Abundance, size composition, and sex ratio of blue cod in the Marlborough Sounds, September 1995

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Introduction

This report is part of the requirements of the Ministry of Fisheries contract CEBC02 "Determination of the size and age distribution and the reproductive biology of blue cod in the Marlborough Sounds". The report describes the first of two surveys carried out in September 1995 and September 1996. These surveys describe the length distribution and relative abundance of blue cod in the Marlborough Sounds, to provide background information for a review of the management of this fishery. Fishery assessments for this fishstock have been based on data collected almost 60 years ago (Rapson 1956), as little recent information is available to assess appropriate management measures. This project updates the biology of blue cod in the Marlborough Sounds.

Blue cod (*Parapercis colias* Forster), is one of the most important recreational target finfish species in the Challenger area (Kilner & Bell 1992). It is the most important recreational finfish species in the Marlborough Sounds and also supports a small commercial fishery which is confined to the outer Marlborough Sounds. The fishery is widely considered to be overfished (Annala & Sullivan 1996).

Blue cod may exhibit protogynous hermaphroditism (Mutch 1983, Sadovy & Shapiro 1987), but current data are equivocal. The reproductive capacity of such species may be reduced under heavy fishing pressure (Hunstman & Schaaf 1994), which has management implications for this fishstock. This report reviews the relationships between length and reproductive state, and examines the minimum size at sexual maturity which has implications for regulatory size limits. Otoliths were collected to provide input to a yield per recruit model. The report provides data on relative catch per unit effort (CPUE) and size structure, which may indicate variations in fishing intensity within the Marlborough Sounds.

Project objectives

1. To determine the size distribution of blue cod at selected sites throughout the Marlborough Sounds.
2. To determine the sex ratios of blue cod in various length classes.
3. To determine the length of blue cod at sexual maturity.
4. To review the relationship between length, reproductive state, and age of blue cod in the Marlborough Sounds.

Project and voyage personnel

The first of two blue cod potting and lining surveys (LHR9501) was carried out between 4 and 14 September 1995 under contract to the Ministry of Fisheries. The project leader was Ron Blackwell, who was also responsible for database editing and the provision of the final report. Craig Aston was the skipper of the FV *Lady H.R.* chartered for the sampling programme.

Survey area

The Marlborough Sounds (Figure 1) are a series of drowned valleys at the northeastern end of the South Island of New Zealand. The two major sounds within this area (Queen Charlotte and Pelorus) have complex coastlines that provide a wide variety of habitats, from sheltered reefs to exposed rocky coasts and offshore islands. Queen Charlotte Sound is characterised by complex tidal current patterns and has no major freshwater input. Intrusions of cold, nutrient-rich water from the adjacent deep waters of Cook Strait enter through the mouth of the Sound and also through Tory Channel to the southeast (Heath 1974).

Although Pelorus Sound is also influenced by this cold water at the mouth, the effect is moderated by the intrusion of warmer, less nutrient-rich tidal currents from Tasman Bay that enter through French Pass. Pelorus Sound is strongly influenced by the major freshwater input of the Pelorus River (Heath 1982).

Blue cod biology

Blue cod are distributed widely throughout New Zealand and the Chatham Islands, especially around rocky reefs, exposed rocky coasts, and offshore islands, generally to a depth of about 150 m (Ayling & Cox 1982). Blue cod is classified within the Family Pinguipedidae which includes weevers and torrent fish in New Zealand. Blue cod are not closely related to the true cod (Family Gadidae) (Paulin *et al.* 1989).

Within the Marlborough Sounds, blue cod are locally abundant over loose rubble and rock on the reefs and drop-offs that are commonly found in a 70–90 m wide strip from mean low water (Mace & Johnston 1983). It has been suggested (C. Aston, commercial fisher, Nelson, pers. comm. 1995) that large blue cod are common in the Outer Sounds, particularly around D'Urville Island.

The catchability of blue cod may vary with tide (Mace & Johnston 1983). Blue cod may exhibit complex small scale migratory behaviour, in response to tidal currents (Mace & Johnston 1983), suspended sediment following heavy surf action, or after significant river flooding (Rapson 1956). Within these migratory patterns, complex spatial interactions may occur, which break down in the presence of food (G. Carbines, NIWA, Dunedin, pers. comm. 1995). Recent diver and remote video observations suggest that blue cod may be more active during the early morning and late afternoon (K. Grange, NIWA, Nelson, pers.comm. 1995).

Blue cod may exhibit protogynous hermaphroditism (Rapson 1956, Mutch 1983), in which fish initially mature as females, then change sex to become functional males, but the evidence for this is equivocal.

Sexual maturity occurs between 10 and 19 cm (total length) and at an age of about 2 years (Annala & Sullivan 1996). Spawning occurs in late winter/early spring in the Marlborough Sounds (Rapson 1956), but a more extended spawning season is known elsewhere (Mutch 1983, Pankhurst & Conroy 1987). Spawning aggregations have been reported in inshore waters (Rapson 1956) and mid-shelf waters (Robertson 1973). Rapson (1956) noted that spawning aggregations occur at the Rangitoto Islands, D'Urville Island, and the Trio Island Banks. Blue cod may undertake spawning migrations (Rapson 1956, Robertson 1973); however, ripe blue cod are found in all areas fished by commercial fishers (McGregor 1988, Annala & Sullivan 1996).

Growth is rapid until the end of the first year (Ayling & Cox 1982). Subsequent growth is slower as fish tend to increase in weight rather than length (Rapson 1956, Mutch 1983). From tagging data, a 33 cm fish would be about 5 years old, and a 36 cm fish about 6 years old (Mace & Johnston 1983). Rapson (1956) estimated that blue cod reach a maximum age of 12–17 years, but the annuli in blue cod otoliths have not been validated.

The Marlborough Sounds blue cod fishery

The Marlborough Sounds blue cod commercial fishery is managed under the Quota Management System (QMS) as part of the Challenger blue cod fishstock (BCO 7). No estimates of current and reference biomass, or current annual yield (CAY) are available for this fishstock (Annala & Sullivan 1996). Maximum constant yield (MCY) was estimated at 83 t (rounded to 85 t), using the $Y_{average}$ method, based on the average commercial landings between 1983 and 1986, and assuming a natural mortality (M) of between 0.27 and 0.38 (Annala & Sullivan 1996). Annala (1995) noted that whilst the MCY estimate is probably conservative, it is not known whether the combined commercial and recreational catches are sustainable, or if they are at levels that would allow the stock to move towards a size that would support the maximum sustainable yield (MSY).

The 1994–95 Total Allowable Commercial Catch (TACC) of 70 t was reduced in 1992 from 136 t (Annala 1995). The TACC has constrained the fishery (Annala & Sullivan 1996) and target fishing has declined. Within the Marlborough Sounds, target cod potting now occurs off Stephens and D'Urville Island (Warren 1994). Juvenile blue cod are not caught by commercial potting or lining and are not vulnerable to the main commercial fishing methods until they are sexually mature (Annala & Sullivan 1996). Most of the commercial landing of 67 t (1993–94) within the Marlborough Sounds was taken as bycatch of trawling for flatfish and snapper (Warren 1994).

Blue cod was the most important recreational target finfish species (by numbers caught) in the Marlborough Sounds from the 1991 Central Region Recreational Catch and Effort Diary Survey (Teirney & Kilner 1996) and the 1992 Central Region Recreational Linking Survey (Blackwell 1996). Recreational catch estimates of 72 t (1992–93) exceed both the current TACC and recent commercial catches (Annala & Sullivan 1996).

This fishery is widely considered to be overfished (Mace & Johnston 1983, Kilner & Bell 1992, Annala & Sullivan 1996). Recreational fishers report decreased catch rates, local depletion, and a high proportion of undersized fish (L. Bull, recreational fisher, Nelson, pers. comm. 1996).

In 1993, the amateur bag limit for the Marlborough Sounds was reduced from 30 to a combined total of 20 fish, including blue cod. The minimum size was increased from 30 to 33 cm for both amateur and commercial fishers. In 1994, the daily amateur bag limit within the Marlborough Sounds was further reduced to six blue cod and the size limit was reduced to 28 cm (Annala & Sullivan 1996). A Code of Practice has been developed (Anon 1993) to reduce the incidental mortality of undersized blue cod, and the effects of hook size and handling treatment on the post-capture survival of blue cod in the Marlborough Sounds have recently been reviewed (G. Carbines, NIWA, Dunedin, unpublished results).

Methods

Survey area

A pot and line fishing survey of the Marlborough Sounds was carried out in September 1995. Limited survey time and vessel availability precluded sampling the entire Marlborough Sounds. Sampling was concentrated in Queen Charlotte Sound as the level of recreational fishing effort during 1993–94 in this area was almost three times that in Pelorus Sound (Teirney & Kilner 1996).

Within Queen Charlotte Sound (Figure 2), recreational fishers advised that because of silt build-up on the reefs inside a line from "The Snout" (Waikawa Bay) to Allports Island to Pihaka Point, few areas of suitable blue cod habitat currently exist. This area was excluded from the survey. The seaward limits of the survey area were taken as a line between Cape Koamaru, Cape Jackson and Alligator Head, including Tory Channel inside East Head and West Head (Figure 2).

Within Pelorus Sound, the seaward limits of the survey area were taken as a line from Alligator Point, to the Chetwode Islands, then to Clay Point (Figure 2). The Inner Pelorus Sound south of The Reef was not sampled during the 1995 survey.

Sampling methodology and survey design

Line fishing is the most common target recreational fishing method for blue cod in the Marlborough Sounds (Teirney & Kilner 1996), but anecdotal information suggested that catch rates in the inner Marlborough Sounds would be too low to provide the numbers of blue cod required for age and sex determination. Commercial blue cod fishers advised that the purpose-designed pots used in this fishery were capable of catching the required numbers of blue cod. Davidson (1995) suggested that blue cod in the inner Marlborough Sounds may be pot-shy, so a combination of cod potting and lining methods was used in this survey to compare the effectiveness of these methods.

Sampling was undertaken at the peak of the local spawning season (C. Aston, pers. comm. 1995). Blue cod habitat within the Marlborough Sounds was taken to include all possible sites within a band about 10–60 m deep.

The survey area was divided into five strata, based on the relative level of recreational fishing effort: IQCH (Inner Queen Charlotte); OQCH (Outer Queen Charlotte); EQCH (Extreme Outer Queen Charlotte); OPEL (Outer Pelorus); EOPE (Extreme Outer Pelorus) (Table 1). Inner Pelorus Sound (IPEL) was not sampled in the 1995 survey. These strata will be referred to by their acronyms in this report.

Within each of these strata, eight areas of suitable habitat were identified, based upon habitat and anecdotal advice. Of these, four areas (A–D) were selected using random number tables. The areas sampled are shown in Figure 2.

Previous studies (K. Grange, NIWA, Nelson, pers.comm. 1995) suggested that the time of day may affect blue cod availability and hence numbers caught by potting. To examine this effect, the time of sampling was randomly allocated. Two days were required to complete the four sampling areas within each stratum. Two of these areas were sampled during the morning, and two were sampled during the afternoon.

Within each of these four main sampling areas, the nine pots on the vessel were sequentially set and retrieved as three replicate pots (a–c), fished at each of three sites (1–3).

A lag effect may occur in the time required for baited cod pots to attract blue cod (C. Aston, pers. comm. 1995) which may influence the effective soak time. This effect was examined by standardising soak (fishing) time at 1 h, and by repeating the fishing for a second hour at each sampling station, using re-baited pots. In Table 1, pot stations a–c thus represent the initial stations and pot stations d–f represent the repeated stations for each of the three sites within a sampling area.

To provide a comparison between catch rates from potting and lining methods, two line fishing stations (g and h) were established (Table 1) adjacent to the first (a) and last (c) potting stations at each of the three sites within each area and stratum.

L. Bull, (recreational fisher, Nelson, pers. comm. 1995) suggested that blue cod density was likely to be low in some areas. Additional sampling stations (see Table 1, Figure 2) were thus established to ensure that sufficient blue cod would be available for biological sampling, gonad maturity determination, and otolith collection. Repeat potting and line fishing were not routinely carried out. These stations have not been included in catch rate analyses.

Vessel and gear specifications

The commercial vessel FV *Lady H.R.*, complete with cod pots, was chartered for the survey. The vessel is 9.6 m, with a 3.2 m beam and a displacement of 10 t. It is powered by a 60 kilowatt Ford diesel and is fitted with power hauling gear for cod pot fishing. It has a Koden colour depth sounder. For the survey it was equipped with a voltage inverter to power the 5 kg motion-compensating Seaway electronic scales and Trimble portable GPS system.

The nine pots used in the survey were modified commercial rectangular cod pots (1.87 x 1.40 x 0.93 m) , built on a 40 mm steel rod frame and covered with 60 mm nylon mesh. The bottom and sides were lined with a 15 mm galvanised wire mesh inner liner for the survey. The pots had either three or four entrances of 10 cm external diameter, which opened into a 20 cm long steel wire tube. The internal entrance to this tube had a diameter of 8 cm and was provided with inward-facing wire spines to assist in the retention of captured fish. The bait (frozen pilchard, *Sardinops neopilchardus*) was enclosed in a 15 mm mesh bait bag which was attached to the inside bottom face of the pot. At repeat stations, fresh bait was used for the second hour of fishing.

At each handline station, two braided nylon handlines were fished for 15 min. Each line had two 6/0 Kale hooks and frozen pilchard bait.

Sampling procedure

All stations were occupied in daylight. For the area randomly selected for morning fishing, the nine potting stations were sequentially established between 0600 and 0800. At each station, the vessel position was recorded by GPS. The pot was deemed to be fishing once the pot was deployed at the station and the float was detached from the vessel.

Whilst the nine pots were fishing, the vessel steamed back to a position adjacent to the initial potting station to complete the first line fishing station. After the pots were sequentially recovered and the catch was removed, each pot was re-baited and allowed to fish for a second hour between 1000 and 1200. During this time, the second line fishing station was completed. After the second hour of fishing, all pots were sequentially retrieved and the vessel then steamed to the sampling area that had been randomly selected for afternoon fishing.

For the afternoon fishing, the initial sampling was carried out between 1300 and 1500 and the repeat sampling between 1600 and 1800. Stations were identified in the same number sequence as for the morning sampling.

Catch and biological sampling

Each station was numbered sequentially, the pot stations starting at 1, and line fishing stations at 900. All data were recorded on to the standard NIWA research database recording forms (trawl survey forms, 1989 edition). For each station, location data (date, latitude and longitude, depth, and times of set and haul) were recorded. Wind direction (degrees), strength (Beaufort scale), cloud cover (1–8), water condition and colour, and the height and direction of swell were also recorded.

The bottom type was recorded, based upon data from the depth sounder and on observations of the substrate attached to the pot upon recovery. Standard bottom type categories from the NIWA research database were used:

1 mud
2 sand/mud
4 sand/gravel
7 rock/rubble

The catch from each pot or line fishing station was sorted by species on deck and weighed (to the nearest 0.1 kg) using 5 kg electronic motion-compensating Seaway scales. The number and total weight by species caught were recorded. Non-QMS species were weighed and returned alive to the sea where possible. For all QMS species, length (to the nearest centimetre below actual length), and sex were recorded.

For blue cod, biological data were collected for a subsample of 20 fish from each station. The individual fish length (total length), weight (to the nearest 0.1 kg), sex (by visual examination of gonads), and gonad maturity stages were measured and recorded. The gonad stages used were:

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 freely flowing)
5 spent

Otoliths were collected from 20 fish of each 1 cm size class per sex and sampling stratum. Data from otolith records are not presented in this report and further analysis awaits the completion of an associated blue cod otolith age validation project (G. Carbines, NIWA, Dunedin).

Data analysis

Initial data editing was carried out in Nelson and the data were entered on to the Greta Point research database (as LHR9501) following standard data checking procedures.

From the depths recorded on the station records, stations were stratified into six depth strata within the overall depth range of 10–70 metres:

1 10–19.9 m
2 20–29.9 m
3 30–39.9 m
4 40–49.9 m
5 50–59.9 m
6 60 m +

The catch rate (kg per pot-hour) was analysed by fishing method, time of day, depth of fishing and sample location, using the analysis of variance (ANOVA) procedures of the SAS statistical analysis programme (SAS 1989). Use of ANOVA involves assumptions of random sampling, independence, homogeneity of variances, normality, and additivity and compliance with these assumptions was examined during analysis. Although ANOVA is normally robust against departures from heterogeneity of variance (Green 1979), the catch data were subjected to a log (X+1) transformation before analysis. Heterogeneity of variance was then examined using the maximum variance ratio test (Sokal & Rohlf 1969).

Where a factor was found to be significant under ANOVA, means were compared using Tukey's Test (Sokal & Rohlf 1969, SAS 1989) where appropriate.

Length frequency distributions were determined for each fishing method (potting and lining). Because the spatial area within which a pot or fishing line may attract fish is unknown, these distribution data are presented as unscaled length frequencies.

All blue cod were dissected to determine sex. The percentage of males was determined for each stratum and sampling area and analysed with reference to the four length categories proposed by Rapson (1956):

1 less than 18 cm in length, coloured rusty brown, considered juvenile
2 18–30 cm in length, coloured grey or brown, considered female
3 30–35 cm in length, coloured iridescent grey green considered male
4 greater than 35 cm in length, coloured deep blue to black, considered male

A conservative estimate of length at sexual maturity was determined from the minimum length at which running ripe (stage 4) gonads were observed. Gonad samples of each maturation stage were collected for subsequent histological examination.

Results

Sampling

Of 448 stations completed (Table 2), 360 were main potting stations, 28 were supplementary potting stations and 60 were line fishing stations. The station position and catch data are provided in Appendix 1. Although no time was lost to bad weather, a heavy swell in the Cape Jackson area (OQCH) precluded sampling at the Kempe Point site. An alternative sampling site in the lee of Cape Jackson (Onehunga) was sampled instead. One cod pot was lost in a heavy tidal flow at Ninepin rocks (EOPE) and the site was re-sampled. All other planned stations were sampled.

Catch composition

Blue cod were taken at 300 of 448 stations and made up 68% (by weight) of the total survey catch of 1.3 t (Table 3). A total of 2139 blue cod were caught, 1365 males and 774 females. Conger eel represented 9% and sea perch 6% of the catch by weight.

The remainder of the catch comprised 16 species (Table 3) and made up a minor proportion of the landed weight. The size range and numbers caught of the main finfish species taken are given in Table 4. Lengths were not recorded for sea perch.

Catch rate analysis

Stratum. The mean catch per unit effort (CPUE) for the 72 main potting stations in each stratum is given in Figure 3. The mean CPUE (kg per pot hour) within Queen Charlotte Sound increased from a low of 0.64 ± 0.15 kg per pot hour (IQCH), to a high of 2.42 ± 0.34 kg per pot hour in EQCH. This low catch rate reflects the zero catch recorded at 46 of these 72 stations. In contrast, zero catches occurred at only 12 stations in OQCH and 15 stations in EQCH (Appendix 1).

For the two Pelorus Sound strata, mean CPUE was higher than for the equivalent area in Queen Charlotte Sound. For OPEL, the CPUE was 2.71 + 0.43 kg per pot hour, while the highest CPUE was recorded from EOPE at 3.28 ± 0.41 kg per pot hour. Zero catches occurred at 15 stations in OPEL, and 15 in EOPE. Insufficient line fishing data are available to permit analysis of line fishing CPUE.

