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Survey of the Northern Abalone (*Haliotis kamtschatkana*) in the  
Central Coast of British Columbia, May 1997

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## Abstract

Northern or "Pinto" Abalone, *Haliotis kamtschatkana*, fisheries in British Columbia (B.C.) have been closed since 1990 due to conservation concerns. Surveys by DFO (Fisheries and Oceans Canada) at indicator sites, during 1979-97, indicated a continued decline of abalone densities on the central coast of B.C. Total abalone density declined 43.75 % between the 1993 and 1997 survey. The percentage of index sites in which no "legal" abalone were found almost doubled to 62.5 % in 1997 from 33.3 % in 1993. Comparison between areas, surveyed during 1997, indicated higher total exposed abalone densities in the south, such as the Simonds Group and near Stryker Island, than for other north areas. The density estimates from this study were similar to those from an independent transect survey conducted by the Heiltsuk First Nations in the Simonds Group and near Stryker Island during May, 1997, after the data were standardized to similar depth ranges. However, abalone densities in these southern areas of the central coast of B.C. were still well below those reported by Breen and Adkins (1982) in a few samples during 1980, and were at density levels similar to those at index sites when the fishery was closed. The mean size of a sample of over 6000 illegally harvested abalone, found in Calamity Bay during 1997, was larger than that found in any of the abalone populations surveyed in this study. This indicated that poachers had selectively harvested mostly large mature abalone, but with no regard for the legal size limit since 16.6 % of the illegally harvested abalone were < 100 mm SL. Illegal harvesting not only further depletes already depressed abalone stocks, but also reduces their reproductive potential, by removal of large mature abalone, and hinders attempts to rehabilitate abalone populations in B.C. through fishery closure.

## Résumé

La pêche de l'ormeau nordique, *Haliotis kamtschatkana*, de la Colombie-Britannique est fermée depuis 1990 afin d'en assurer la conservation. Des relevés réalisés par le MPO (Pêches et Océans Canada) à des sites indicateurs, de 1979 à 1997, montrent un déclin constant des densités d'ormeaux de la côte centrale de la C.-B. La densité totale des ormeaux a diminué de 43,75 % entre 1993 et 1997. Le pourcentage des sites indices où aucun ormeau de taille légale n'a été décelé a presque doublé pour passer de 33,3 % en 1993 à 62,5 % en 1997. La comparaison entre les zones ayant fait l'objet d'un relevé en 1997 indique des densités d'ormeaux exposés plus élevés dans le sud, comme dans le groupe Simonds et dans la région de l'île Stryker, comparativement aux régions situées plus au nord. Il s'est avéré, après standardisation des données pour les gammes de profondeur, que les densités estimées suite à cette étude étaient semblables à celles d'un relevé indépendant par virées réalisé en mai 1997 par la Première Nation Heiltsuk dans le groupe Simonds et à proximité de l'île Stryker. Les densités d'ormeaux dans ces zones situées plus au sud de la côte centrale étaient cependant bien inférieures à celles signalées par Breen et Adkins (1982) pour quelques échantillons prélevés en 1980, et étaient semblables à celles des sites indices au moment de la fermeture de la pêche. La taille moyenne des ormeaux d'un échantillon de plus de 6000 individus récoltés illégalement, trouvés dans la baie Calamity en 1997, était plus importante que celle des populations évaluées au cours de la présente étude. Cela indique que les braconniers avaient sélectivement récolté des ormeaux en grande partie matures et de grande taille, mais sans égard à la taille limite légale car 16,6 % de ces ormeaux étaient de moins de 100 mm. La récolte illégale ne fait pas qu'appauvrir des stocks déjà diminué, elle en réduit aussi le potentiel reproducteur en retirant les gros individus matures et nuisant au rétablissement des populations d'ormeaux visé par la fermeture de la pêche en C.-B.

