one)						
difference	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	Total
-15																				1	1
-13																				1	1
-11																				3	3
-10																				1	1
-9																		1		3	4
-8																1			1	8	10
-7															1			1	1	4	7
-6													1					3		3	7
-5											1			1	1		1			3	7
-4								1			1	2	1	1	4	2	2	1		2	17
-3							1		3		2	2	1	2	1		1	1			14
-2				2		1	3	4	2	2	5	5		5	1		1			1	32
-1		1	15	12	20	10	11	9	2	3	1		2			2	1			1	90
0		7	19	32	13	7	7	8	4	3	3	2	1	1	4	1	1				113
1			1			2			1	1	1	1				1					8
Total		8	35	46	33	20	22	22	12	9	14	12	6	10	12	7	7	7	2	31	315
% agreement		88	54	70	39	35	32	36	33	33	21	17	17	10	33	14	14	0	0	0	35.9

Appendix 5: Reader comparisons with agreed age from otolith data collected in the 2008 Banks Peninsula survey.

Reader one	Agreed age class																			
difference	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	Total
-6																				1	1
-4																				2	2
-3												1									1
-1				2	2	1		1												2	8
0		8	33	43	31	20	21	20	9	9	13	12	6	10	9	5	5	5	1	14	274
1			1	1			2	2		1				2	2	2	1			3	17
2																1		2		5	8
3																1		1	1		3
4																			1		1
Total		8	34	46	33	21	23	23	9	10	13	13	6	12	11	9	6	8	3	27	315
% agreement		100	97	93	94	95	91	87	100	90	100	92	100	83	82	56	83	63	33	52	87

Reader two	Agreed age class																			
difference	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	Total
-15																				1	1
-14																				1	1
-13																				1	1
-12																				1	1
-11																				1	1
-10																				1	1
-9																		1		3	4
-8																1			1	6	8
-7															1			1			2
-6													1					1		4	6
-5											1			1			2	2	1	4	11
-4								1			1	3	1	2	3	3	1	1		2	18
-3							1		2		2	2	1	3	1	1	1	2	1		17
-2				3	2	2	3	6	1	2	5	5		5	1		1			1	37
-1		1	14	10	18	10	10	8	1	3			2			1				1	79
0		7	19	33	13	7	9	8	4	4	3	2	1	1	5	2	1				119
1			1			2			1	1	1	1				1					8
Total		8	34	46	33	21	23	23	9	10	13	13	6	12	11	9	6	8	3	27	315
% agreement		88	56	72	39	33	39	35	44	40	23	15	17	8	45	22	17	0	0	0	38

Appendix 6: Age length key for all strata and both sexes combined for the 2008 Banks Peninsula survey.

	Age (years)																			
Length (cm)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	19>	No. aged
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
18	0.17	0.83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
19	0.4	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
20	0.1	0.8	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
21	0.1	0.7	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
22	0	0.6	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
23	0	0.1	0.6	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
24	0	0.3	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
25	0	0.22	0.67	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
26	0	0.11	0.78	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
27	0	0	0.71	0.29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
28	0	0	0.27	0.64	0	0	0.09	0	0	0	0	0	0	0	0	0	0	0	0	11
29	0	0	0.3	0.6	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	10
30	0	0	0.33	0.56	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	9
31	0	0	0.09	0.18	0.45	0.27	0	0	0	0	0	0	0	0	0	0	0	0	0	11
32	0	0	0.09	0.18	0.27	0.18	0.18	0.09	0	0	0	0	0	0	0	0	0	0	0	11
33	0	0	0	0.25	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	8
34	0	0	0	0.2	0.4	0.1	0.2	0.1	0	0	0	0	0	0	0	0	0	0	0	10
35	0	0	0	0	0.27	0.18	0.18	0	0.09	0.09	0	0.09	0	0.09	0	0	0	0	0	11
36	0	0	0	0	0.2	0	0.2	0.2	0	0.1	0.2	0.1	0	0	0	0	0	0	0	10
37	0	0	0	0	0.3	0.2	0	0	0.2	0.1	0.2	0	0	0	0	0	0	0	0	10
38	0	0	0	0	0	0.25	0.25	0	0	0	0.25	0	0	0.12	0.12	0	0	0	0	8
39	0	0	0	0	0	0	0.5	0	0	0.12	0	0	0.38	0	0	0	0	0	0	8
40	0	0	0	0	0	0.2	0.2	0	0	0.1	0	0.1	0.2	0.1	0	0	0.1	0	0	10
41	0	0	0	0	0	0.17	0.17	0	0	0.17	0.17	0	0	0	0.17	0.17	0	0	0	6
42	0	0	0	0	0	0	0.2	0.1	0.2	0.2	0	0	0.1	0	0	0.1	0.1	0	0	10
43	0	0	0	0	0	0.1	0.1	0	0.3	0	0	0	0	0.1	0.1	0	0	0	0.3	10
44	0	0	0	0	0	0	0.11	0.11	0	0.33	0.11	0	0	0.11	0.11	0	0	0.11	0	9
45	0	0	0	0	0	0	0	0.08	0.08	0.08	0.08	0	0.17	0.08	0	0	0.17	0	0.24	12
46	0	0	0	0	0	0	0	0.29	0.14	0	0.14	0	0.14	0.14	0	0	0	0	0.14	7
47	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0.1	0.1	0.1	0	0	0.2	0.3	10
48	0	0	0	0	0	0	0	0	0	0	0	0.2	0.2	0.1	0.1	0	0	0	0.4	10
49	0	0	0	0	0	0	0	0	0	0	0	0.17	0	0	0.17	0.17	0.33	0	0.17	6
50	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0.25	0	0	0	0.25	4
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.4	0.2	0	0.2	5
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0.8	5
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0.5	2
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0.75	4
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0.5	2
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total																				315