Fishing method. A total catch of 72 blue cod (46 males and 26 females) was recorded from the 60 line fishing stations (Table 5), an overall sex ratio of 57% males. Of these, only 10 fish (13%) were less than 26 cm in length (Figure 4).

From the potting stations (Table 5), a total of 2007 blue cod (1320 males and 748 females) was caught. A much wider size range of blue cod was caught (Figure 4), although the sex ratio (57% male) was the same as that for the line fishing stations. From Figure 4, the modal length for line caught blue cod (27–28 cm) appears to be smaller than for those caught by pots (28–30 cm). This may be an artefact of the smaller sample size; however, these data have been kept separate in subsequent analyses.

Time of fishing. The effect of time of fishing (morning or afternoon) on the log (x+1) transformed CPUE data was examined by analysis of variance for each fishing method separately (Appendix 3).

For the 360 main potting stations, time of fishing appeared to have no effect upon the overall catch rate, the number of females caught, or the number of larger fish (greater than 28 cm) taken (Appendix 3.1.1)

For the 60 line fishing stations, the F_{max} test indicated that significant heterogeneity of variance existed in the catch rate data. The reported F values in the ANOVA results (Appendix 3.1.2) may not be conservative and should be interpreted with caution. These data suggest that the overall catch rate was higher for the morning stations than for the afternoon stations ($F_{(1,59)} = 8.89$: $p < 0.01$). More female blue cod were caught by lines during the morning ($F_{(1,59)} = 9.81$: $p < 0.01$) and these fish were larger ($F_{(1,59)} = 15.12$: $p < 0.01$) than those caught during the afternoon.

Sequence of potting. The sequence of potting appears to have no effect upon the log (x+1) transformed mean catch rates (Appendix 3.1.1). This suggests that maximum catch at these stations may not have been reached during the 2 h soak time provided in the sampling programme.

Depth range and substrate. As stations were not selected with respect to depth, sample sizes were unequal. The F_{max} test indicated significant heterogeneity of variance remained in the log (x+1) transformed data and F values derived from ANOVA may not be conservative. No statistically significant effect due to depth or substrate could be demonstrated for either fishing method (Appendix 3.2). The unequal replication of stations within the depth strata may have reduced the statistical power of the analysis. From Appendix 3.2, most potting stations (83%) were located over rocky or hard rubble bottom, whilst 16% were located over sandy substrate. Few stations (2%) were located over mud or sandy mud bottom.

Length frequency

From the unscaled length frequency distributions by stratum (fishing methods combined), both small males and large females were found in all areas sampled (Figure 5). The truncated length frequency distribution seen in IQCH was probably due to the low numbers caught. Small fish (less than 18 cm in length) were more abundant in Pelorus Sound (OPEL and EOPE) than in Queen Charlotte Sound and larger fish (greater than 40 cm in length) were more abundant in the extreme outer sounds strata (EQCH and EOPE). Mean length data by stratum and by fishing method are given in Table 5. Length frequencies by sampling areas within each stratum are given in Appendix 4.

The sex and maturity stages of the dissected blue cod were described after reference to the size categories of Rapson (1956). It was not possible to consistently determine the sex or level of sexual maturity by examination of external features. For category 1 fish (less than 18 cm in length, coloured mottled brown), most were female; however, some small males were identified in OPEL and EPEL. Both category 2 fish (18–30 cm in length, coloured grey/brown) and category 3 fish (30–35 cm in length, coloured grey green) were found to be highly variable in colouration (from light blue to dark grey) and in pattern. Both male and female fish were consistently recorded.

Most category 4 fish (greater than 35 cm in length, coloured deep blue) were male, but large females occurred in all areas.

Mean length by sampling area for the potting stations, is presented in Table 5. For OPEL, the mean size of both males (28.75 $\pm$ 0.47 cm) and females (25.22 $\pm$ 0.61 cm) was slightly smaller than for OQCH (29.97 $\pm$ 0.51 cm and 28.11 $\pm$ 0.39 cm, respectively). A similar pattern in mean length by sex occurred for the potting station data from the two outer sounds strata (EOPE and EQCH).

Sex ratio

The overall percentage of males by stratum and size class is given in Table 6. Although males and females were present in all strata sampled, females were dominant in OQCH, where the overall sex ratio was 43% male. For the remaining strata, males were dominant. The sex ratios ranged from a low of 56% (OPEL) to a high of 84% (EQCH).

The sex ratios by length class within these strata are also shown in Table 6. For category 1 fish, numbers were low in all strata. Most fish examined were females, but males were recorded in OPEL and EPEL. For category 2 fish, females were dominant in OQCH (35% male) and the ratio was almost 1:1 in OPEL. For the remaining categories in each strata, males were dominant. EQCH and EOPE were characterised by extreme dominance of category 4 males (greater than 35 cm).

Length at sexual maturity

The range of length by sexual maturity stage is presented in Figure 6. Sexually mature (stage four gonad, running ripe) male and female blue cod were obtained from all five strata. Minimum length at sexual maturity varied from 19 cm in EOPE to 27 cm in IQCH and EQCH for males and for females from 18 cm in OPEL to 27 cm in IQCH and EQCH.

The relative proportions of sexual maturity stages (Figure 7) varied among strata. For males this varied from 16% in EQCH (320 fish sampled) to 62% in IQCH (58 fish sampled), and for females from 6% in EQCH (62 fish sampled) to 40% in EOPE (147 fish sampled).

Discussion

This report presents data from the first year of a planned 2 year sampling programme on the Marlborough Sounds blue cod population. The Inner Pelorus Sound was not included in the 1995 survey and it is planned to sample this area in September 1996.

Although the effectiveness of pots in target fishing blue cod has been questioned (Davidson 1995), the commercial pots used in this survey proved successful, and when provided with a mesh liner proved capable of retaining blue cod over 15 cm in length. The bycatch of triplefins, juvenile tarakihi, and juvenile red cod indicated that the pots were effective in retaining small fish. As experiments were not carried out using fine mesh, the escapement of smaller sizes (i.e., less than 15 cm) is not known. The spatial area within which blue cod are attracted to pots is unknown, and these data can only provide relative estimates of abundance. The effectiveness of fishing gear can be influenced by fish behaviour such as territoriality, as well as by fishing method. Commercial fishers set pots in a linear sequence in accordance with the tide (C. Aston, pers. comm. 1995), to maximise the attractive effect of baited pots. Tidal currents thus carry the oil from the bait downstream and provide a ground bait effect. As repeat potting did not affect the numbers of blue cod caught, size, or sex ratios, it is likely that the attractive effect of the pots would continue for longer than the soak times used in the programme.

The catch from the line fishing stations was poor compared with that from potting for all of the five strata sampled; however, catch rates appeared to be proportionally similar by site. Both mean size and sex ratios were similar between fishing methods which suggests that the two methods have similar biases.

Insufficient numbers were taken by line fishing to permit meaningful comparisons with the recent catch per effort analysis from the Long Island Marine Reserve (Davidson 1995). Davidson (1995) used ground baiting and smaller 2/0 barbless hooks which precludes comparisons of catch rates.

The data from a time-lapse underwater video monitoring programme indicate that blue cod may be more active (and hence more visible) during the early morning and late afternoon (K. Grange, NIWA, Nelson, pers. comm. 1995). In the present survey, time of fishing was not significant for cod pots, but morning fishing was more successful than afternoon fishing for the line fishing stations. Previous blue cod surveys (Rapson 1956, Mace & Johnston 1983, Davidson 1995) did not examine the effect of time of fishing.

Relative catchability can be used as a proxy for relative abundance and provide a crude basis for comparisons among fishing locations. This premise has been accepted by the Inshore Working Group (M. Francis, NIWA, Wellington, pers. comm. 1995). Catch rates were very low in Inner Queen Charlotte Sound, for both potting and line fishing methods, and increased towards the mouth of Queen Charlotte Sound. Catch rates were higher in Pelorus Sound than for the equivalent areas of Queen Charlotte Sound. These data are consistent with the concerns of recreational fishers (Kilner & Bell 1992) who believe that Inner Queen Charlotte Sound is significantly overfished.

Blue cod were present within the 10–60 m depth range throughout the area sampled. Sampling was not stratified by depth. Sample sizes were small in some depth classes, which precluded further analysis. Blue cod appear to prefer rubble habitat and are less common over soft (sand and mud) substrates (Davidson 1995). Further work is required to determine the effect of habitat on the relative abundance of blue cod in the Marlborough Sounds.

Blue cod gonads were clearly differentiated during September and many were running ripe. The sex ratios for most areas favoured males; however, females in the 19–30 cm size class were common in the middle areas of both Sounds (OQCH and OPEL) and sex ratios in OPEL favoured females. Female blue cod were found in all areas sampled. The size at sexual maturity for male blue cod is estimated at 19–20 cm, and for female blue cod at 18–20 cm, which is smaller than the 20–25 cm noted by Rapson (1956) but larger than that noted by Annala & Sullivan (1996).

Rapson (1956) proposed that large scale migrations of large male blue cod occur, perhaps as a result of loss of territory to smaller, more competitive, and aggressive males. However, more recent observations (K. Grange, pers.comm. 1995) suggest that migratory blue cod may be generally smaller males which may not have not established a territory. Tagging studies (Mace &

Johnston 1983, Carter 1992) suggest that once blue cod establish a territory, they remain in that area. Both large male and female blue cod were taken throughout the study area and the effects of such migrations on the distribution and relative abundance of blue cod requires further work.

Blue cod have been considered to be protogynous hermaphrodites (Rapson 1956, Mutch 1983). Such fish initially mature as females, then change sex to become functional males (Shapiro 1986). The occurrence of this process in blue cod is based upon unvalidated age and growth data (Rapson 1956, Mutch 1983), and the presence of a single transitional hermaphrodite blue cod (Mutch 1983). Secondary male blue cod have not been found, which contrasts with the biology of other known protogynous hermaphrodite fish species (such as labrids) where these males are common (Cole & Robertson 1982, Mutch 1983). Species that exhibit protogynous hermaphroditism may not be resilient to heavy fishing pressure (Hunstman & Schaaf 1994), as increased fishing mortality may reduce the abundance of older age classes and hence the relative abundance of males.

The present data do not support the existence of protogynous hermaphroditism in blue cod. Small males and large females were present in all five strata sampled, and are commonly taken in the commercial catch (C. Aston, pers. comm.1995). This is consistent with the findings of Drummond & Stevenson (1995) who recorded female blue cod between 16 and 45 cm, and males from 23 to 44 cm in length from a trawl survey of Tasman and Golden Bays during 1994 and of Blackwell & Stevenson (1996) who reported female blue cod from 21 to 40 cm and males from 21 to 43 cm in length from these bays in 1996.

Further work may be necessary to review the effect of other factors, such as fishing pressure and territorial behaviour, on the reproductive biology of blue cod.

Rapson (1956) found that juvenile blue cod (less than 18 cm in length) occurred in the deeper waters of the Outer Marlborough Sounds, and proposed a pattern of migration inshore, at the onset of sexual maturity. This has been disputed by Mutch (1983). The distribution of juvenile blue cod found in the present study is consistent with Mutch (1983).

Rapson (1956) also proposed a migration to deeper water spawning grounds. Such migrations were noted for blue cod in Southland by Robertson (1973). Sexually mature blue cod were found in all five strata sampled in the present study. The range of gonad maturity stages found during the survey strongly suggest that both male and female blue cod spawn on-site throughout the Marlborough Sounds. This is consistent with the conclusions of Mace & Johnston (1983).

The presence of spawning blue cod in September 1996 supports the late winter/early spring spawning season for the Marlborough Sounds proposed by Rapson (1956). However, the spawning season may be more extensive. Spawning blue cod have been found in Queen Charlotte Sound as late as December (K. Grange, pers.comm. 1995) and serial spawning may occur (Mutch 1983, Pankhurst & Conroy 1987). Further sampling over a longer time period is required to investigate the periodicity of blue cod spawning in the Marlborough Sounds.

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Table 1: Stratification used in the survey

* denotes additional sampling site (see text)

Stratum	Area	Location of area	Site code	Number of pot stations Initial	Number of pot stations Repeat	Line stations
IQCH		Inner Queen Charlotte				
	1	Kaipapa	1A1–1A3	a–c	d–f	g–h
	*	Kaipapa	1A4	a–c		
	*	Perano Shoal	1A5	a–c	d–f	g–h
	2	Dieffenbach Point	1B1–1B3	a–c	d–f	g–h
	3	Luke Rock	1C1–1C3	a–c	d–f	g–h
	4	Bay of Many Coves	1D1–1D3	a–c	d–f	g–h
OQCH		Outer Queen Charlotte Sound				
	1	Tory Channel	2A1–2A3	a–c	d–f	g–h
	*	Tory Channel	2A4	a–c	d–f	g–h
	2	Hawes Rock	2B1–2B3	a–c	d–f	g–h
	3	Resolution Bay	2C1–2C3	a–c	d–f	g–h
	*	Resolution Bay	2C4–2C5	a–c		g–h
	4	Pickersgill Island	2D1–2D3	a–c	d–f	g–h
	*	Arapawa Island	2E	a–c	d–f	g–h
EQCH		Extreme Outer Queen Charlotte Sound				
	1	The Twins	3A1–3A3	a–c	d–f	g–h
	2	Stella Rock	3B1–3B3	a–c	d–f	g–h
	3	Cape Jackson	3C1–3C3	a–c	d–f	g–h
	4	Alligator Head	3D1–3D3	a–c	d–f	g–h
				a–c	d–f	g–h
EOPE		Extreme Outer Pelorus Sound				
	1	Forsyth Island	4A1–4A3	a–c	d–f	g–h
	2	Chetwode Island	4B1–4B3	a–c	d–f	g–h
	3	Clay Point	4C1–4C3	a–c	d–f	g–h
	4	Harris Bay	4D1–4D3	a–c	d–f	g–h
OPEL		Outer Pelorus Sound				
	1	The Reef	5A1–5A3	a–c	d–f	g–h
	2	Boat Rock Point	5B1–5B3	a–c	d–f	g–h
	3	Katira Point	5C1–5C3	a–c	d–f	g–h
	4	Duffers Reef	5D1–5D3	a–c	d–f	g–h
	*	Bulwer	5E1–5E3	a–c		
	*	Camp Bay	5F1–5F3	a–c		
	*	Te Akaroa	5G1–5G3	a–c		

Table 2: Numbers of stations sampled by stratum and area

Stratum	Area	Location of area	Main pot stations	Extra pot stations	Line stations
IQCH	1	Inner Queen Charlotte			
	1A	Perano Shoal	0	6	
	1A	Kaipapa Bay	18	2	3
	1B	Dieffenbach Point	18	0	3
	1C	Luke Rock	18	0	3
	1D	Bay of Many Coves	18	0	3
		Total	72	8	12
OQCH	2	Outer Queen Charlotte			
	2A	Tory Channel	18	3	3
	2B	Hawes Rock	18	0	3
	2C	Resolution Bay	18	6	3
	2D	Pickersgill Island	18	0	3
	2E	Arapawa Island	0	2	0
		Total	72	11	12
EQCH	3	Extreme Outer Queen Charlotte			
	3A	Stella Rock	18	0	3
	3B	The Twins	18	0	3
	3C	Cape Jackson	18	0	3
	3D	Alligator Head	18	0	3
		Total	72	0	12
EOPE	4	Extreme Outer Pelorus			
	4A	Forsyth Island	18	0	3
	4B	Chetwode Islands	18	0	3
	4C	Clay Point	18	0	3
	4D	Harris Bay	18	0	3
		Total	72	0	12
OPEL	5	Outer Pelorus			
	5A	The Reef	18	0	3
	5B	Boat Rock Point	18	0	3
	5C	Katira Point	18	0	3
	5D	Duffers Reef	18	0	3
	5E	Bulwer	0	3	0
	5F	Camp Bay	0	3	0
	5G	Te Akaroa	0	3	0
		Total	72	9	12

Table 3: Species caught, total and percentage weight, and occurence at 448 stations

Common name	Code	Scientific name	Catch (kg)	Percent by weight	Occurrence by station	Min depth (m)	Max depth (m)
Blue cod	BCO	*Parapercis colias*	881.8	67.7	300	8	55
Conger eel	CON	*Conger verreauxi*	111.6	8.6	21	9	42
Sea perch	SPE	*Helicolenus percoides*	77.6	6	80	9	59
Octopus	OCT	*Octopus maorum*	68.5	5.3	18	9	44
Red cod	RCO	*Pseudophycis bachus*	60.7	4.7	40	9	55
Tarakihi	TAR	*Nemadactylus macropterus*	55.2	4.2	75	9	59
Hagfish	HAG	*Eptatretus cirrhatus*	20.1	1.5	33	11	55
Carpet shark	CAR	*Cephaloscyllium isabella*	7.8	0.6	5	18	33
Spotty	STY	*Notolabrus celidotus*	7.7	0.6	30	9	33
Brittle star	OPH	*Pectinura maculata*	4.4	0.3	39	9	55
Leatherjacket	LEA	*Parika scaber*	2.6	0.2	7	15	27
Bastard red cod	BRC	*Pseudophycis breviuscula*	1.7	0.1	1	15	15
Eleven-armed starfish	SFI	*Coscinasterias calamaria*	1.7	0.1	17	9	55
Red gurnard	GUR	*Chelidonichthys kumu*	0.5	<0.1	1	20	20
Trumpeter	TRU	*Latris lineata*	0.4	<0.1	2	8	9
Red mullet	RMU	*Upenichthys lineatus*	0.3	<0.1	1	20	20
Blenny	BLE	Tripterygiidae	0.2	<0.1	2	15	22
Trevally	TRE	*Pseudocaranx dentex*	0.1	<0.1	1	9	9
Kahawai	KAH	*Arripis trutta*	0.2	<0.1	1	7	7
			1 303.4				

Table 4: Maximum and minimum lengths of main finfish fish species caught

Common name	Length (cm)		Number caught	Method
	min.	max.		
Blue cod	12	47	2139	pot, line
Sea perch	-	-	192	pot, line
Tarakihi	5	33	207	pot, line
Red cod	26	75	54	pot, line
Leatherjacket	16	28	4	line

Table 5: Numbers and length of blue cod by stratum and location

StratunArea			Number of blue cod			Mean length of blue cod			
			Total	Males	Females	Males	CI *	Females	CI *
IQCH	**1**	**Inner Queen Charlotte Sound**							
	A	Kaipapa Bay	3	0	3	0.00	0.00	1.45	2.90
	B	Dieffenbach Point	29	20	9	30.60	2.24	30.33	1.24
	C	Luke Rock	40	24	16	31.08	0.86	30.12	1.42
	D	Bay of Many Coves	20	12	8	31.75	2.78	29.87	1.79
		Pots overall	92	56	36	31.05	1.04	30.17	0.92
		Lines overall	2	2	0	33.50	3.90	0.00	0.00
		Total	94	58	36	31.14	1.02	30.17	0.92
OQCH	**2**	**Outer Queen Charlotte Sound**							
	A	Tory channel	96	70	26	29.96	0.84	26.34	1.48
	B	Hawes Rock	92	32	59	31.09	1.34	29.81	0.60
	C	Resolution Bay	178	68	99	29.26	0.95	27.70	0.64
	D	Piggersgill Island	94	31	0	30.42	0.90		
	E	Arapara Island	12	1	11	29.00	0.00	29.90	1.27
		Pots overall	460	202	258	29.97	0.51	28.11	0.39
		Lines overall	12	5	7	30.40	1.02	29.71	3.69
		Total	472	207	265	29.98	0.50	28.15	0.39
EQCH	**3**	**Extreme Outer Queen Charlotte Sound**							
	A	Stella Rock	90	78	12	32.87	0.89	28.50	2.04
	B	The Twins	34	27	7	31.04	1.95	26.00	1.95
	C	Cape Jackson	124	104	20	31.18	0.79	27.25	2.10
	D	Alligator Head	122	100	22	32.11	0.78	26.59	1.08
		Pots overall	370	309	61	31.90	0.47	27.11	0.91
		Lines overall	12	11	1	31.91	3.41	25.00	0.00
		Total	382	320	62	31.90	0.46	27.08	0.90
EOPE	**4**	**Extreme Outer Pelorus Sound**							
	A	Outer Forsyth Island	126	100	26	31.77	0.83	26.38	1.19
	B	Chetwode Islands	157	132	25	30.17	0.71	23.32	2.02
	C	Clay Point	183	128	55	29.67	0.62	25.67	0.91
	D	Harris Bay	92	63	29	29.74	0.90	24.83	1.50
		Pots overall	558	423	135	30.33	0.38	25.19	0.67
		Lines overall	32	22	11	29.62	1093	26.50	1.93
		Total	591	444	147	30.30	0.38	25.30	0.64
OPEL	**5**	**Outer Pelorus Sound**							
	A	The Reef	86	39	47	30.36	1.18	25.68	1.55
	B	Boat Rock Point	147	65	82	30.30	1.16	25.61	1.49
	C	Katira Point	50	36	14	27.80	1.75	26.66	2.36
	D	Duffers Reef	245	168	77	29.81	0.48	27.65	0.62
	E	Bulwer	24	6	18	21.16	1.81	20.55	1.84
	F	Camp Bay	32	13	19	24.92	2.57	22.31	2.64
	G	Te Akaroa	3	3	0	31.33	4.05		
		Pots overall	587	330	257	28.75	0.47	25.22	0.61
		Lines overall	13	6	7	29.00	1.63	26.16	1.50
		Total	600	336	264	28.75	0.46	25.24	0.59

* Where C.I. = 2 x s.e.