## INTRODUCTION

The "northern" or "pinto" abalone, *Haliotis kamtschatkana*, found from Sitka Island, Alaska to Baja California, generally occurs in patchy distribution on exposed and semi-exposed coasts in British Columbia (B.C.). In B.C., northern abalone has been a traditional food of first nations and a target of recreational divers and a small commercial dive fishery until 1990. The biology and fishery of the northern abalone was reviewed by Sloan and Breen (1988) and Farlinger and Campbell (1992). Surveys at index sites in southeastern Queen Charlotte Islands and the north central coast of B.C. indicated that the abundance of northern abalone had declined more than 75% during the period of 1978-84 and remained low until 1994 (e.g., Winther *et al.* 1995; Boutillier *et al.* 1984; Farlinger and Bates. 1986). Faced with continued stock declines and the possibility of abalone population collapse the northern abalone fishery was closed by the Department of Fisheries and Oceans (DFO) in December, 1990, to first nations, recreational divers and commercial fishers. The objective of the coastwide closure was to allow depleted populations of northern abalone to rebuild. Campbell (1997) reviewed some criteria required (e.g., evidence of increase in abundance and /or recruitment strength) for reopening a northern abalone fishery in B.C. and concluded additional information (e.g., on minimum spawning density requirements, variation in growth, recruitment and mortality rates and genetic studies to identify discrete stocks) was needed to better define the criteria levels. Over six years had elapsed since the fishery closure and managers and PSARC requested surveys to monitor northern abalone stock status in B.C. every 4 years.

The objectives of this paper were to report on the results of a survey of abalone along the central coast of B. C. (from Banks Island south to the Breadner Island Group) (Fig. 1) conducted by DFO during May, 1997, and to compare abalone densities at (1) index sites previously surveyed during 1979-80, 1989 and 1993 (Breen and Adkins 1980, 1981, 1982; Farlinger *et al.* 1991; Thomas and Campbell 1996), and (2) transect sites at the Simonds Group and Stryker Island surveyed, independently of DFO, by the Heiltsuk Fishery Program during May, 1997 (Campbell and Cripps 1998). Also we present size frequency data from abalone known to have been illegally harvested from the vicinity of southern Banks Island during February, 1997, to compare with abalone sizes measured in the present survey.

## METHODS

The Coast Guard vessel "Gordon Reid" was utilized as a live-aboard platform from which two dive tender boats were used for the survey of abalone during 11 - 26 May, 1997. Each dive tender boat was equipped with a hand held GPS (Global Positioning System) unit. Diving participants (in two dive teams, 3 divers per team) included personnel from the DFO; two members of the dive team had participated in previous Central Coast abalone surveys.

Most of the sites previously sampled during 1993 by Thomas and Campbell (1996) in study areas 1.0, 2, 3, 4 were resurveyed during 1997 (Fig. 1). The index sites were found from previous chart records, written site descriptions and GPS positions. Additional sample sites were randomly chosen (on a ruler scale along the coastline on charts) within each general area of the 1993 survey and further south in new general study areas 6 - 9, including study area 5 where a transect survey of abalone was conducted in 1996 by Cripps and Campbell (1998) (Fig. 1).

The "Breen" survey method, described by Breen and Adkins (1979), has been used consistently throughout the historical abalone surveys in B.C. Once each site was located, divers randomly placed a 1 m<sup>2</sup> quadrat at the top of the abalone zone and then sampled 16 m<sup>2</sup> plots (4 rows of 4 quadrats) within a 7 m by 17 m area. Vegetation was cleared from the substrate and all visible "exposed" abalone were counted and collected within each quadrat. Divers recorded the number of abalone in each quadrat, dominant vegetation, substrate type, maximum and minimum depths, and time taken to sample the site underwater. Collected abalone for each quadrat were brought to the surface, shell length (mm, SL) measured with vernier calipers and returned to the site immediately. A sample for the density estimates was considered to be one site, with the 16 quadrats per site as secondary sampling units.

In previous surveys divers collected all visible abalone and also lifted rocks to look for 'cryptic' abalone. However, in this survey divers did not look for cryptic abalone to reduce the time taken to sample each site and to increase the sample size for the overall survey (Winther *et al.* 1995; Campbell 1996). Sampling for only the exposed abalone is more efficient, since attempting to find all cryptic abalone is time consuming and the majority (>90%) of fully mature abalone (i.e., ≥70 mm SL) are exposed (Campbell 1996). Abalone densities presented in this survey refer only to exposed abalone and are compared to only the exposed abalone densities calculated from the previous surveys. Data from surveys in 1983 and 1985 (Boutillier *et al.* 1984; Farlinger and Bates 1986) were unavailable to calculate densities of exposed abalone.

In a few cases, divers aborted the sample if no abalone were found in the first eight quadrats (as in past surveys), and the site was treated as a zero abalone count sample. For the random samples, divers swam freely for 5-10 min looking for abalone. If abalone were seen, a 16 - quadrat sample was taken. If no abalone were seen, the site was treated as a zero abalone count sample. In a few situations for the random samples, where abalone were seen, only abalone counts per minute were recorded (a 16-quadrat sample was not taken); this type of sample was not included in any analysis for this report. Additional abalone were collected and SL measured from areas outside the 16-quadrat samples to provide supplementary data on size frequency data, especially in areas with low abalone density.

Abalone density was expressed as the number / m<sup>2</sup> for total (all sizes) and size categories of mature ( $\geq$  70 mm SL), prerecruit (92-99 mm SL), new recruit (100-106 mm SL) and legal ( $\geq$  100 mm SL). The smallest size that 100 % of abalone were mature was found to be approximately 70 mm SL by Campbell *et al.* (1992). The prerecruit and recruit sizes were estimated from abalone growth curves provided by Sloan and Breen (1988). The number of abalone measured for SL from a site occasionally did not match the number of abalone recorded by divers, because some individuals were not accessible (e.g., abalone wedged in a crevice). Consequently, densities by size category ( $D_i$ ) were calculated as  $D_i = P_i D$ , where the proportion of abalone in each size category ( $P_i$  = the number per category  $i$  divided by the total abalone measured in the sample) was multiplied by the total density of abalone ( $D$ ) counted by divers from the 16-quadrat sample.

The historical index sites were originally chosen within areas that were known to contain high densities and represented the productive fishing areas for *H. kamtschatkana* in the central coast of B.C. There was no difference ( $p>0.05$ , Mann-Whitney U test) in abalone density (total

0.27, 0.39; mature 0.20, 0.22; and legal 0.07, 0.06) between the historic index sites and the random sites ( $N = 32, 25$ ), respectively, for areas 1, 2, 3, and 4 (excluding area 1.1) sampled during 1997 (Appendix 1, 2). These results indicated that the historic index sites were representative of the average abalone densities found in the sampled areas during 1997. Consequently, the density data for both the index sites and the random sites were combined (within each size category and area) for subsequent comparisons between areas sampled during 1997 using a Kolmogorov - Smirnov two - sample test. Abalone densities surveyed between two years (of each size category and common index sites only) were compared using the two-tailed Wilcoxon signed-rank test. Comparisons between the 1978-80 and later samples were limited to 11 common index sites, whereas between 1989, 1993 and 1997 samples were limited to 24 common index sites.

Abalone density data were compared between two independent surveys conducted in the Simonds Group (Area 8) and Stryker Island (Area 7) during 1997: (i) Heiltsuk survey used a transect (1m<sup>2</sup> quadrats sampled from shallow to deep) survey during 24-29 May (Campbell and Cripps 1998), and (ii) the DFO 16-quadrat sample survey of this study during 21-25 May. Since abalone density differed by depth (Campbell and Cripps 1998), only data were used from quadrats in the transect survey that were in the same average depth range as the 16-quadrat survey. Densities for common sites for both surveys were compared using the Wilcoxon signed-rank test, whereas densities for all sites surveyed by both surveys were compared using the Mann-Whitney test.

An estimated 6700 abalone shells were found in Calamity Bay (area 1.1, southern Banks Island) (Fig. 1) during 6 March, 1997. The abalone had been illegally harvested from the vicinity of southern Banks Island (Calamity Bay and Otter Pass) during January - February, 1997. Many of the shells had rotting material from the discarded remaining abalone biological parts. A random subsample of 1971 shells was made to obtain a size frequency of the shells.

## RESULTS

### Survey Summary

A total of 153 index and random sites were sampled for abalone density in 10 general areas in the central coast of British Columbia during 14 days in May, 1997 (Fig. 1, Appendix 1). An average of 1.99 (min. 0.94, max 4.13) minutes/quadrat, 30.9 (min. 14, max 66) minutes/site, 15.6 (min. 8, max 16) quadrats/site was taken per dive team which is similar to that reported for other similar surveys (Campbell 1996).