Table 6: Blue cod sex ratio by length class

Stratum	Length class (cm)	Number males	Number females	Number total	% male
IQCH	< 18	0	0		0
	18–30	27	20	47	57
	31–35	25	14	39	64
	>35	6	2	8	75
	Total	58	36	94	62
OQCH	< 18	0	1	1	0
	18–30	115	209	324	35
	31–35	79	50	129	61
	>35	13	5	18	72
	Total	207	265	472	44
EQCH	< 18	0	0	0	0
	18–30	118	55	173	68
	31–35	147	5	152	97
	>35	55	2	57	96
	Total	320	62	382	84
OPEL	< 18	4	23	27	15
	18–30	220	210	430	51
	31–35	104	31	135	77
	>35	8	0	8	100
	Total	336	264	600	56
EOPE	< 18	2	5	7	29
	18–30	227	134	361	63
	31–35	184	7	191	96
	>35	31	1	32	94
	Total	444	147	591	75

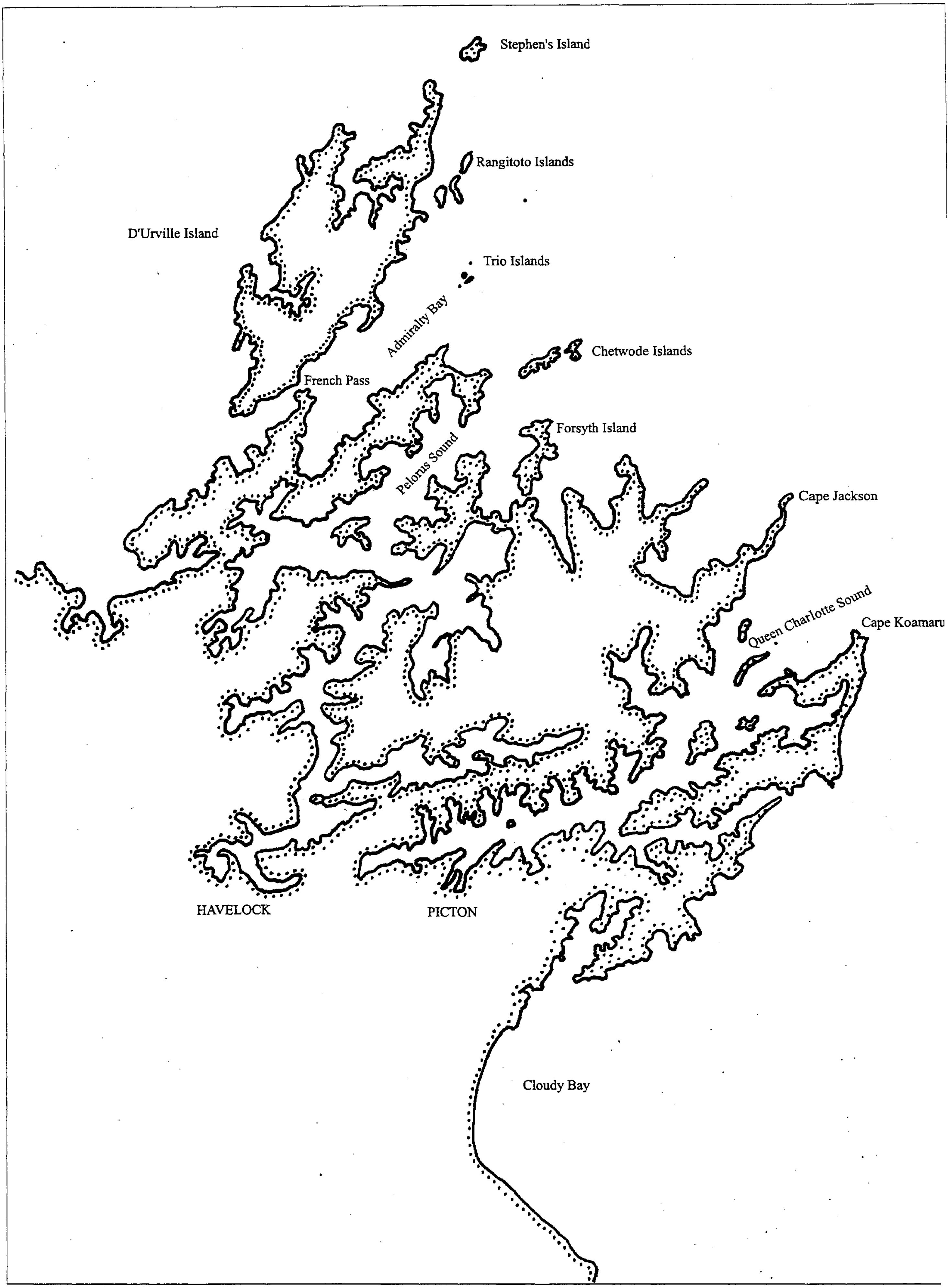


Figure 1: Marlborough Sounds survey area

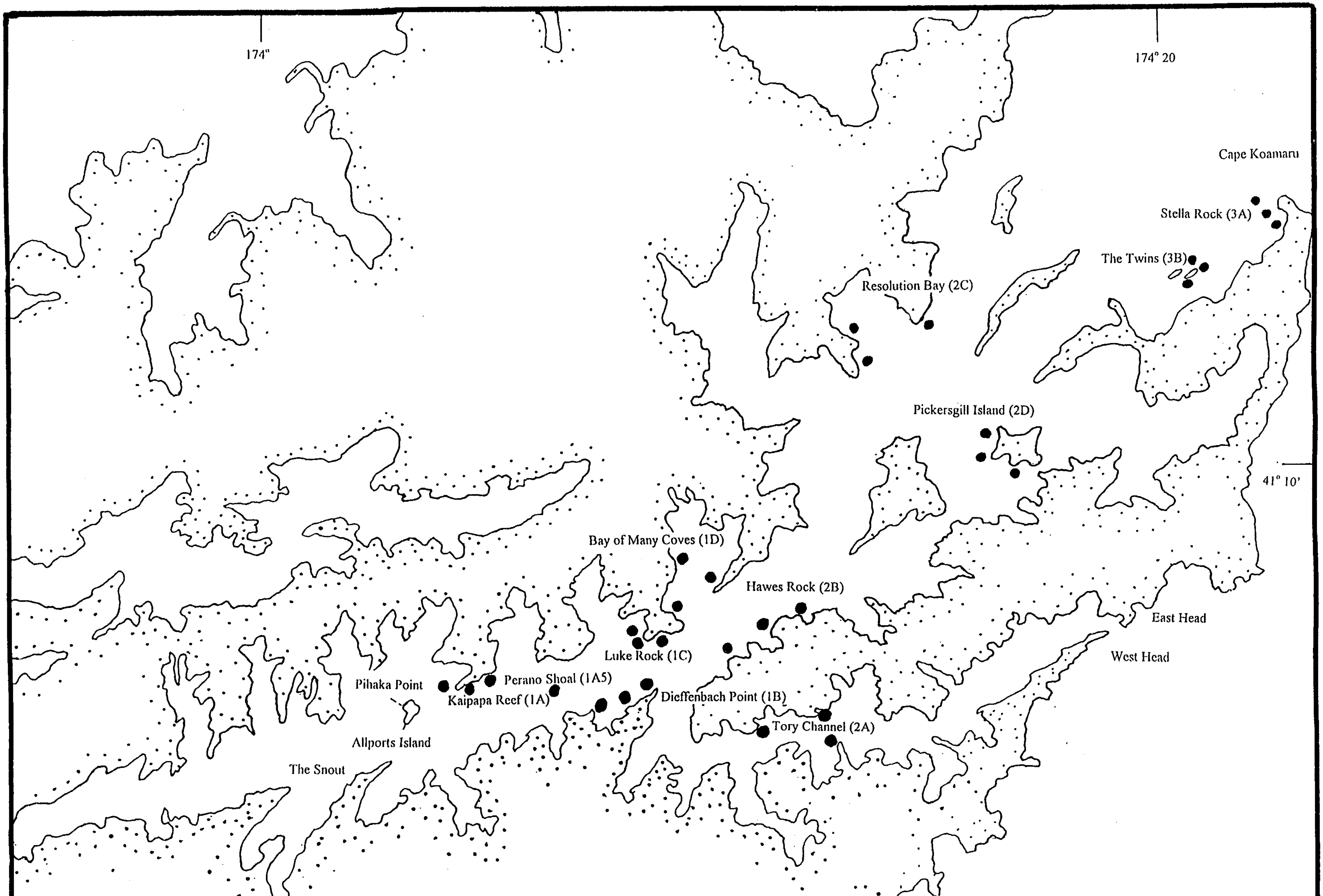


Figure 2a: Sampling areas within Queen Charlotte Sound

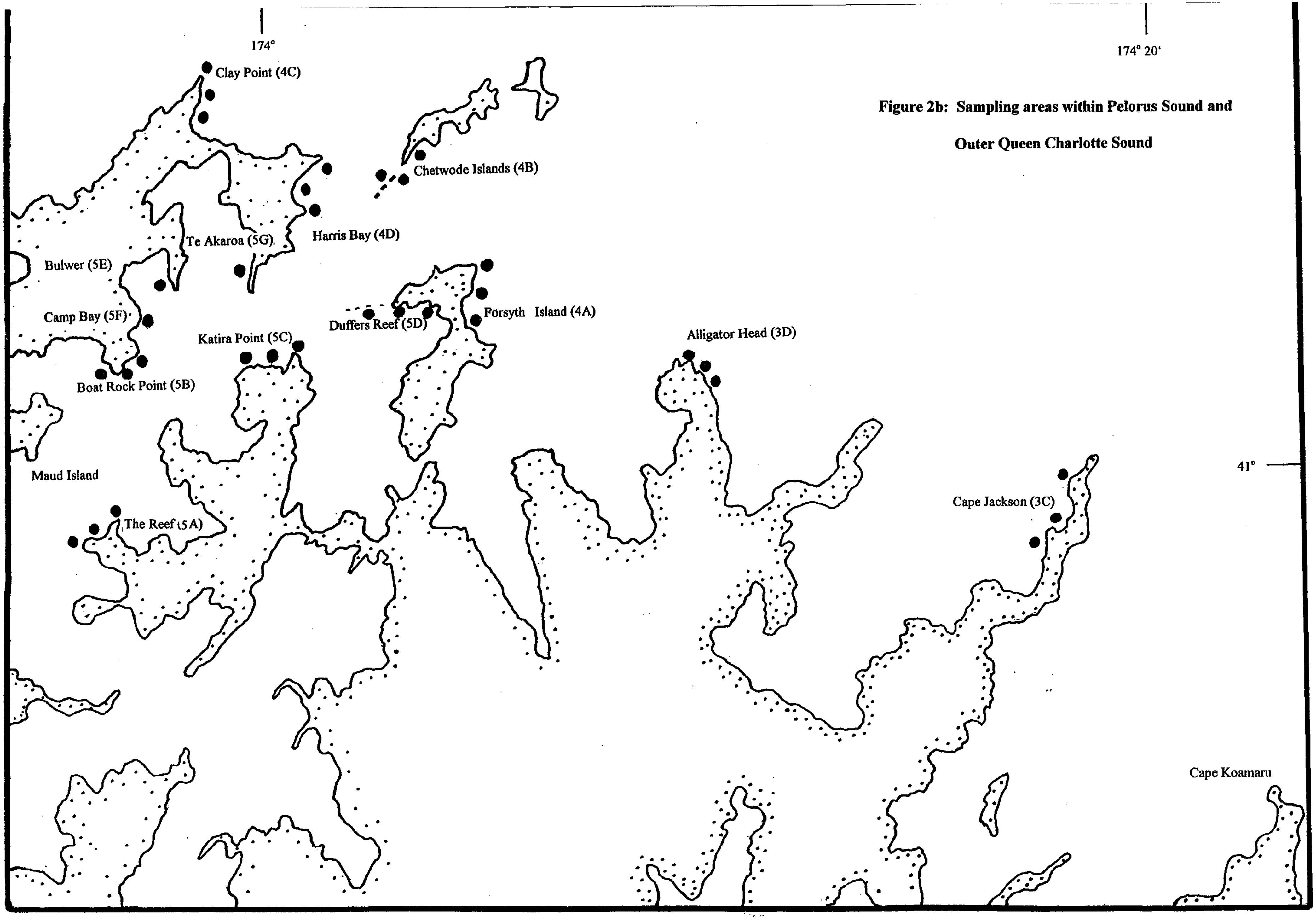


Figure 2b: Sampling areas within Pelorus Sound and Outer Queen Charlotte Sound

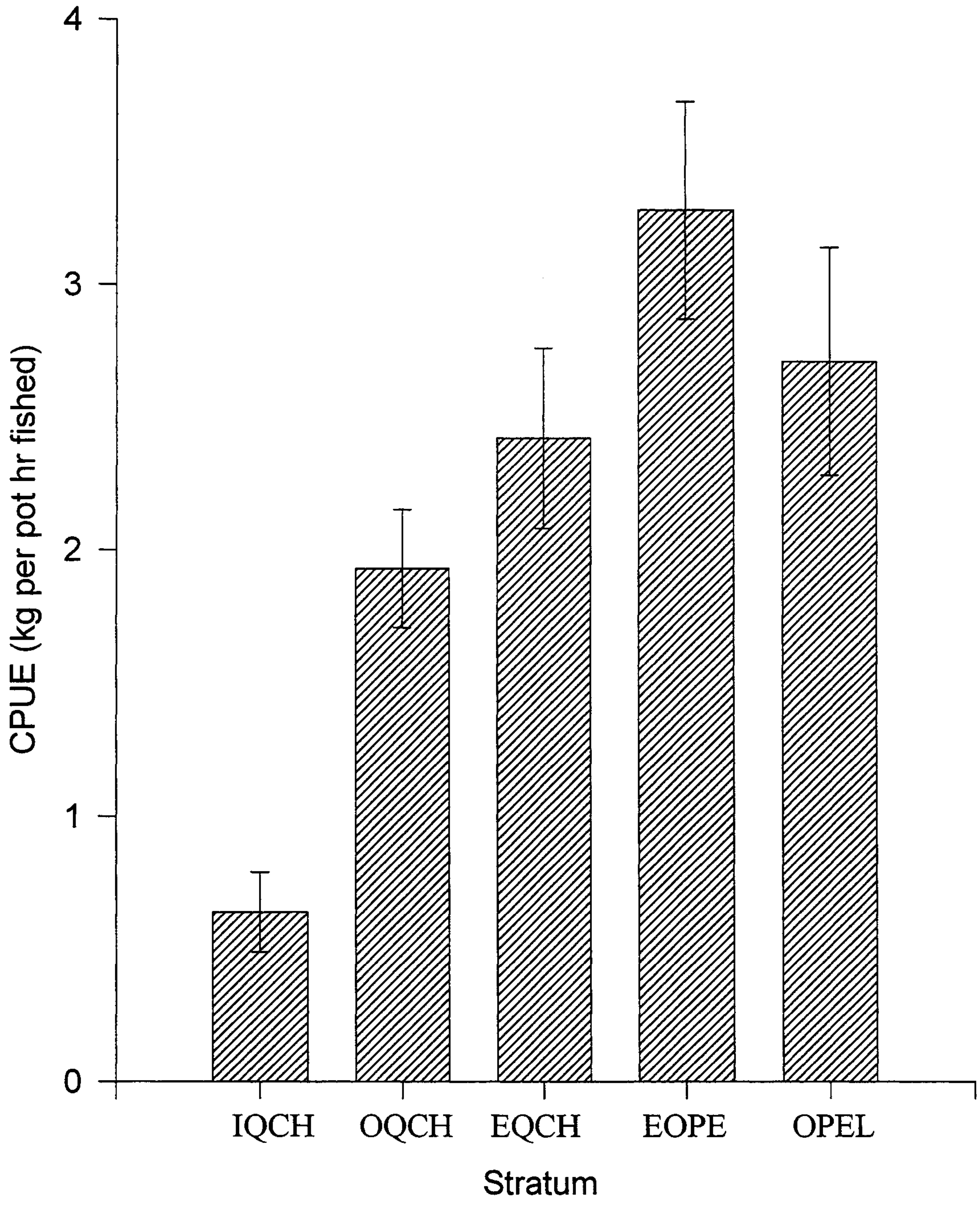


Figure 3: Blue cod CPUE by stratum - major potting stations only
n = 72 stations per stratum. C.I. = 2 x *s.e.*

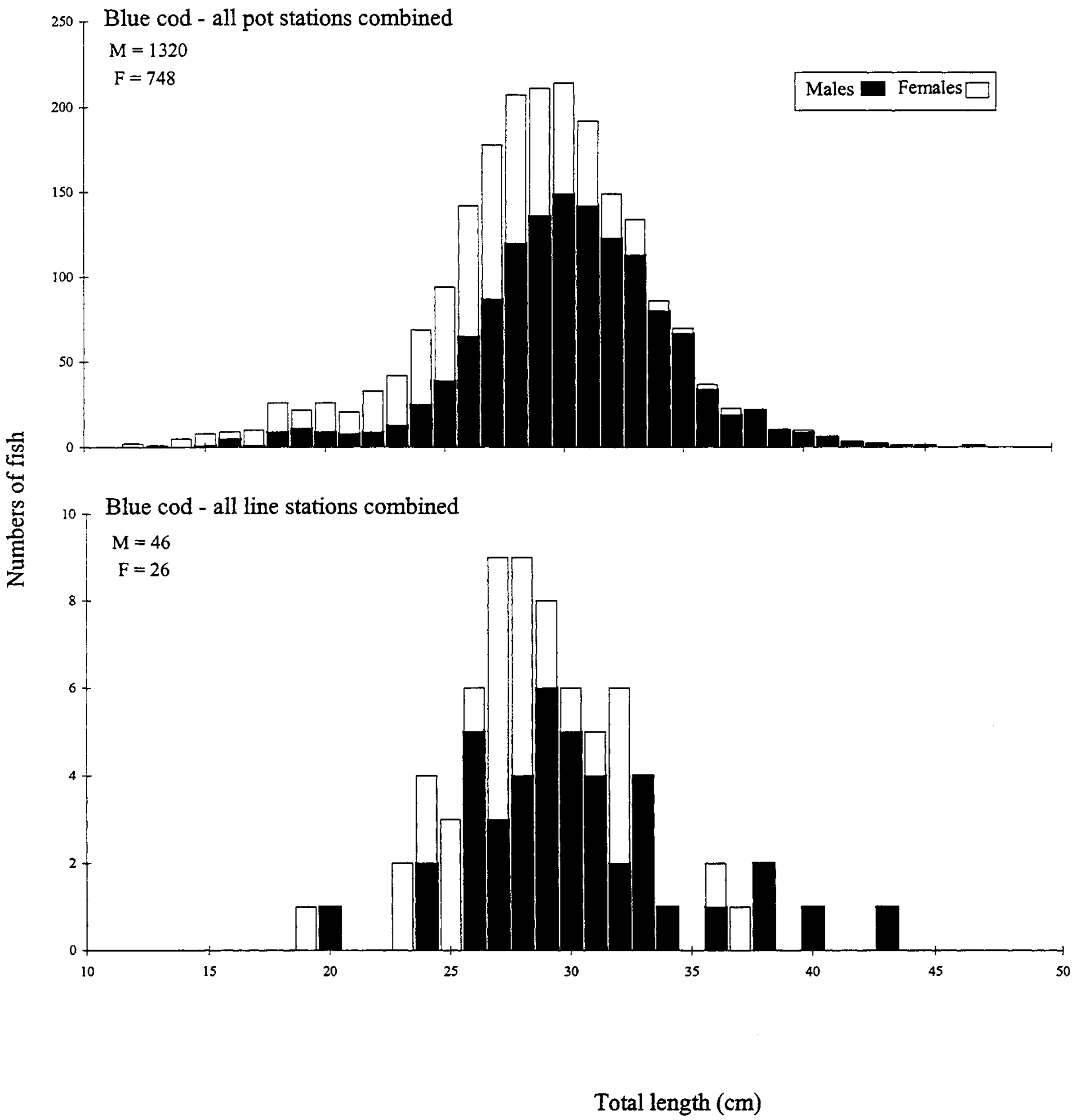


Figure 4: Length frequency distribution of blue cod by fishing method. Numbers of male and female blue cod are actual numbers measured.

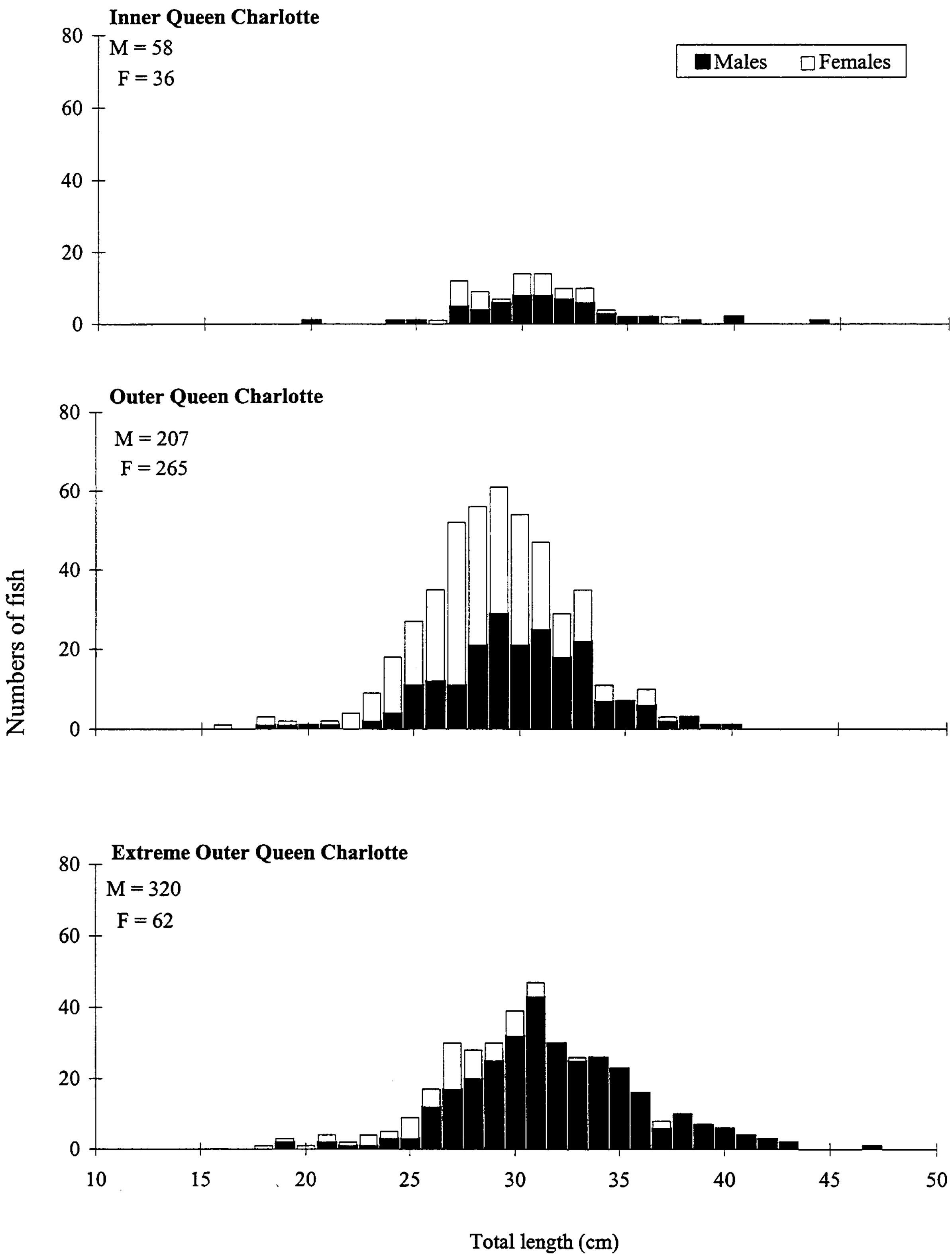


Figure 5: Length frequency distribution of blue cod by stratum.
Numbers of male and female blue cod are actual numbers measured.

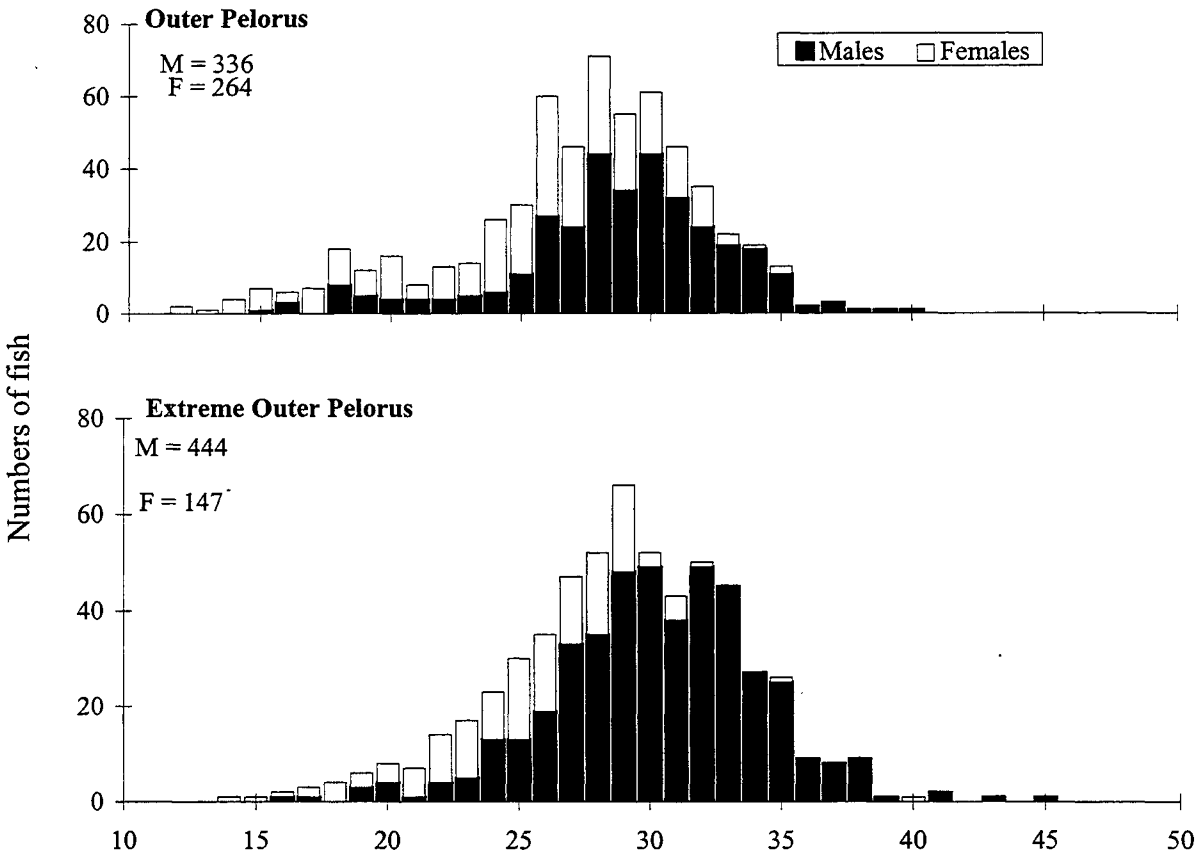


Figure 5: — *continued*

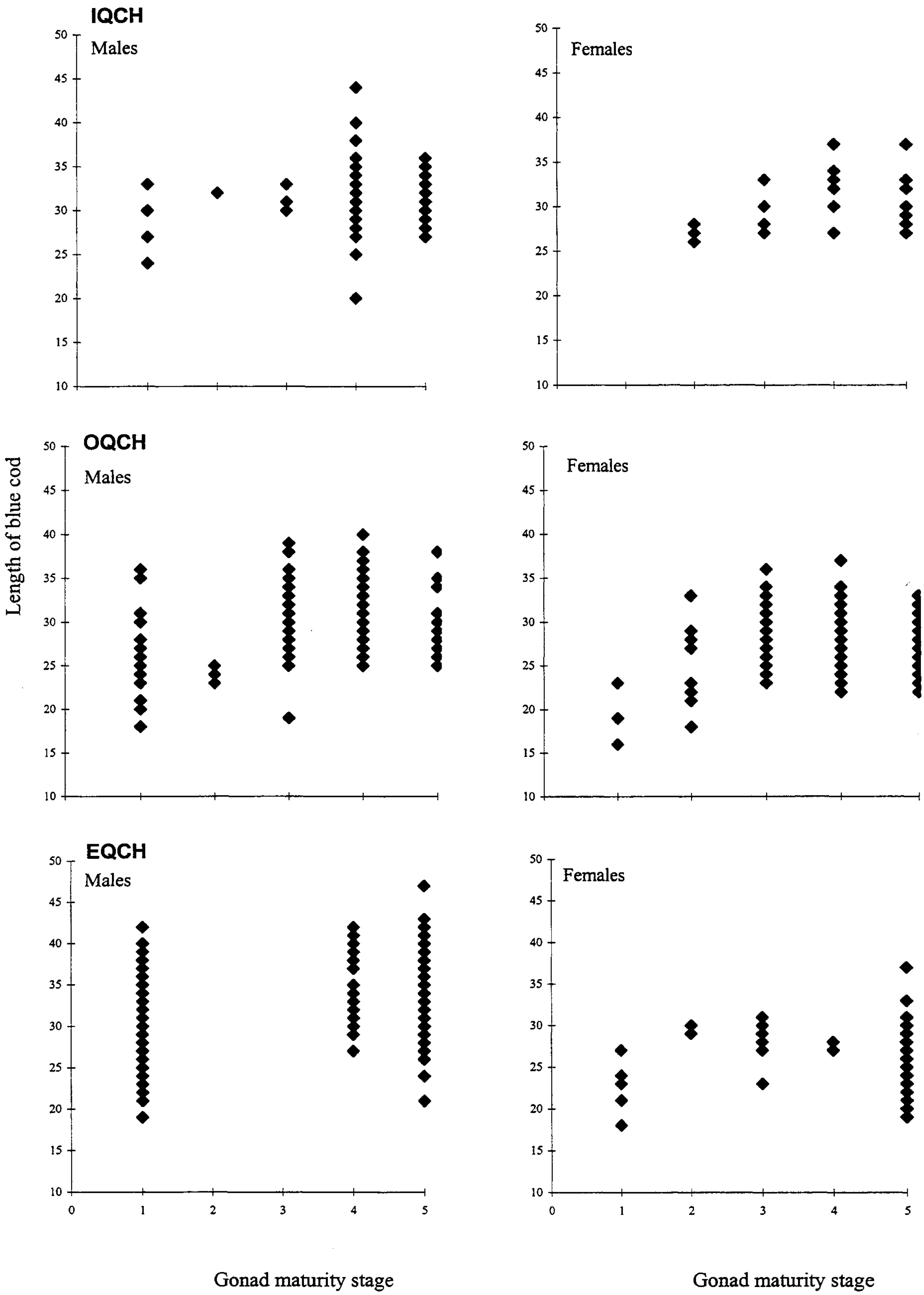


Figure 6: Blue cod length and gonad maturity stage by sampling stratum

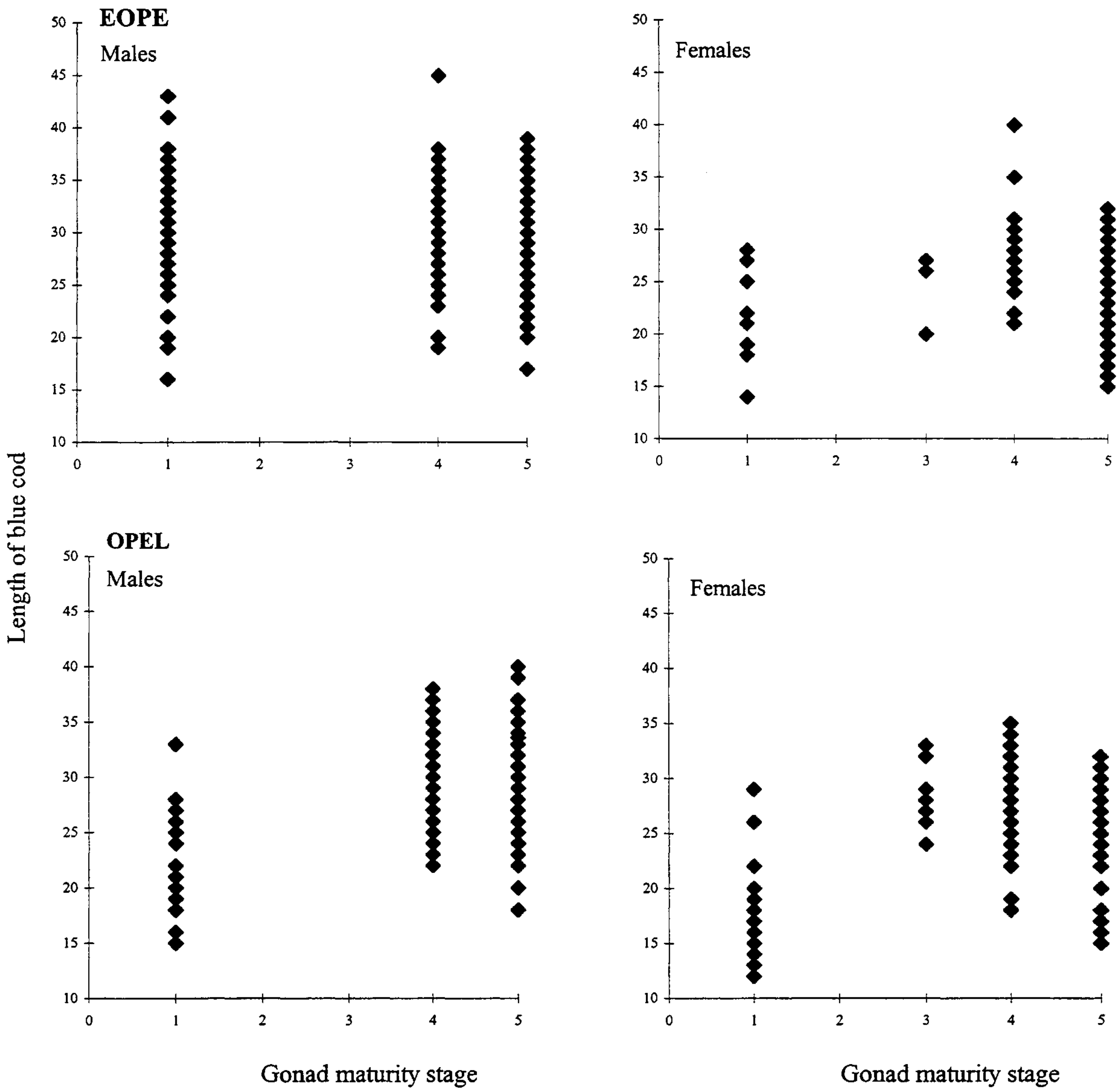


Figure 6:–*continued*

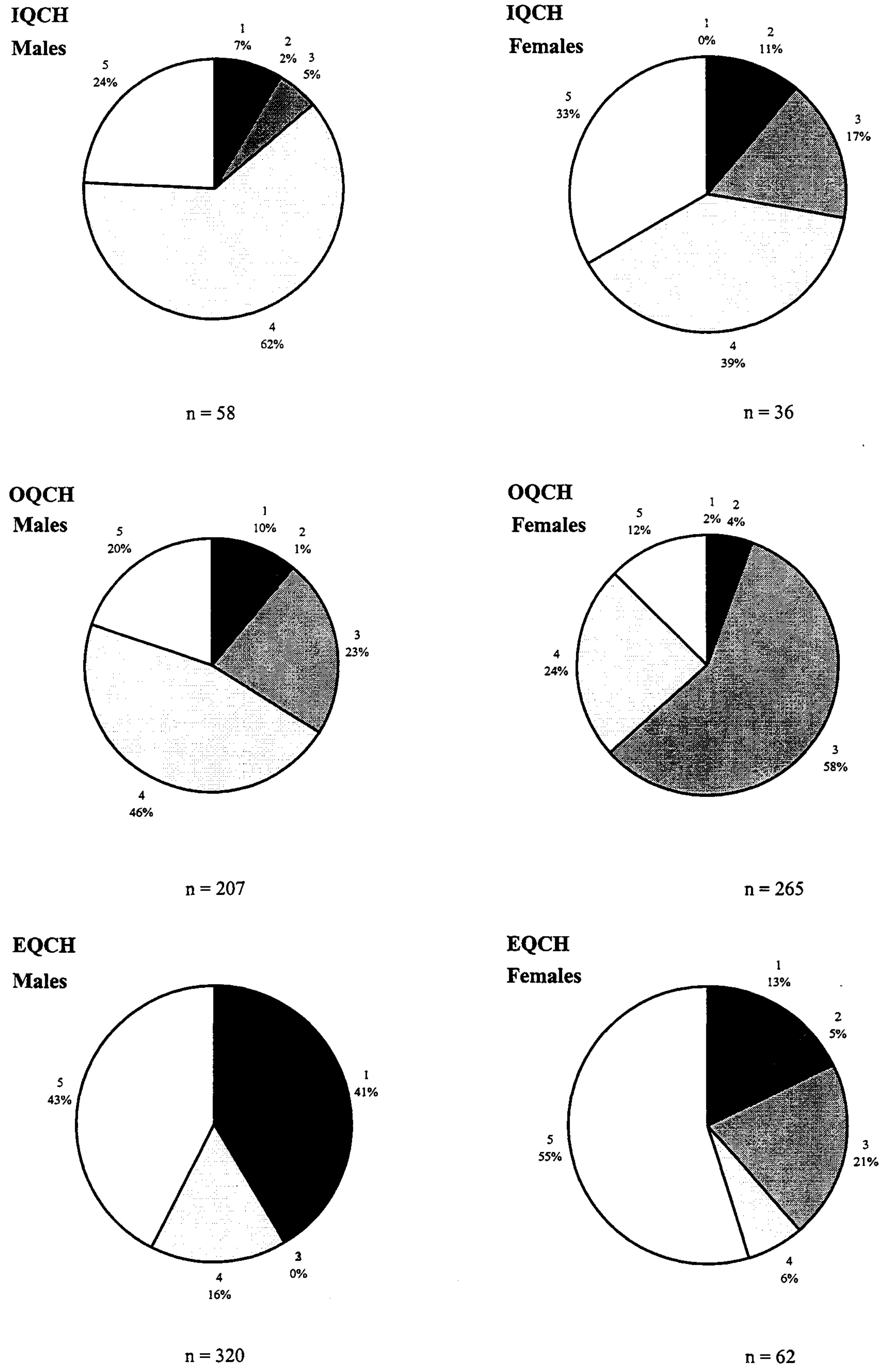


Figure 7: Relative sexual maturity stages by sampling stratum.