### Density

#### *Comparison between areas*

Total abalone densities, by area, were significantly ( $p < 0.05$ ) higher from Stryker Island and the Simonds Group (Areas 7 and 8) than from the other areas sampled, except for those from North Aristazabal Island (Area 3) (Table 1).

### *Comparison of index sites between years*

Mean total exposed abalone densities for 11 comparable sites sampled progressively declined over time in the four surveys (Table 2, Appendix 3). Although the 1997 abalone densities (for the different size groups) were significantly lower from those in the earlier (1989 and 1979-80) surveys, densities were similar for the two recent (1993 and 1997) surveys (except for prerecruits) (Table 2). Similarly total densities declined over time for 24 comparable sites for three surveys and were significantly lower for 1997 compared to those in 1989 and 1993 (Table 3). There were fewer abalone, for each size group analyzed, for 1997 compared to 1989 and 1993, although not all comparisons were significant (Table 3).

The mean densities of total exposed abalone (0.79 and 0.81, respectively) at Stryker Island and the Simonds Group (Table 1), although higher than the index sites for 1997, were lower than those for the historical surveys conducted in 1979-80 (Table 2), and 1983 and 1985 (even assuming only 80 % of the abalone were exposed) (Thomas and Campbell 1996).

The number of sites in which no abalone were found increased to 5 (20.8 % of 24 comparable sites) in 1997 compared to 1 (4.2 %) in 1989 and 1993 (Table 4). The number of sites in which no "legal" abalone were found also increased to 15 (62.5% of 24 comparable sites) in 1997 compared to earlier years (Table 4). For all areas surveyed in 1997, the average percentage of total (index and non-index) sites where no abalone (22.2 %) and no "legal" abalone (64.05 %) were found was similar to those of the 1997 index sites (Table 5).

### *Comparison between Heiltsuk and DFO 1997 surveys*

Comparing only common survey sites or all sites surveyed indicated that the DFO survey generally recorded higher abalone densities than for the Heiltsuk survey (Table 6, 7, Appendix 4) (Campbell and Cripps 1998). There were no significant differences in total density between both surveys for the Simonds Group (Table 6, 7). There were significant differences in total density between both surveys using only common sites for Stryker Island (Table 6), however total densities were not significantly different when comparing all sites (Table 7).

### **Size frequency**

#### *DFO 1997 survey*

For each area, the size frequencies of abalone SL are shown in Fig. 2 and mean SL and percent of "legal" sized abalone are summarized in Table 8. The average mean SL was 83.1 mm and 22.1 % were of "legal" size for the areas (1,2,3,4) which included the historic index sites (Table 8). N. Aristazabal had the largest mean SL (88.6 mm) and highest percent of "legal" sized abalone (37.4%) of all the areas surveyed during 1997 (Table 8, Fig. 2D). The mean SL and % "legal" size have fluctuated over the last three surveys, but were slightly higher in 1997 than in previous years (Table 9).

### *Comparison between Heiltsuk and DFO 1997 surveys*

The mean shell length of abalone from the depth trimmed Heiltsuk survey for the Simonds group was lower (75.7 mm SL, 1.9 S.E., N = 182) and for Stryker Island was similar (72.0 mm SL, 2.0 S.E., N = 108) to that of the DFO survey (81.5 and 72.6 mm SL, respectively) (Table 8).

### *Illegally harvested abalone*

The shells from the illegally harvested abalone found in Calamity Bay were mostly (83.4%) of "legal" size ( $\geq 100$  mm SL), the largest being 137 mm SL, however 16.6 % were of "sublegal" size (when the abalone fishery was open) with the smallest abalone being 74 mm SL (Fig. 3). The mean SL (109 mm) (Fig. 3) was larger than that of the populations found in any of the areas surveyed (this study; Campbell and Cripps 1998; Cripps and Campbell 1998) including the Calamity Bay area. 1.1 (Table 8, Fig. 2B). The size frequency of the illegally harvested abalone indicated that poachers had selectively exploited mostly large abalone, but had no regard for the legal size limit since 16.6 % of the harvested abalone were  $< 100$  mm SL.