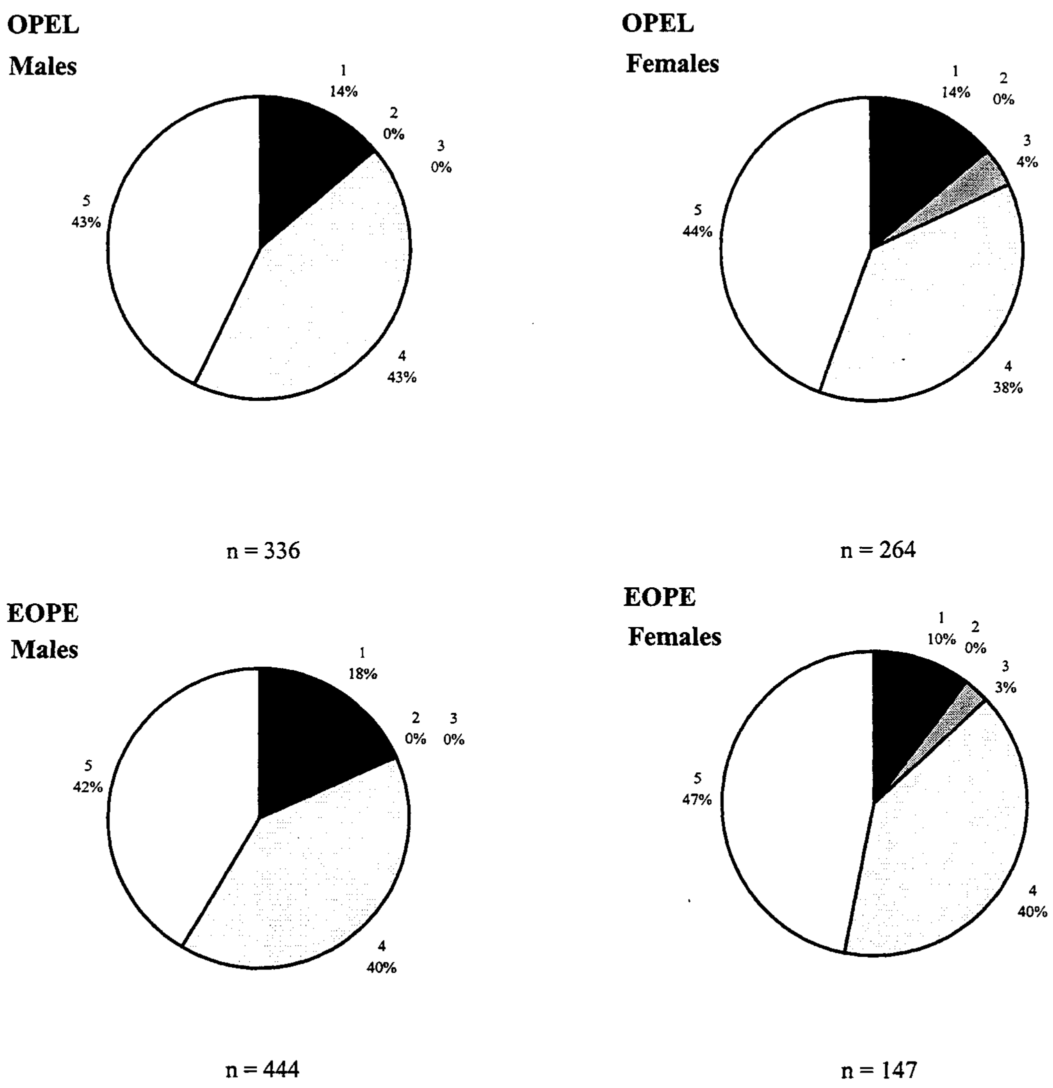


Figure 7:—*continued*

Appendix 1: Individual station data

Main potting stations

Station	Date	Stratum	Straum code	Area	Location	Latitude	Longitude	Site	Pot	Depth (m)	Bottom type	Total BCO	BCO > 28 cm	Male BCO	Female BCO
1	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	a	22	7	1	1	0	1
2	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	b	38	7	0	0	0	0
3	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	c	42	7	0	0	0	0
4	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.45	2	a	27	7	0	0	0	0
5	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.45	2	b	44	7	0	0	0	0
6	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.45	2	c	18	7	0	0	0	0
7	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	a	24	7	0	0	0	0
8	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	b	27	7	0	0	0	0
9	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	c	16	7	0	0	0	0
10	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	d	22	7	0	0	0	0
11	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	e	38	7	0	0	0	0
12	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	f	33	7	0	0	0	0
13	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.45	2	d	27	7	0	0	0	0
14	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.45	2	e	44	7	0	0	0	0
15	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.45	2	f	18	7	0	0	0	0
16	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	d	24	7	0	0	0	0
17	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	e	27	7	0	0	0	0
18	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	f	16	7	1	1	0	1
24	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	a	16	7	1	1	1	0
25	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	b	38	7	0	0	0	0
26	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	c	18	7	0	0	0	0
27	9/04/95	IQCH	1	B	Dieffenbach	41.14.21	174.08.06	2	a	15	7	2	0	2	0
28	9/04/95	IQCH	1	B	Dieffenbach	41.14.21	174.08.06	2	b	15	7	0	0	0	0
29	9/04/95	IQCH	1	B	Dieffenbach	41.14.21	174.08.06	2	c	13	7	3	3	3	0
30	9/04/95	IQCH	1	B	Dieffenbach	41.13.85	174.08.78	3	a	13	7	5	4	4	1
31	9/04/95	IQCH	1	B	Dieffenbach	41.13.85	174.08.78	3	b	15	7	3	3	2	1
32	9/04/95	IQCH	1	B	Dieffenbach	41.13.85	174.08.78	3	c	26	7	6	4	4	2
33	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	d	18	7	0	0	0	0
34	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	e	38	2	0	0	0	0
35	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	f	18	2	0	0	0	0
36	9/04/95	IQCH	1	B	Dieffenbach	41.14.21	174.08.06	2	d	15	2	4	3	1	3
37	9/04/95	IQCH	1	B	Dieffenbach	41.14.21	174.08.06	2	e	15	2	1	1	0	1
38	9/04/95	IQCH	1	B	Dieffenbach	41.14.21	174.08.06	2	f	13	7	1	1	1	0
39	9/04/95	IQCH	1	B	Dieffenbach	41.13.85	174.08.78	3	d	13	7	0	0	0	0
40	9/04/95	IQCH	1	B	Dieffenbach	41.13.85	174.08.78	3	e	15	7	0	0	0	0
41	9/04/95	IQCH	1	B	Dieffenbach	41.13.85	174.08.78	3	f	26	7	3	2	2	1
45	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	a	48	7	0	0	0	0
46	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	b	29	7	1	1	1	0
47	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	c	22	7	0	0	0	0
48	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	a	13	7	2	2	0	2
49	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	b	13	7	0	0	0	0
50	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	c	22	7	0	0	0	0
51	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	a	13	7	1	1	0	1
52	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	b	16	7	11	10	11	0
53	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	c	16	7	0	0	0	0
54	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	d	48	7	0	0	0	0
55	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	e	29	7	11	8	5	6
56	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	f	22	7	9	8	7	2
57	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	d	13	7	2	2	0	2
58	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	e	13	7	0	0	0	0
59	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	f	22	7	0	0	0	0
60	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	d	13	7	4	4	1	3
61	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	e	16	7	0	0	0	0
62	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	f	16	7	0	0	0	0
84	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	a	26	7	7	7	4	3
85	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	b	51	2	4	3	2	2
86	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	c	59	4	0	0	0	0
87	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	a	15	2	4	2	1	3
88	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	b	27	2	0	0	0	0
89	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	c	22	2	0	0	0	0
90	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	a	27	7	0	0	0	0
91	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	b	18	2	0	0	0	0
92	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	c	16	7	0	0	0	0
93	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	d	26	7	2	2	2	0
94	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	e	51	2	1	1	1	0
95	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	f	53	7	0	0	0	0
96	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	d	13	2	0	0	0	0
97	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	e	24	2	2	1	2	0
98	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	f	22	7	0	0	0	0
99	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	d	18	2	0	0	0	0
100	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	e	16	2	0	0	0	0
101	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	f	16	2	0	0	0	0
63	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	a	18	7	6	4	6	0
64	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	b	15	7	3	3	2	1
65	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	c	13	7	1	1	0	1
66	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	a	9	7	5	4	5	0
67	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	b	18	7	1	1	1	0

Appendix 1: —*continued*

Station	Date	Stratum	Straum code	Area	Location	Latitude	Longitude	Site	Pot	Depth (m)	Bottom type	Total BCO	BCO > 28 cm	Male BCO	Female BCO
68	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	c	31	7	5	4	3	2
69	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	a	27	7	8	3	4	4
70	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	b	16	7	4	4	4	0
71	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	c	11	7	1	1	0	1
72	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	d	18	7	0	0	0	0
73	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	e	15	7	1	0	0	1
74	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	f	13	7	2	1	1	1
75	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	d	9	7	1	1	1	0
76	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	e	18	7	0	0	0	0
77	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	f	31	7	0	0	0	0
78	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	d	27	7	0	0	0	0
79	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	e	16	7	5	3	3	2
80	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	f	11	7	7	0	5	2
102	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	a	20	7	1	1	1	0
103	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	b	31	7	10	5	7	3
104	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	c	15	7	0	0	0	0
105	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	a	20	7	7	5	2	5
106	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	b	31	7	13	12	4	9
107	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	c	13	7	5	4	3	2
108	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	a	33	7	14	13	5	9
109	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	b	33	7	8	8	0	8
110	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	c	22	7	1	1	0	1
111	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	d	20	7	3	3	2	1
112	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	e	31	7	0	0	0	0
113	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	f	24	7	4	4	1	3
114	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	d	26	7	0	0	0	0
115	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	e	31	7	6	6	2	4
116	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	f	16	7	4	4	1	3
117	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	d	16	7	1	1	0	1
118	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	e	33	7	10	8	3	7
119	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	f	27	7	4	4	1	3
123	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	a	31	7	4	3	2	2
124	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	b	20	7	5	4	3	2
125	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	c	15	7	9	7	1	8
126	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	a	27	7	6	6	5	1
127	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	b	44	7	0	0	0	0
128	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	c	18	7	0	0	0	0
129	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	a	20	7	5	2	2	3
130	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	b	27	7	1	0	0	1
131	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	c	15	7	14	6	7	7
132	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	d	22	7	13	8	3	10
133	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	e	26	7	7	4	0	7
134	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	f	15	7	10	3	2	8
135	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	d	24	7	2	1	0	2
136	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	e	31	7	3	3	0	3
137	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	f	24	7	2	1	1	1
138	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	d	24	7	8	3	4	4
139	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	e	29	7	10	7	7	3
140	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	f	15	7	14	8	10	4
141	9/07/95	OQCH	2	D	Pickersgill	41.09.20	174.16.15	1	a	55	7	1	0	1	0
142	9/07/95	OQCH	2	D	Pickersgill	41.09.20	174.16.15	1	b	18	7	1	0	0	1
143	9/07/95	OQCH	2	D	Pickersgill	41.09.20	174.16.15	1	c	37	7	27	12	8	19
144	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	a	27	7	0	0	0	0
145	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	b	27	7	4	4	2	1
146	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	c	31	7	2	1	1	1
147	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	a	16	7	7	5	3	4
148	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	b	13	7	0	0	0	0
149	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	c	26	7	2	2	0	2
150	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	1	d	18	7	1	0	0	1
151	9/07/95	OQCH	2	D	Pickersgill	41.09.20	174.16.15	1	e	18	7	4	1	1	3
152	9/07/95	OQCH	2	D	Pickersgill	41.09.20	174.16.15	1	f	26	7	4	2	2	2
153	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	d	27	7	6	5	5	1
154	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	e	26	7	5	4	2	3
155	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	f	29	4	9	4	1	8
156	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	d	13	7	8	7	3	5
157	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	e	24	7	13	7	6	7
158	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	f	26	7	0	0	0	0
162	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	a	11	7	4	3	3	1
163	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	b	15	7	1	1	0	1
164	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	c	26	7	29	29	26	3
165	9/08/95	EQCH	3	A	Stella Rock	41.05.58	174.21.90	2	a	33	7	14	12	13	1
166	9/08/95	EQCH	3	A	Stella Rock	41.05.58	174.21.90	2	b	22	7	6	6	6	0
167	9/08/95	EQCH	3	A	Stella Rock	41.05.58	174.21.90	2	c	26	7	8	8	8	0
168	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	a	15	7	0	0	0	0
169	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	b	15	7	0	0	0	0
170	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	c	15	7	0	0	0	0
171	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	d	11	7	0	0	0	0
172	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	e	15	7	4	3	3	1
173	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	f	27	7	10	10	9	1
174	9/08/95	EQCH	3	A	Stella Rock	41.05.58	174.21.90	2	d	35	7	3	3	2	1
175	9/08/95	EQCH	3	A	Stella Rock	41.05.58	174.21.90	2	e	29	7	5	3	3	2
176	9/08/95	EQCH	3	A	Stella Rock	41.05.58	174.21.90	2	f	22	7	5	4	4	1

Appendix 1: *—continued*

Station	Date	Stratum	Straum code	Area	Location	Latitude	Longitude	Site	Pot	Depth (m)	Bottom type	Total BCO	BCO > 28 cm	Male BCO	Female BCO
177	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	d	15	7	0	0	0	0
178	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	e	16	7	1	0	0	1
179	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	f	9	7	0	0	0	0
180	9/08/95	EQCH	3	B	The Twins	41.06.45	174.19.45	1	a	16	7	6	4	4	2
181	9/08/95	EQCH	3	B	The Twins	41.06.45	174.19.45	1	b	18	7	2	1	2	0
182	9/08/95	EQCH	3	B	The Twins	41.06.45	174.19.45	1	c	20	7	3	3	3	0
183	9/08/95	EQCH	3	B	The Twins	41.06.55	174.19.55	2	a	33	7	1	1	1	0
184	9/08/95	EQCH	3	B	The Twins	41.06.55	174.19.55	2	b	24	7	0	0	0	0
185	9/08/95	EQCH	3	B	The Twins	41.06.55	174.19.55	2	c	18	7	0	0	0	0
186	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	a	18	7	1	1	1	0
187	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	b	16	7	2	1	1	1
188	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	c	16	7	10	6	8	2
189	9/08/95	EQCH	3	B	The Twins	41.06.45	174.19.45	1	d	18	7	4	3	3	1
190	9/08/95	EQCH	3	B	The Twins	41.06.45	174.19.45	1	e	20	7	0	0	0	0
191	9/08/95	EQCH	3	B	The Twins	41.06.45	174.19.45	1	f	18	7	1	1	1	0
192	9/08/95	EQCH	3	B	The Twins	41.06.55	174.19.55	2	d	33	7	0	0	0	0
193	9/08/95	EQCH	3	B	The Twins	41.06.55	174.19.55	2	e	24	7	0	0	0	0
194	9/08/95	EQCH	3	B	The Twins	41.06.55	174.19.55	2	f	15	7	3	1	2	1
195	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	d	16	7	1	1	1	0
196	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	e	18	7	0	0	0	0
197	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	f	18	7	0	0	0	0
200	9/09/95	EQCH	3	C	Jackson	41.00.10	174.18.20	1	a	24	7	17	17	16	1
201	9/09/95	EQCH	3	C	Jackson	41.00.10	174.18.20	1	b	16	7	6	3	6	0
202	9/09/95	EQCH	3	C	Jackson	41.00.10	174.18.20	1	c	18	7	3	1	3	0
203	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	a	16	7	16	10	14	2
204	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	b	18	7	4	3	4	0
205	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	c	18	7	18	16	15	3
206	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	a	20	7	5	3	3	2
207	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	b	33	7	1	1	0	1
208	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	c	18	7	4	4	3	1
209	9/09/95	EQCH	3	C	Jackson	41.00.10	174.18.20	1	d	24	7	3	2	2	1
210	9/09/95	EQCH	3	C	Jackson	41.00.10	174.18.20	1	e	13	7	0	0	0	0
211	9/09/95	EQCH	3	C	Jackson	41.00.10	174.18.20	1	f	15	7	0	0	0	0
212	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	d	16	7	10	8	8	2
213	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	e	16	7	7	1	4	3
214	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	f	18	7	14	14	13	1
215	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	d	27	7	6	5	6	0
216	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	e	16	7	6	4	5	1
217	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	f	18	7	4	3	2	2
218	9/09/95	EQCH	3	D	Alligator	40.58.60	174.10.16	1	a	15	7	5	3	3	2
219	9/09/95	EQCH	3	D	Alligator	40.58.60	174.10.16	1	b	16	7	5	4	5	0
220	9/09/95	EQCH	3	D	Alligator	40.58.60	174.10.16	1	c	22	7	4	3	4	0
221	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	a	26	7	6	5	5	1
222	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	b	13	7	3	3	2	1
223	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	c	11	7	3	3	3	0
224	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	a	22	7	27	17	18	9
225	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	b	15	7	2	2	1	1
226	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	c	15	7	11	11	11	0
227	9/09/95	EQCH	3	D	Alligator	40.58.60	174.10.16	1	d	31	7	4	3	4	0
228	9/09/95	EQCH	3	D	Alligator	40.58.60	174.10.16	1	e	27	7	3	2	2	1
229	9/09/95	EQCH	3	D	Alligator	40.58.60	174.10.16	1	f	31	7	25	23	23	2
230	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	d	20	7	4	4	4	0
231	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	e	15	7	3	3	3	0
232	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	f	11	7	1	0	0	1
233	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	d	27	7	5	2	2	3
234	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	e	18	7	2	0	1	1
235	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	f	20	7	9	9	8	1
236	9/10/95	EOPE	4	A	Outer Forsyth	40.57.55	174.05.22	1	a	33	7	20	19	19	1
237	9/10/95	EOPE	4	A	Outer Forsyth	40.57.55	174.05.22	1	b	31	7	15	15	14	1
238	9/10/95	EOPE	4	A	Outer Forsyth	40.57.55	174.05.22	1	c	22	2	16	7	9	7
239	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	a	33	2	0	0	0	0
240	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	b	26	2	2	1	1	1
241	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	c	16	2	0	0	0	0
242	9/10/95	EOPE	4	A	Outer Forsyth	40.57.05	174.04.88	3	a	55	7	6	4	6	0
243	9/10/95	EOPE	4	A	Outer Forsyth	40.57.05	174.04.88	3	b	37	1	9	6	7	2
244	9/10/95	EOPE	4	A	Outer Forsyth	40.57.05	174.04.88	3	c	16	2	7	7	6	1
245	9/10/95	EOPE	4	A	Outer Forsyth	40.57.55	174.05.22	1	d	31	7	13	12	12	1
246	9/10/95	EOPE	4	A	Outer Forsyth	40.57.55	174.05.22	1	e	37	7	7	7	6	1
247	9/10/95	EOPE	4	A	Outer Forsyth	40.57.55	174.05.22	1	f	24	2	6	1	2	4
248	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	d	35	2	0	0	0	0
249	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	e	26	2	0	0	0	0
250	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	f	16	2	0	0	0	0
251	9/10/95	EOPE	4	A	Outer Forsyth	40.57.05	174.04.88	3	d	55	2	10	8	9	1
252	9/10/95	EOPE	4	A	Outer Forsyth	40.57.05	174.04.88	3	e	37	2	2	2	2	0
253	9/10/95	EOPE	4	A	Outer Forsyth	40.57.05	174.04.88	3	f	18	2	13	10	7	6
254	9/10/95	EOPE	4	B	Chetwode	40.54.42	174.03.95	1	a	26	7	4	3	3	1
255	9/10/95	EOPE	4	B	Chetwode	40.54.42	174.03.95	1	b	37	7	6	1	3	3
256	9/10/95	EOPE	4	B	Chetwode	40.54.42	174.03.95	1	c	18	7	7	1	4	3
257	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	a	33	7	10	9	10	0
258	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	b	27	7	10	8	10	0
259	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	c	44	7	19	19	19	0
260	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	a	33	7	5	3	4	1