## DISCUSSION

The 1997 DFO survey of the historic index sites provided no evidence of recovery in abalone populations in the northern portion of the central coast of B.C. since 1990 when the fishery was closed. Abalone densities measured from indicator sites continued to decline. Abundance of abalone in 1997, as indicated by mean densities at the index sites, were at about 10 % of 1979-80 levels and 30.7 - 54.0 % of 1989 levels. Similarly, observed densities of exposed prerecruit and recruit abalone (0.04 and 0.02 / m<sup>2</sup>) (Table 3) remain far below the replacement levels recommended by Breen (1986) of approximately 0.50 and 0.40 / m<sup>2</sup>, respectively [0.55 and 0.45 / m<sup>2</sup> multiplied by 0.90 to remove cryptic abalone (Campbell 1996)]. The percentage of index sites without abalone had also increased to 20.8 % by 1997, which suggested that there were fewer patches of abalone than observed in previous years in these areas.

Comparison between areas, surveyed during 1997, indicated higher abalone densities in the Simonds Group and near Stryker Island than for other areas. The Heiltsuk 1997 surveys of Stryker Island and the Simonds Group (Campbell and Cripps 1998) generally agreed with the results found with the present survey conducted within the same month. However, abalone densities in these southern areas of the central coast of B.C. were (1) still well below those (1.6 - 7.7 abalone / m<sup>2</sup>) found by Breen and Adkins (1982) in a few samples from Spider Island, Triquet Island and the Goose Group during 1980, and (2) at similar density levels when the fishery was closed in 1990 (Campbell 1997).

The 1997 DFO survey of East Higgins Passage abalone bed showed lower total exposed abalone densities (0.22) (Table 1) compared to that (0.43) reported for the transect survey of the same area in May, 1996 (Cripps and Campbell 1998). The reason for the reduction in abalone density between 1996 and 1997 at E. Higgins is unknown. Possible factors for this reduction may be due to (a) differences in survey methodology, (b) low water visibility in the area during the DFO survey, and/or (c) mortality due to poaching and/or natural factors.

Both transect surveys reported by Cripps and Campbell (1998) and Campbell and Cripps (1998) emphasized how abalone density and size changed with the depth sampled and confirmed similar conclusions of previous studies (Sloan and Breen 1988). These surveys provided evidence that the "Breen" survey method sampled the depth range where adult abalone were generally most abundant. Several authors (e.g., Sloan and Breen 1988; Campbell 1996) have suggested that to improve the statistical precision and power of the "Breen" survey method, for showing significant changes in density between years, sample sizes should be increased or alternative survey methods should be explored. The "Breen" survey method has provided a valuable time series of general population trends of mature emergent northern abalone at indicator index sites in large remote areas throughout northern B.C. Considering the time consuming and logistical difficulty of surveying abalone at low densities over a large broad spatial scale the survey method has provided a consistent and logically reliable procedure. The similarity in abalone density between the new random sites and index sites suggested that the mean densities from all index sites were reasonably representative of adult abalone sampled in areas of the central coast of B.C. Sampling additional randomly chosen sites in all areas whenever possible should be encouraged in future broad spatial scale surveys of northern abalone. Alternate survey methods may require development depending on the objectives and logistics involved in studying northern abalone (e.g., estimating small juvenile abundance) (Campbell 1997).

The illegal harvest of the northern abalone, which has probably occurred during the last two decades, has been difficult to quantify and control. How much poaching of northern abalone has affected the overall exploitation and landings when the commercial fishery was open in B.C. is unknown. Since the fishery closure in 1990, there probably has been a significant illegal harvest of northern abalone, evidenced by the thousands of poached abalone found in Calamity Bay and other seizures (Campbell 1997) in B.C. The illegal size selective harvest on large mature abalone would reduce the reproductive potential of the wild brood stock and lower possible future recruitment. The combined high black market value for illegally harvested abalone and difficulty of enforcing a fishery closure in a large (mostly uninhabited) coastline suggests that poaching may be a serious hindrance to northern abalone stock recovery.