Appendix 1: *—continued*

Station	Date	Stratum	Straum code	Area	Location	Latitude	Longitude	Site	Pot	Depth (m)	Bottom type	Total BCO	BCO > 28 cm	Male BCO	Female BCO
261	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	b	29	7	8	2	3	5
262	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	c	20	7	1	1	1	0
263	9/10/95	EOPE	4	B	Chetwode	40.54.42	174.03.95	1	d	37	7	8	0	3	5
264	9/10/95	EOPE	4	B	Chetwode	40.54.42	174.03.95	1	e	26	7	3	2	3	0
265	9/10/95	EOPE	4	B	Chetwode	40.54.42	174.03.95	1	f	20	7	2	1	2	0
266	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	d	27	7	0	0	0	0
267	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	e	29	7	12	10	10	0
268	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	f	38	7	4	4	4	0
269	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	d	27	7	35	26	32	3
270	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	e	26	7	18	9	16	2
271	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	f	18	7	5	2	4	1
275	9/11/95	OPEL	5	A	The Reef	41.00.35	173.56.40	1	a	40	7	18	16	5	13
276	9/11/95	OPEL	5	A	The Reef	41.00.35	173.56.40	1	b	38	7	10	3	4	6
277	9/11/95	OPEL	5	A	The Reef	41.00.35	173.56.40	1	c	26	7	9	3	3	6
278	9/11/95	OPEL	5	A	The Reef	41.00.50	173.56.40	2	a	26	2	0	0	0	0
279	9/11/95	OPEL	5	A	The Reef	41.00.50	173.56.40	2	b	27	2	0	0	0	0
280	9/11/95	OPEL	5	A	The Reef	41.00.50	173.56.40	2	c	29	2	0	0	0	0
281	9/11/95	OPEL	5	A	The Reef	41.10.05	173.56.15	3	a	20	2	0	0	0	0
282	9/11/95	OPEL	5	A	The Reef	41.10.05	173.56.15	3	b	26	2	1	0	0	1
283	9/11/95	OPEL	5	A	The Reef	41.10.05	173.56.15	3	c	29	2	0	0	0	0
284	9/11/95	OPEL	5	A	The Reef	41.00.35	173.56.40	1	d	44	7	14	11	7	7
285	9/11/95	OPEL	5	A	The Reef	41.00.35	173.56.40	1	e	33	7	14	12	9	5
286	9/11/95	OPEL	5	A	The Reef	41.00.35	173.56.40	1	f	27	7	9	4	6	3
287	9/11/95	OPEL	5	A	The Reef	41.00.50	173.56.40	2	d	26	2	0	0	0	0
288	9/11/95	OPEL	5	A	The Reef	41.00.50	173.56.40	2	e	26	2	2	0	0	2
289	9/11/95	OPEL	5	A	The Reef	41.00.50	173.56.40	2	f	13	2	0	0	0	0
290	9/11/95	OPEL	5	A	The Reef	41.10.05	173.56.15	3	d	11	7	2	0	0	2
291	9/11/95	OPEL	5	A	The Reef	41.10.05	173.56.15	3	e	20	7	1	0	0	1
292	9/11/95	OPEL	5	A	The Reef	41.10.05	173.56.15	3	f	16	7	6	4	4	2
293	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.40	1	a	27	7	2	0	1	1
294	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.40	1	b	29	7	4	0	2	2
295	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.40	1	c	20	7	6	4	3	3
296	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.10	2	a	16	7	2	0	0	2
297	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.10	2	b	20	7	19	10	9	10
298	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.10	2	c	16	7	1	0	0	1
299	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.50	173.56.60	3	a	20	7	32	11	14	18
300	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.50	173.56.60	3	b	22	7	14	3	7	7
301	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.50	173.56.60	3	c	29	7	9	0	5	4
302	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.40	1	d	24	7	4	2	3	1
303	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.40	1	e	29	7	5	0	1	4
304	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.40	1	f	24	7	5	3	2	3
305	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.10	2	d	13	7	8	1	2	6
306	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.10	2	e	18	7	7	3	4	3
307	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.25	173.57.10	2	f	16	7	1	0	0	1
308	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.50	173.56.60	3	d	15	7	17	7	7	10
309	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.50	173.56.60	3	e	24	7	3	2	3	0
310	9/11/95	OPEL	5	B	Boat Rock Poin	40.58.50	173.56.60	3	f	29	7	8	1	2	6
332	9/12/95	OPEL	5	C	Katira Point	40.58.05	174.01.10	1	a	18	2	2	2	1	1
333	9/12/95	OPEL	5	C	Katira Point	40.58.05	174.01.10	1	b	18	2	10	8	8	2
334	9/12/95	OPEL	5	C	Katira Point	40.58.05	174.01.10	1	c	16	2	4	3	2	2
335	9/12/95	OPEL	5	C	Katira Point	40.58.15	174.00.50	2	a	33	2	0	0	0	0
336	9/12/95	OPEL	5	C	Katira Point	40.58.15	174.00.50	2	b	31	2	6	6	6	0
337	9/12/95	OPEL	5	C	Katira Point	40.58.15	174.00.50	2	c	16	2	1	0	0	0
338	9/12/95	OPEL	5	C	Katira Point	40.58.00	174.00.20	3	a	15	2	0	0	0	0
339	9/12/95	OPEL	5	C	Katira Point	40.58.00	174.00.20	3	b	16	2	1	0	1	0
340	9/12/95	OPEL	5	C	Katira Point	40.58.00	174.00.20	3	c	22	2	1	1	1	0
341	9/12/95	OPEL	5	C	Katira Point	40.58.05	174.01.10	1	d	20	7	1	1	1	0
342	9/12/95	OPEL	5	C	Katira Point	40.58.05	174.01.10	1	e	18	1	9	4	8	1
343	9/12/95	OPEL	5	C	Katira Point	40.58.05	174.01.10	1	f	18	1	5	1	3	2
344	9/12/95	OPEL	5	C	Katira Point	40.58.15	174.00.50	2	d	33	7	6	3	2	4
345	9/12/95	OPEL	5	C	Katira Point	40.58.15	174.00.50	2	e	20	7	1	1	1	0
346	9/12/95	OPEL	5	C	Katira Point	40.58.15	174.00.50	2	f	18	2	0	0	0	0
347	9/12/95	OPEL	5	C	Katira Point	40.58.00	174.00.20	3	d	8	7	4	2	2	2
348	9/12/95	OPEL	5	C	Katira Point	40.58.00	174.00.20	3	e	16	7	0	0	0	0
349	9/12/95	OPEL	5	C	Katira Point	40.58.00	174.00.20	3	f	16	7	0	0	0	0
314	9/12/95	OPEL	5	D	Duffers Reef	40.57.52	174.02.25	1	a	20	7	11	10	9	2
315	9/12/95	OPEL	5	D	Duffers Reef	40.57.52	174.02.25	1	b	38	7	0	0	0	0
316	9/12/95	OPEL	5	D	Duffers Reef	40.57.52	174.02.25	1	c	18	7	54	32	41	13
317	9/12/95	OPEL	5	D	Duffers Reef	40.57.41	174.02.50	2	a	18	7	6	5	4	2
318	9/12/95	OPEL	5	D	Duffers Reef	40.57.41	174.02.50	2	b	27	7	1	0	1	0
319	9/12/95	OPEL	5	D	Duffers Reef	40.57.41	174.02.50	2	c	20	7	24	15	17	7
320	9/12/95	OPEL	5	D	Duffers Reef	40.57.25	174.03.25	3	a	22	7	18	12	9	9
321	9/12/95	OPEL	5	D	Duffers Reef	40.57.25	174.03.25	3	b	18	7	15	12	11	4
322	9/12/95	OPEL	5	D	Duffers Reef	40.57.25	174.03.25	3	c	33	2	0	0	0	0
323	9/12/95	OPEL	5	D	Duffers Reef	40.57.52	174.02.25	1	d	20	2	18	8	9	9
324	9/12/95	OPEL	5	D	Duffers Reef	40.57.52	174.02.25	1	e	18	7	4	2	3	1
325	9/12/95	OPEL	5	D	Duffers Reef	40.57.52	174.02.25	1	f	26	7	33	16	25	8
326	9/12/95	OPEL	5	D	Duffers Reef	40.57.41	174.02.50	2	d	24	7	3	2	2	1
327	9/12/95	OPEL	5	D	Duffers Reef	40.57.41	174.02.50	2	e	18	7	12	12	9	3
328	9/12/95	OPEL	5	D	Duffers Reef	40.57.41	174.02.50	2	f	18	7	20	15	12	8
329	9/12/95	OPEL	5	D	Duffers Reef	40.57.25	174.03.25	3	d	24	7	6	5	5	1
330	9/12/95	OPEL	5	D	Duffers Reef	40.57.25	174.03.25	3	e	18	7	9	5	5	4

Appendix 1: —*continued*

Station	Date	Stratum	Straum code	Area	Location	Latitude	Longitude	Site	Pot	Depth (m)	Bottom type	Total BCO	BCO > 28 cm	Male BCO	Female BCO
331	9/12/95	OPEL	5	D	Duffers Reef	40.57.25	174.03.25	3	f	24	7	11	4	6	5
353	9/12/95	EOPE	4	C	Clay Point	40.53.40	173.58.85	1	a	38	7	19	17	13	6
354	9/12/95	EOPE	4	C	Clay Point	40.53.40	173.58.85	1	b	38	7	8	7	7	1
355	9/12/95	EOPE	4	C	Clay Point	40.53.40	173.58.85	1	c	20	7	4	1	2	2
356	9/12/95	EOPE	4	C	Clay Point	40.53.65	173.58.70	2	a	46	7	11	6	8	3
357	9/12/95	EOPE	4	C	Clay Point	40.53.65	173.58.70	2	b	31	7	10	7	8	2
358	9/12/95	EOPE	4	C	Clay Point	40.53.65	173.58.70	2	c	29	7	8	5	7	1
359	9/12/95	EOPE	4	C	Clay Point	40.54.05	173.58.60	3	a	37	7	15	5	6	9
360	9/12/95	EOPE	4	C	Clay Point	40.54.05	173.58.60	3	b	27	7	2	2	2	0
361	9/12/95	EOPE	4	C	Clay Point	40.54.05	173.58.60	3	c	33	7	9	5	2	7
362	9/12/95	EOPE	4	C	Clay Point	40.53.40	173.58.85	1	d	35	7	19	10	13	6
363	9/12/95	EOPE	4	C	Clay Point	40.53.40	173.58.85	1	e	27	7	21	14	17	4
364	9/12/95	EOPE	4	C	Clay Point	40.53.40	173.58.85	1	f	22	7	20	3	11	9
365	9/12/95	EOPE	4	C	Clay Point	40.53.65	173.58.70	2	d	35	7	4	4	4	0
366	9/12/95	EOPE	4	C	Clay Point	40.53.65	173.58.70	2	e	15	7	6	6	6	0
367	9/12/95	EOPE	4	C	Clay Point	40.53.65	173.58.70	2	f	27	7	0	0	0	0
368	9/12/95	EOPE	4	C	Clay Point	40.54.05	173.58.60	3	d	37	7	16	10	13	3
369	9/12/95	EOPE	4	C	Clay Point	40.54.05	173.58.60	3	e	27	7	7	5	6	1
370	9/12/95	EOPE	4	C	Clay Point	40.54.05	173.58.60	3	f	33	7	4	4	4	0
371	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	a	15	7	4	4	3	1
372	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	b	20	7	4	1	3	1
373	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	c	24	7	5	2	3	2
374	13/9/95	EOPE	4	D	Harris Bay	40.55.15	174.01.05	2	a	9	2	19	19	18	1
375	13/9/95	EOPE	4	D	Harris Bay	40.55.15	174.01.05	2	b	15	2	0	0	0	0
376	13/9/95	EOPE	4	D	Harris Bay	40.55.15	174.01.05	2	c	15	2	0	0	0	0
377	13/9/95	EOPE	4	D	Harris Bay	40.55.35	174.01.20	3	a	16	2	0	0	0	0
378	13/9/95	EOPE	4	D	Harris Bay	40.55.35	174.01.20	3	b	31	7	3	1	2	1
379	13/9/95	EOPE	4	D	Harris Bay	40.55.35	174.01.20	3	c	15	7	32	25	21	11
380	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	d	15	7	5	4	4	1
381	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	e	13	7	1	0	0	1
382	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	f	20	7	7	2	4	3
383	13/9/95	EOPE	4	D	Harris Bay	40.55.15	174.01.05	2	d	9	2	0	0	0	0
384	13/9/95	EOPE	4	D	Harris Bay	40.55.15	174.01.05	2	e	18	2	0	0	0	0
385	13/9/95	EOPE	4	D	Harris Bay	40.55.15	174.01.05	2	f	15	2	0	0	0	0
386	13/9/95	EOPE	4	D	Harris Bay	40.55.35	174.01.20	3	d	13	2	3	0	0	1
387	13/9/95	EOPE	4	D	Harris Bay	40.55.35	174.01.20	3	e	16	7	4	3	3	1
388	13/9/95	EOPE	4	D	Harris Bay	40.55.35	174.01.20	3	f	15	7	5	1	0	5

Line fishing stations

900	9/05/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	g	26	7	0	0	0	0
901	9/04/95	IQCH	1	A	Kaipapa	41.13.92	174.04.82	3	h	16	7	0	0	0	0
902	9/04/95	IQCH	1	A	Kaipapa	41.13.75	174.04.28	1	g	42	7	0	0	0	0
903	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	g	22	7	2	2	2	0
904	9/04/95	IQCH	1	B	Dieffenbach	41.04.33	174.07.61	4	a	37	7	0	0	0	0
905	9/04/95	IQCH	1	B	Dieffenbach	41.14.23	174.07.50	1	g	35	7	0	0	0	0
906	9/04/95	IQCH	1	A	Dieffenbach	41.14.23	174.07.50	1	h	9	7	0	0	0	0
907	9/05/95	IQCH	1	C	Luke	41.13.33	174.08.12	1	g	37	7	0	0	0	0
908	9/05/95	IQCH	1	C	Luke	41.12.73	174.08.07	2	g	26	7	0	0	0	0
909	9/05/95	IQCH	1	C	Luke	41.13.08	174.08.62	3	g	7	7	0	0	0	0
910	9/05/95	OQCH	2	A	Tory	41.14.25	174.12.63	3	g	15	7	0	0	0	0
911	9/05/95	OQCH	2	A	Tory	41.14.44	174.11.24	1	g	26	7	0	0	0	0
912	9/05/95	OQCH	2	A	Tory	41.14.68	174.12.00	2	g	15	7	0	0	0	0
913	9/06/95	IQCH	1	D	Coves	41.11.46	174.09.29	3	g	26	7	0	0	0	0
914	9/06/95	IQCH	1	D	Coves	41.11.54	174.09.22	2	g	22	7	0	0	0	0
915	9/06/95	IQCH	1	D	Coves	41.12.40	174.10.21	1	g	44	7	0	0	0	0
916	9/06/95	OQCH	2	B	Hawes	41.11.62	174.13.12	3	g	13	7	1	1	0	1
917	9/06/95	OQCH	2	B	Hawes	41.12.71	174.11.45	1	g	26	7	0	0	0	0
918	9/06/95	OQCH	2	B	Hawes	41.12.42	174.12.88	2	g	22	7	0	0	0	0
919	9/07/95	OQCH	2	C	Resolution	41.07.50	174.14.88	3	g	16	7	5	3	2	3
920	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	g	27	7	0	0	0	0
921	9/07/95	OQCH	2	C	Resolution	41.08.52	174.13.36	2	g	26	7	3	3	1	2
922	9/07/95	OQCH	2	C	Resolution	41.08.01	174.13.34	1	h	26	7	3	3	2	1
923	9/07/95	OQCH	2	D	Pickersgill	41.10.00	174.16.51	3	g	11	7	0	0	0	0
924	9/07/95	OQCH	2	D	Pickersgill	41.09.77	174.16.30	2	g	16	7	0	0	0	0
925	9/07/95	OQCH	2	D	Pickersgill	41.09.90	174.16.69	3	h	26	7	0	0	0	0
926	9/08/95	EQCH	3	A	Stella Rock	41.05.50	174.22.35	1	g	7	7	0	0	0	0
927	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	g	7	7	0	0	0	0
928	9/08/95	EQCH	3	A	Stella Rock	41.06.00	174.22.55	3	h	9	7	0	0	0	0
929	9/08/95	EQCH	3	B	The Twins	41.06.94	174.19.90	3	g	16	.	0	0	0	0
930	9/08/95	EQCH	3	B	The Twins	41.06.30	174.19.50	3	h	15	7	0	0	0	0
959	9/08/95	EQCH	3	B	The Twins	41.06.30	174.19.50	3	h	15	7	0	0	0	0
931	9/09/95	EQCH	3	C	Jackson	40.59.10	174.18.20	3	g	18	7	1	0	1	0
932	9/09/95	EQCH	3	C	Jackson	41.00.60	174.18.20	2	g	18	7	8	7	6	1
933	9/09/95	EQCH	3	D	Jackson	41.58.60	174.10.16	1	g	22	7	2	2	2	0
934	9/09/95	EQCH	3	D	Alligator	40.58.00	174.10.30	2	g	20	7	0	0	0	0
935	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	g	24	7	1	1	1	0
960	9/09/95	EQCH	3	D	Alligator	40.57.40	174.09.20	3	g	24	7	0	0	0	0
936	9/10/95	EPOE	4	A	Outer Forsyth	40.57.05	174.04.88	3	g	9	7	2	2	1	1
937	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	2	g	31	7	0	0	0	0
938	9/10/95	EOPE	4	A	Outer Forsyth	40.57.50	174.04.62	1	g	31	7	4	2	3	1

Appendix 1: —*continued*

Station	Date	Stratum	Straum code	Area	Location	Latitude	Longitude	Site	Pot	Depth (m)	Bottom type	Total BCO	BCO > 28 cm	Male BCO	Female BCO
939	9/10/95	EOPE	4	B	Chetwode	40.55.00	174.03.35	2	g	29	7	0	0	0	0
940	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	3	g	20	7	0	0	0	0
961	9/10/95	EOPE	4	B	Chetwode	40.54.80	174.03.45	1	g	20	7	0	0	0	0
941	9/11/95	EOPE	5	A	The Reef	41.00.35	173.56.40	1	g	27	7	2	1	1	1
942	9/11/95	EOPE	5	A	The Reef	41.00.50	173.56.40	2	g	15	7	1	0	0	1
943	9/11/95	EOPE	5	A	The Reef	41.10.05	173.56.15	2	g	15	7	0	0	0	0
944	9/11/95	EOPE	5	B	Boat Rock Poin	40.58.10	173.57.40	3	g	20	7	0	0	0	0
945	9/11/95	EOPE	5	B	Boat Rock Poin	40.58.25	173.57.40	2	g	18	7	0	0	0	0
946	9/11/95	EOPE	5	B	Boat Rock Poin	40.58.25	173.57.40	2	g	18	7	0	0	0	0
950	9/12/95	OPEL	5	C	Katira	40.58.00	174.00.20	3	g	20	2	0	0	0	0
951	9/12/95	OPEL	5	C	Katira	40.58.00	174.00.50	2	g	18	7	0	0	0	0
952	9/12/95	OPEL	5	C	Katira	40.58.00	174.00.20	1	g	20	7	0	0	0	0
947	9/12/95	OPEL	5	D	Duffers Reef	40.57.15	174.03.25	3	g	24	7	4	3	3	1
948	9/12/95	OPEL	5	D	Duffers Reef	40.57.30	174.02.25	1	g	16	7	2	0	1	1
949	9/12/95	OPEL	5	D	Duffers Reef	40.57.15	174.02.50	2	g	22	7	4	2	2	2
953	13/9/1995	EOPE	4	C	Clay Point	40.54.04	173.58.60	3	g	35	7	6	6	6	0
954	13/9/1995	EOPE	4	C	Clay Point	40.54.04	173.58.40	2	g	9	7	7	3	3	4
955	13/9/1995	EOPE	4	C	Clay Point	40.53.65	173.58.70	1	g	20	7	12	5	7	5
956	13/9/1995	EOPE	4	D	Harris Bay	40.55.55	174.01.15	3	g	13	7	1	1	1	0
957	13/9/95	EOPE	4	D	Harris Bay	40.55.00	174.03.35	2	g	13	2	0	0	0	0
958	13/9/95	EOPE	4	D	Harris Bay	40.54.85	174.01.35	1	g	18	7	0	0	0	0

Extra pot stations

19	4/09/95	IQCH	1	A	Kaipapa	41.13.61	174.04.02	4	a	44	7	0	0	0	0
20	4/09/95	IQCH	1	A	Kaipapa	41.13.61	174.04.02	4	b	44	1	0	0	0	0
21	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	a	27	2	0	0	0	0
22	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	b	46	2	0	0	0	0
23	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	c	9	7	1	1	0	1
42	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	d	9	8	0	0	0	0
43	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	e	16	8	0	0	0	0
44	9/04/95	IQCH	1	A	Perano	41.13.58	174.06.11	5	f	16	8	0	0	0	0
81	9/05/95	OQCH	2	A	Tory	41.14.64	174.13.05	4	c	15	7	9	7	7	2
82	9/05/95	OQCH	2	A	Tory	41.14.64	174.13.05	4	b	20	7	25	14	18	7
83	9/05/95	OQCH	2	A	Tory	41.14.64	174.13.05	4	c	42	7	12	12	10	2
120	9/06/95	OQCH	2	C	Resolution	41.07.32	174.07.32	4	a	16	7	3	3	2	1
121	9/06/95	OQCH	2	C	Resolution	41.07.32	174.07.32	4	b	11	7	13	9	5	8
122	9/06/95	OQCH	2	C	Resolution	41.07.32	174.07.32	4	c	9	7	1	1	1	0
159	9/07/95	OQCH	2	C	Resolution	41.07.30	174.13.50	5	a	27	7	2	1	2	2
160	9/07/95	OQCH	2	C	Resolution	41.07.30	174.13.50	5	b	33	7	3	3	1	2
161	9/07/95	OQCH	2	C	Resolution	41.07.30	174.13.50	5	c	22	7	32	14	11	21
198	9/08/95	OQCH	2	E	Arapawa Isl	41.09.90	174.19.30	1	a	33	2	6	4	1	5
199	9/08/95	OQCH	2	E	Arapawa Isl	41.09.90	174.19.30	1	b	18	2	6	6	0	6
272	9/11/95	OPEL	5	E	Bulwer	40.57.00	173.58.82	1	a	26	2	9	1	3	6
273	9/11/95	OPEL	5	E	Bulwer	40.57.00	173.58.82	1	b	27	2	6	0	0	6
274	9/11/95	OPEL	5	E	Bulwer	40.57.00	173.58.82	1	c	26	2	9	0	2	7
311	9/11/95	OPEL	5	F	Camp Bay	40.57.30	173.57.35	1	a	20	7	2	0	1	1
312	9/11/95	OPEL	5	F	Camp Bay	40.57.30	173.57.35	1	b	18	7	11	1	4	7
313	9/11/95	OPEL	5	F	Camp Bay	40.57.30	173.57.35	1	c	20	7	19	4	8	11
350	9/12/95	OPEL	5	G	TeAkaroa	40.56.40	174.00.05	1	a	16	2	0	0	0	0
351	9/12/95	OPEL	5	G	TeAkaroa	40.56.40	174.00.05	1	b	15	2	3	3	3	0
352	9/12/95	OPEL	5	G	TeAkaroa	40.56.40	174.00.05	1	c	13	2	0	0	0	0

Appendix 2: CPUE by stratum

Stratum	Mean CPUE Kg per h fished	C.I. (as 2 x S.E.)
IQCH	0.64	0.15
OQCH	1.93	0.22
EQCH	2.42	0.34
EOPE	3.28	0.41
OPEL	2.71	0.43

Appendix 3: Catch rate analysis

3.1 Catch rate of blue cod by time of fishing and sequence of potting

(Catch rate as mean number of blue cod per pot fished)

Class	Levels	Values	
Time	2	1 (morning),	2 (afternoon)
Sequence	2	1 (initial),	2 (repeat)

3.1.1 Pot fishing

(a) Total blue cod

Fmax test indicates significant departure from assumption of heterogeneity of variance.

Log (x+1) transformed data are not significantly heterogenous (s2max/s2min = 1.62, Fmax= 1.96 at 5% level)

ANOVA Table for log (x+1) catch of total BCO per pot hour fished

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	3	2.61	0.87	0.81	0.49	ns
Error	356	384.90	1.08			
Total	359	387.51				
Time	1	0.04	0.04	0.04	0.85	ns
Sequence	1	0.98	0.98	0.90	0.34	ns
Time * Sequence	1	1.59	1.59	1.47	0.23	ns

Class means (Catch per pot hour fished)

Time of fishing	**Sequence of potting**			
	Initial	*s.e.*	Repeat	*s.e.*
Morning	5.988	8.399	5.455	6.453
Afternoon	5.494	6.781	4.123	5.483

Appendix 3–*continued*

(b) Female blue cod

Fmax test indicates significant departure from asssumption of heterogeneity of variance.
Log (x+1) transformed data are not significantly heterogenous (s2max/s2min = 1.23, Fmax= 1.96 at 5% level.

ANOVA Table for log (x+1) catch of female BCO per pot hour fished

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	3	0.37	0.12	0.21	0.888	ns
Error	356	204.86	0.58			
Total	359	205.22				
Time	1	0.01	0.01	0.02	0.895	ns
Sequence	1	0.04	0.04	0.07	0.786	ns
Time * Sequence		0.31	0.31	0.54	0.461	ns

Class means (Catch per pot hour fished)

Time of fishing	**Sequence of potting**			
	Initial	s.*e.*	Repeat	s.*e.*
Morning	1.766	2.840	1.9	2.557
Afternoon	1.989	3.507	1.561	2.099

(c) Large (>28 cm) blue cod

Fmax test indicates significant departure from asssumption of heterogeneity of variance.
Log (x+1) transformed data are not significantly heterogenous (s2max/s2min = 1.65. Fmax= 1.96 at 5% level)

ANOVA Table for log (x+1) catch of large (>28 cm) BCO per pot hour fished

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	3	4.06	1.35	1.51	0.210	ns
Error	356	318.18	0.89			
Total	359	322.24				
Time	1	0.88	0.88	0.98	0.323	ns
Sequence	1	1.96	1.96	2.19	0.140	ns
Time * Sequence	1	1.23	1.23	1.38	0.241	ns

Class means (Catch per pot hour fished)

Time of fishing	**Mean catch rate**	**N**
Morning	3.972	180
Afternoon	3.039	180

Sequence of potting	**Mean catch rate**	**N**
Initial	3.989	180
Repeat	3.016	180

Appendix 3–*continued*

3.1.2 Line fishing

Class	Levels	Values
Time	2	1 (morning), 2 (afternoon)

(a) Total blue cod

Fmax test indicates that assumption of homogeneity of variance does not hold for this analysis.
Log (x+1) transformed data are not significantly heterogenous (s2max/s2min = 1.65. Fmax= 39.0 at 5% level)

ANOVA Table for log (x+1) of total BCO per 15 m soak time

Source	DF	SS	MS	F	Pr > F	Significance
Model	1	7.498	7.498	8.890	0.0042	*
Error	58	48.901	0.843			
Total	59	56.400				
Time	1	7.498	7.498	8.890	0.0042	*

Class means (Catch per 15 m soak time)

Time of fishing	Mean catch rate	s.e.	N
Morning	2.032	2.971	31
Afternoon	0.137	0.441	29

(b) Female blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) catch of female BCO per 15 m soak time

Source	DF	SS	MS	F	Pr > F	Significance
Model	1	2.966	2.966	9.810	0.003	*
Error	58	17.542	0.302			
Total	59	20.508				
Time	1	2.966	2.966	9.810	0.003	*

Class means (Catch per 15 m soak time)

Time of fishing	Mean catch rate	s.e.	N
Morning	1.699	2.056	31
Afternoon	1.089	1.302	29

Appendix 3–*continued*

(c) Large (>28 cm) blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) catch of large (>28 cm) BCO per 15 m soak time

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	1	6.185	6.185	15.120	0.000	*
Error	58	23.724	0.409			
Total	59	29.910				
Time	1	6.185	6.185	15.120	0.000	*

Class means (Catch per 15 m soak time)

Time of fishing	Mean catch rate	s.*e.*	N
Morning	2.071	2.343	31
Afternoon	1.089	1.302	29

3.2 Catch rate by depth range and substrate

Class	Levels	Values
Substrate	4	1 (mud); 2 (sand/mud); 4 (sand/gravel); 7 (rock/rubble)
Depth class	6	1 10 20 30 40 50

3.2.1 Pot fishing

(a) Total blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) catch of total BCO per pot hour fished.

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	14	49.529	3.537	3.610	0.0001	*
Error	345	337.983	0.976			
Total	359	387.512				
		SS (Type III)				
Substrate	3	4.837	1.612	1.650	0.179	ns
Depth class	5	4.106	0.821	0.840	0.523	ns
Substrate*Depth class	6	10.333	1.722	1.760	0.106	ns

Appendix 3–*continued*

Class means (Catch per pot hour fished)

Substrate	Mean catch rate	N
1	7.667	3
7	5.769	299
4	4.500	2
2	2.500	56

Depth class	Mean catch rate	N
30	7.127	55
20	5.977	131
40	5.727	11
1	4.833	6
10	4.053	150
50	3.143	7

(b) Female blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) catch of female BCO per pot hour fished.

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	14	18.978	1.355	2.510	0.002	*
Error	345	186.241	0.539			
Total	359	205.219				
		SS (Type III)				
Substrate	3	1.795	0.598	1.110	0.345	ns
Depth class	5	3.839	0.767	1.420	0.215	ns
Substrate*Depth class	6	5.701	0.950	1.760	0.106	ns

Class means (Catch per pot hour fished)

Substrate	**Mean catch rate**	**N**
4	4.000	2
7	1.970	299
1	1.667	3
2	0.857	56

Depth class	**Mean catch rate**	**N**
30	2.491	55
40	2.182	11
20	2.107	131
10	1.380	150
1	0.500	6
50	0.429	7

Appendix 3–*continued*

(c) Large (>28 cm) blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) catch of large (> 28 cm) BCO per pot hour fished.

Source	DF	SS	MS	F	Pr > F	Significance
Model	14	38.020	2.715	3.300	0.0001	**
Error	345	284.220	0.824			
Total	359	322.241				
		SS (Type III)				
Substrate	3	1.645	0.551	0.670	0.571	ns
Depth class	5	2.620	0.524	0.640	0.672	ns
Substrate*Depth class	6	9.095	1.515	1.840	0.090	ns

Class means (Catch per pot hour fished)

Substrate type	Mean catch rate	N
7	3.856	299
1	3.667	3
4	2.000	2
2	1.679	56

Depth class	Mean catch rate	N
30	5.273	55
40	4.727	11
1	4.333	6
20	3.626	131
10	2.687	150
50	2.286	7

3.2.2 Line fishing

Class	Levels	Values
Substrate	2	2 7
Depth class	3	1 10 20

(a) Total blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) of total BCO per 15 m soak time

Source	DF	SS	MS	F	Pr > F	Significance
Model	4	1.513	0.378	0.380	0.822	ns
Error	55	54.866	0.997			
Total	56	56.400				
Depth class	4	1.513	0.378	0.380	0.822	ns

Appendix 3–*continued*

Class means (Catch per 15 m soak time)

Depth class	**Mean catch rate**	***s.e.***	**N**
0	1.285	2.627	7
10	0.857	2.007	21
20	1.250	2.641	24
30	1.666	2.658	6
40	0.000	0.000	2

(b) Female blue cod

Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) of female BCO per 15 m soak time

Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	4	0.837	0.209	0.590	0.674	ns
Error	55	19.671	0.357			
Total	9	20.508				
Depth class	4	0.837	0.209	0.590	0.674	ns

Class means (Catch per 15 m soak time)

Depth class	Mean catch rate	*s.e.*	N
0	0.571	1.133	7
10	0.476	1.364	21
20	0.791	1.587	24
30	1.500	2.509	6
40	0.000	0.000	2

(c) Large (>28 cm) blue cod

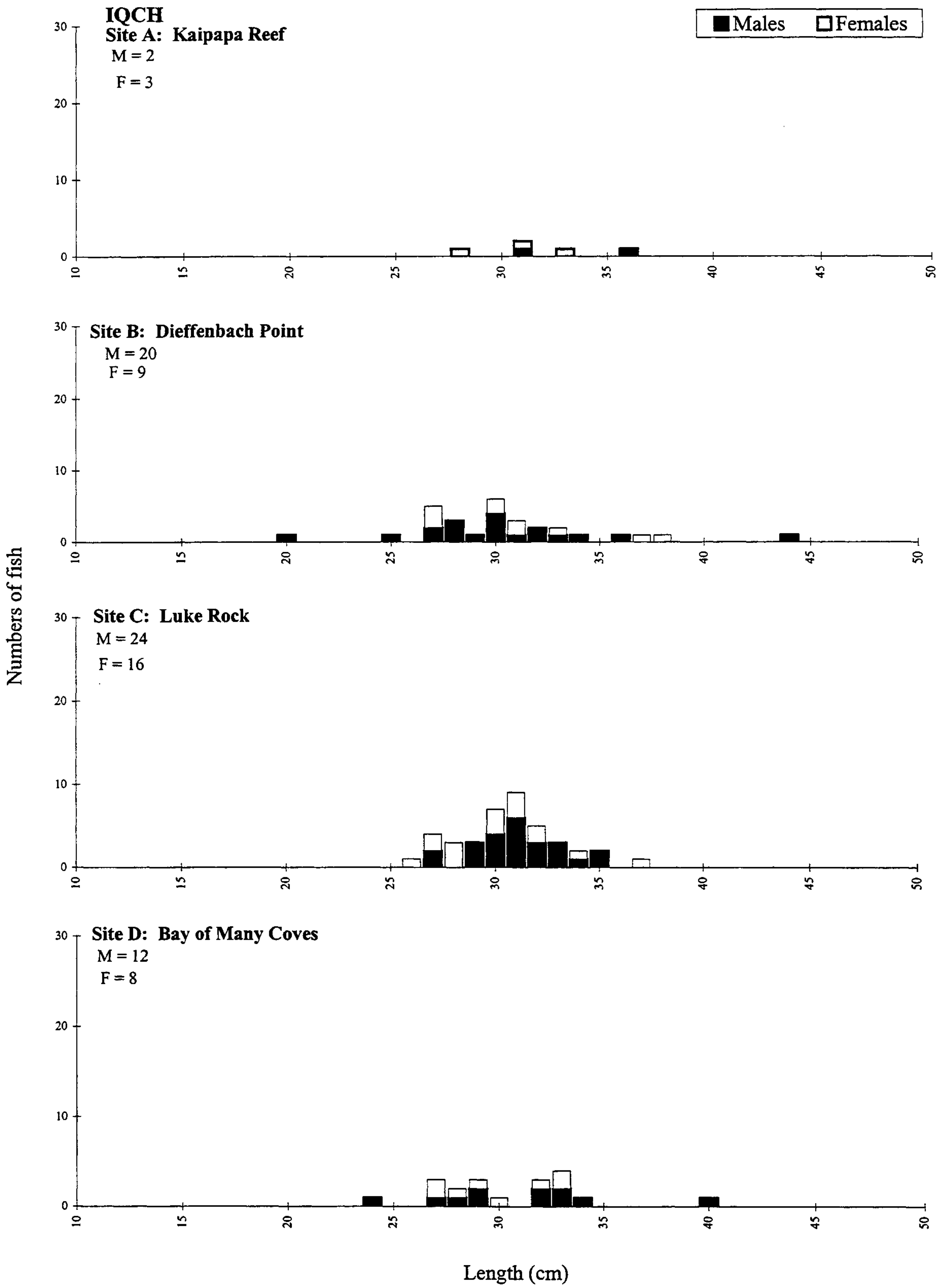
Fmax test indicates that assumption of *homogeneity* of variance does not hold for this analysis.

ANOVA Table for log (x+1) of large (>28 cm) BCO per 15 m soak time

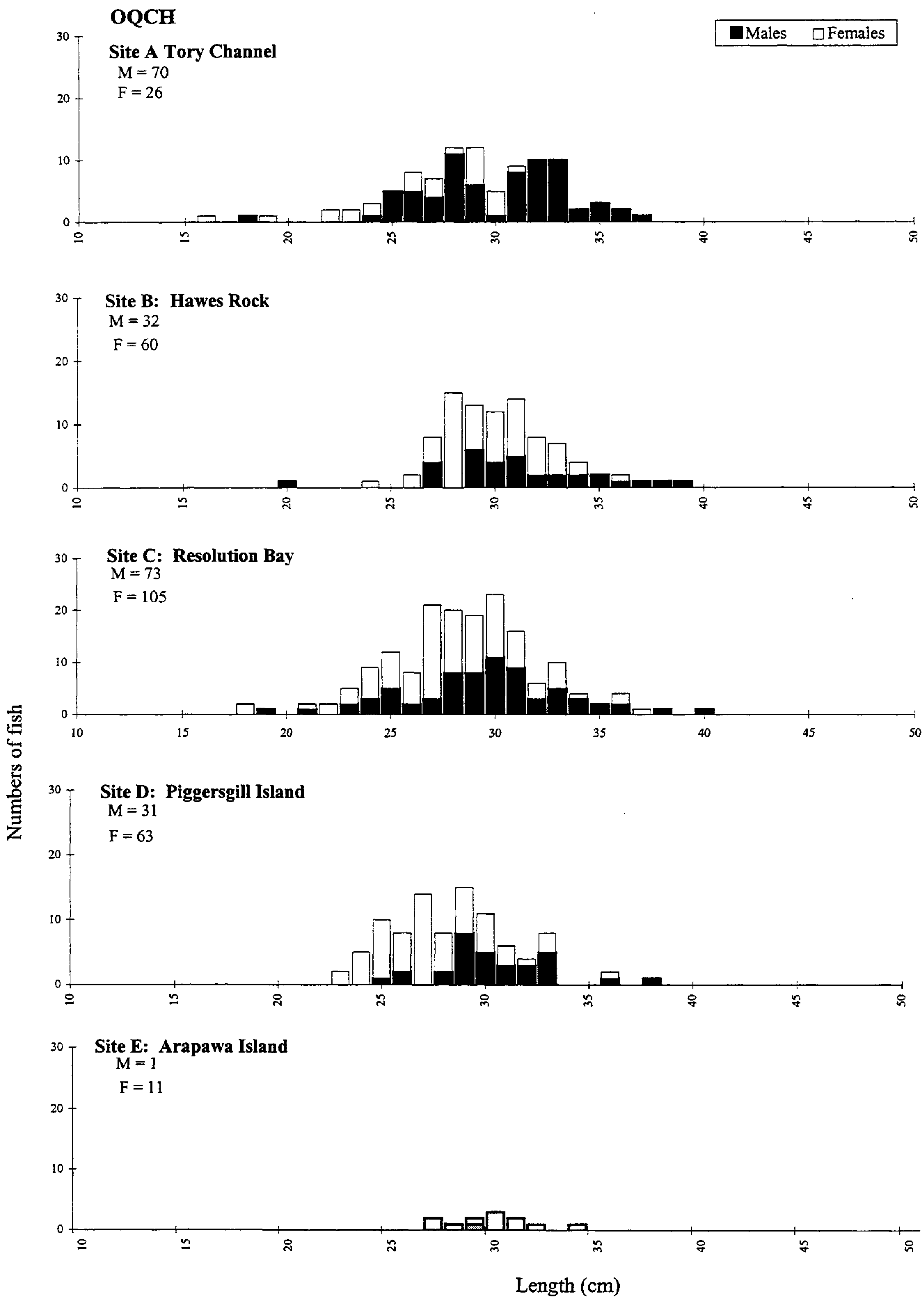
Source	**DF**	**SS**	**MS**	**F**	**Pr > F**	**Significance**
Model	4	0.717	0.178	0.340	0.851	ns
Error	55	29.192	0.530			
Total	59	20.194	0.374			
Depth class	4	0.717	0.178	0.340	0.851	ns

Class means (Catch per 15 m soak time)

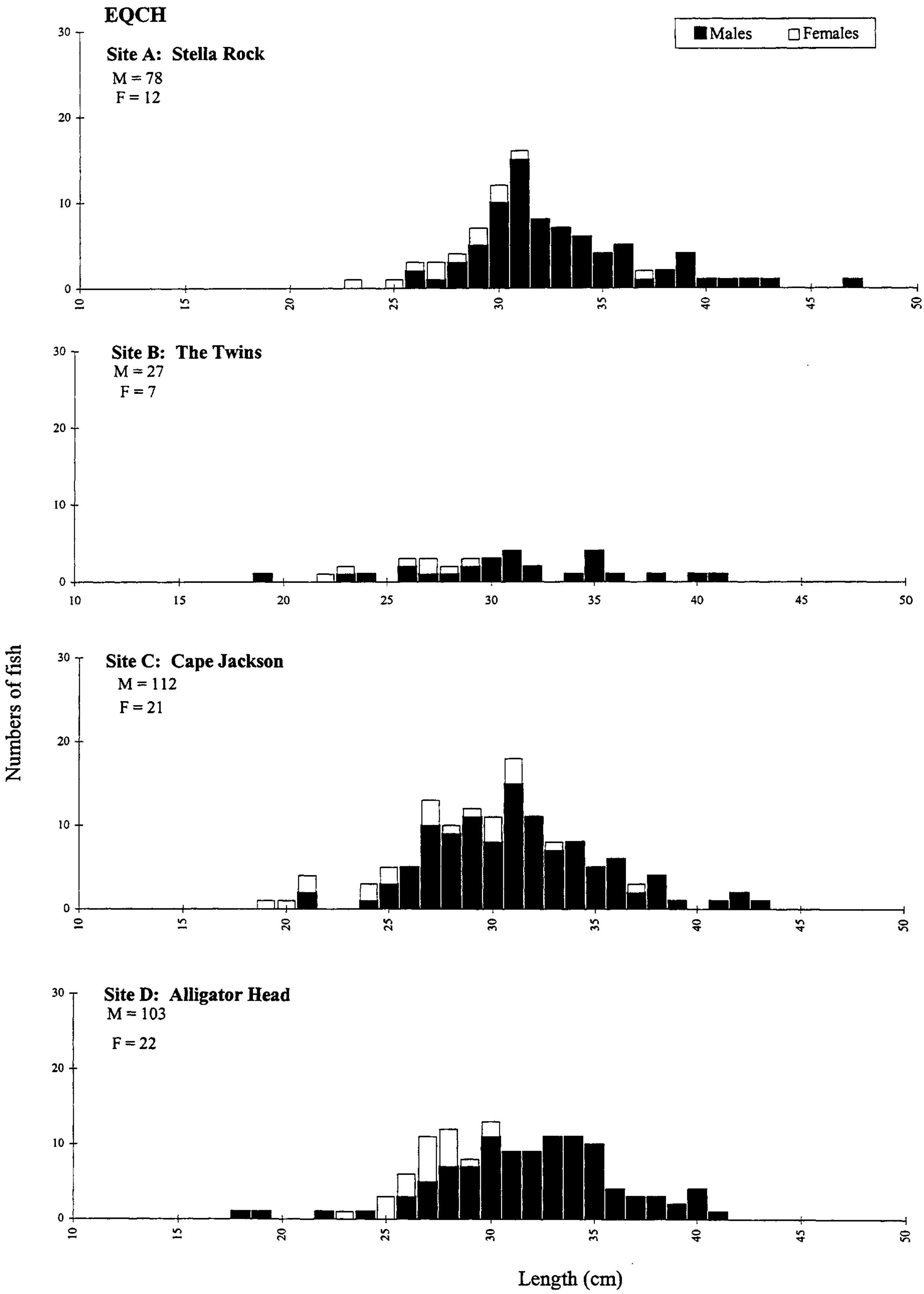
Depth class	**Mean catch rate**	***s.e.***	**N**
0	0.714	0.253	7
10	0.528	1.631	21
20	0.791	1.350	24
30	1.333	2.422	6
40	0.000	0.000	2



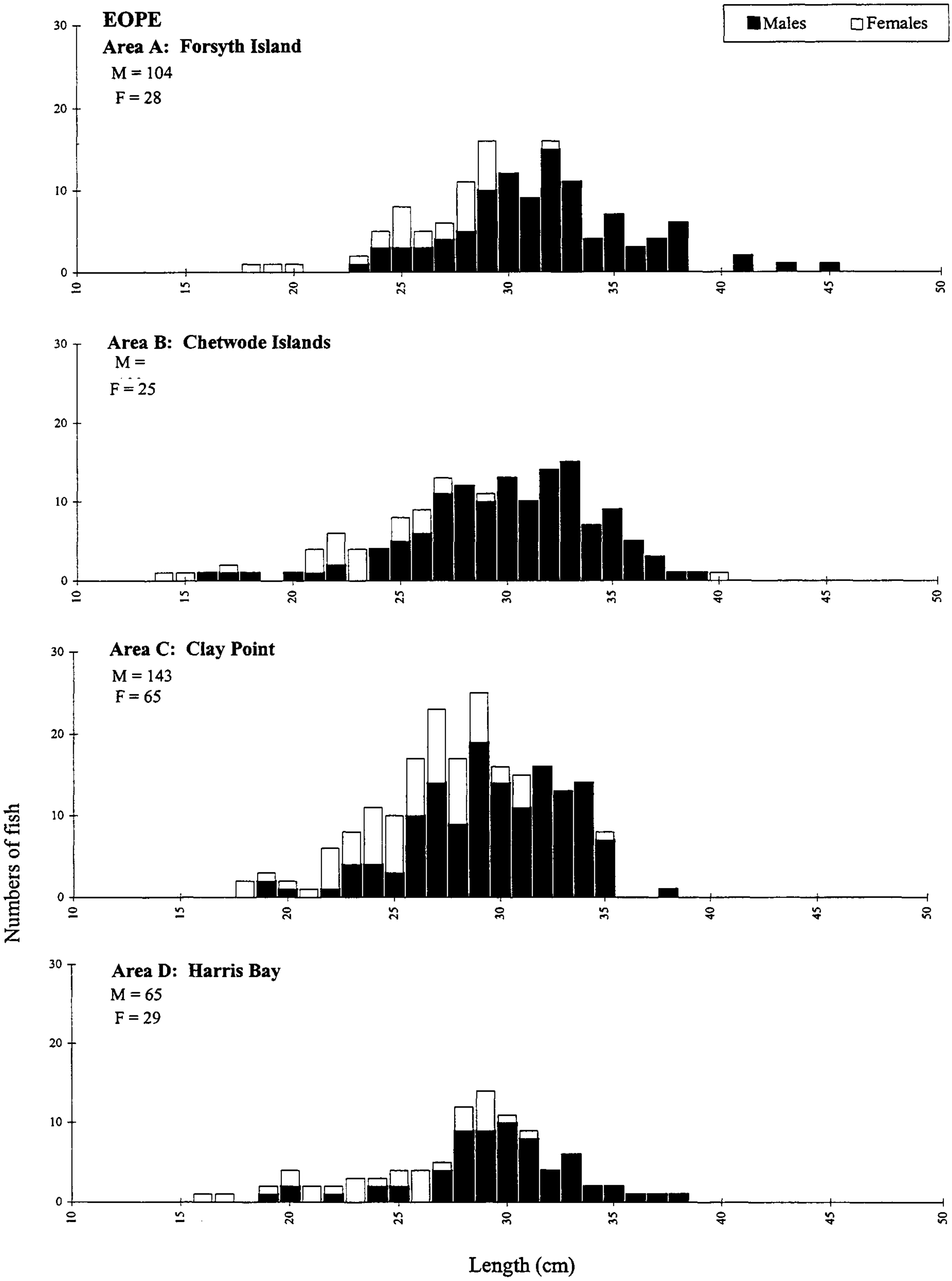
Appendix 4: Length frequency distribution of blue cod by stratum and sample site. Numbers of male and female blue cod are actual numbers measured



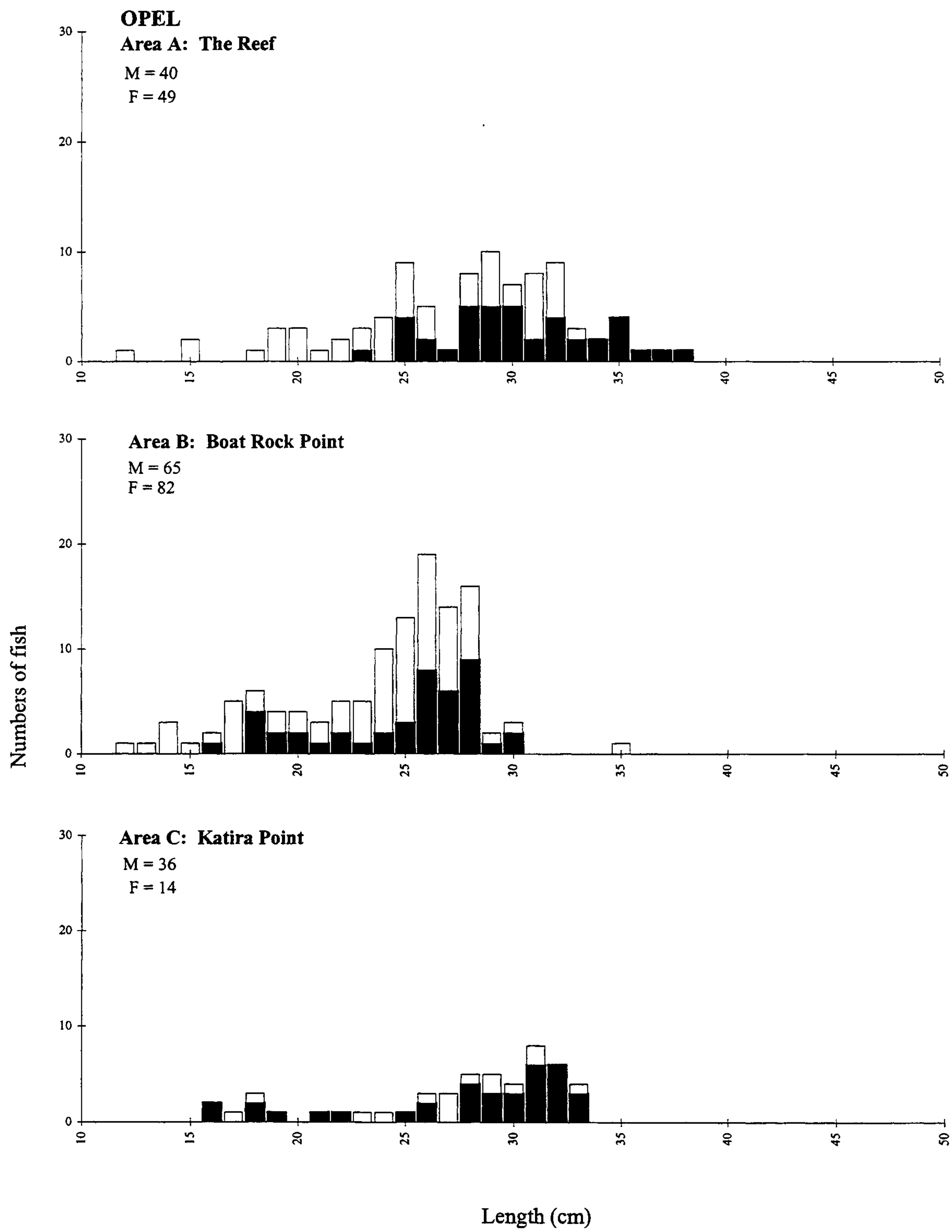
Appendix 4—*continued*



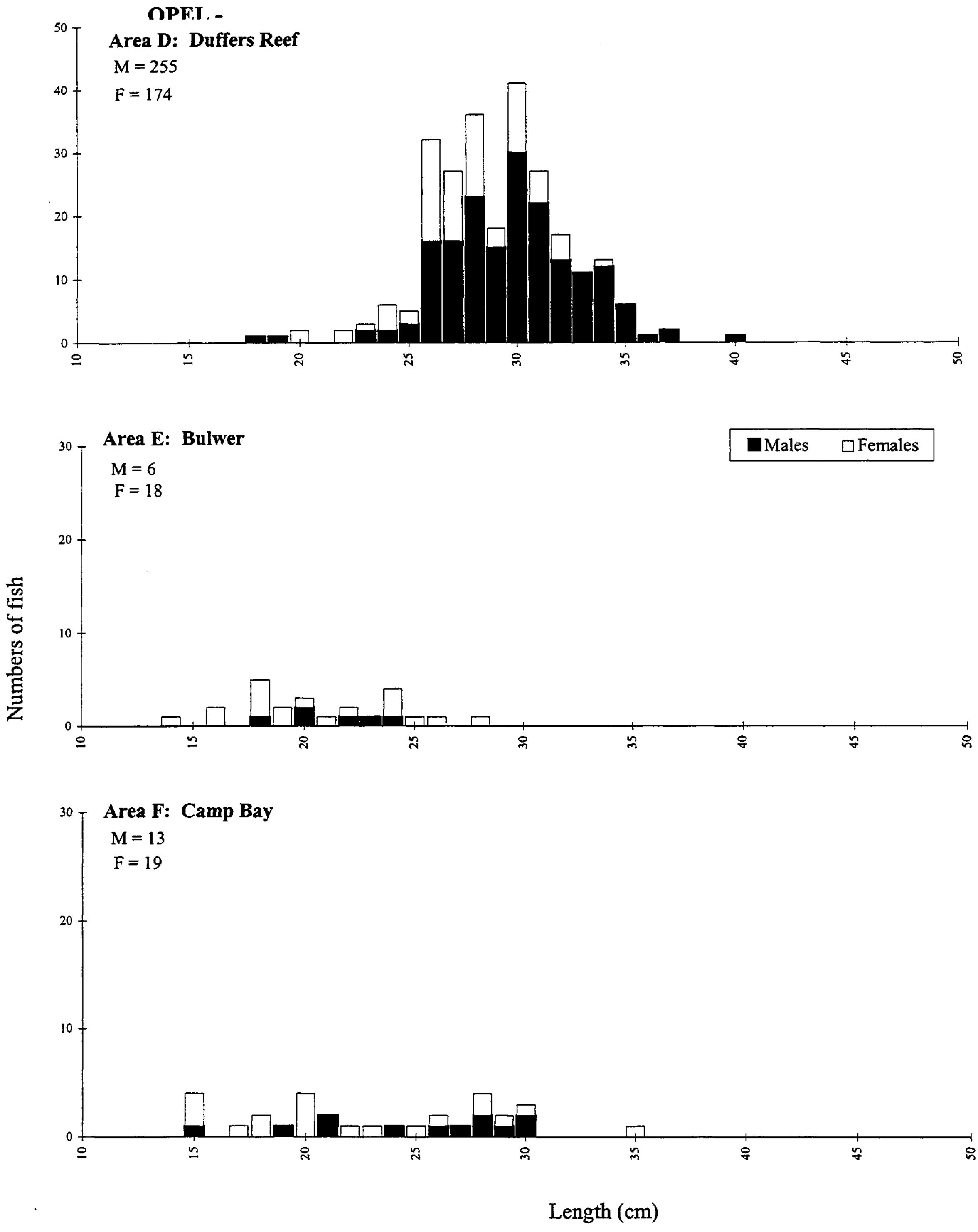
Appendix 4 —*continued*



Appendix 4 —*continued*



Appendix 4—*continued*



Appendix 4—*continued*