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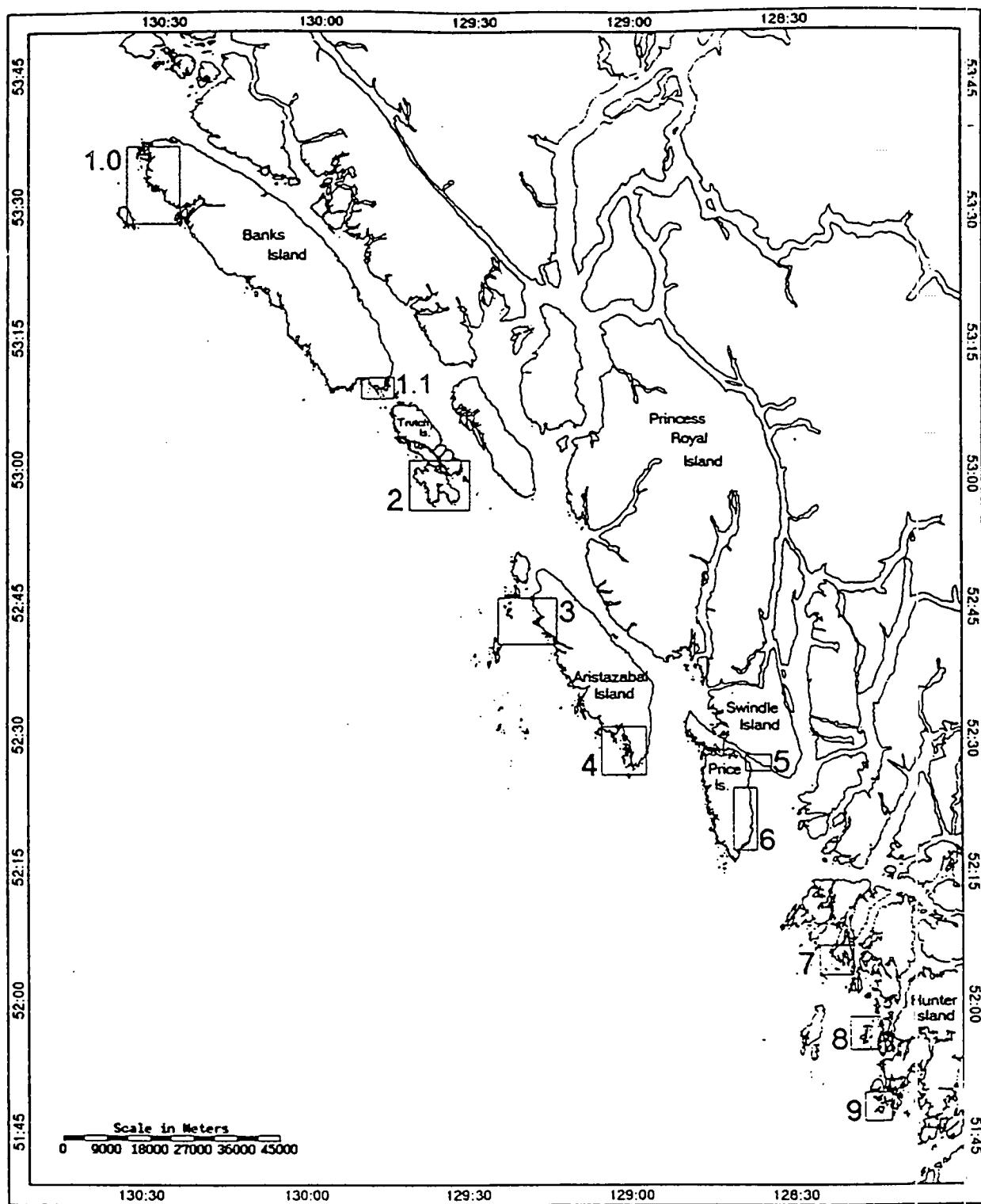


Fig.1. General areas where the abalone survey was conducted during 11-26 May, 1997: (1.0) North Banks Island (Statistical area 5-20); (1.1) South Banks Island (Statistical area 6-9); (2) Estevan Group of islands (Statistical area 6-9); (3) North Aristazabal Island (Statistical area 6-13); (4) South Aristazabal Island (Statistical area 5-13); (5) East Higgins Passage (Statistical area 7-3); (6) East Price Island (Statistical area 7-3); (7 = Stryker Island (Statistical areas 7-18, 7-19); (8) Simonds Group of islands (Statistical area 7-25); (9) Breadner Group of islands (Statistical areas 7-26, 7-27).

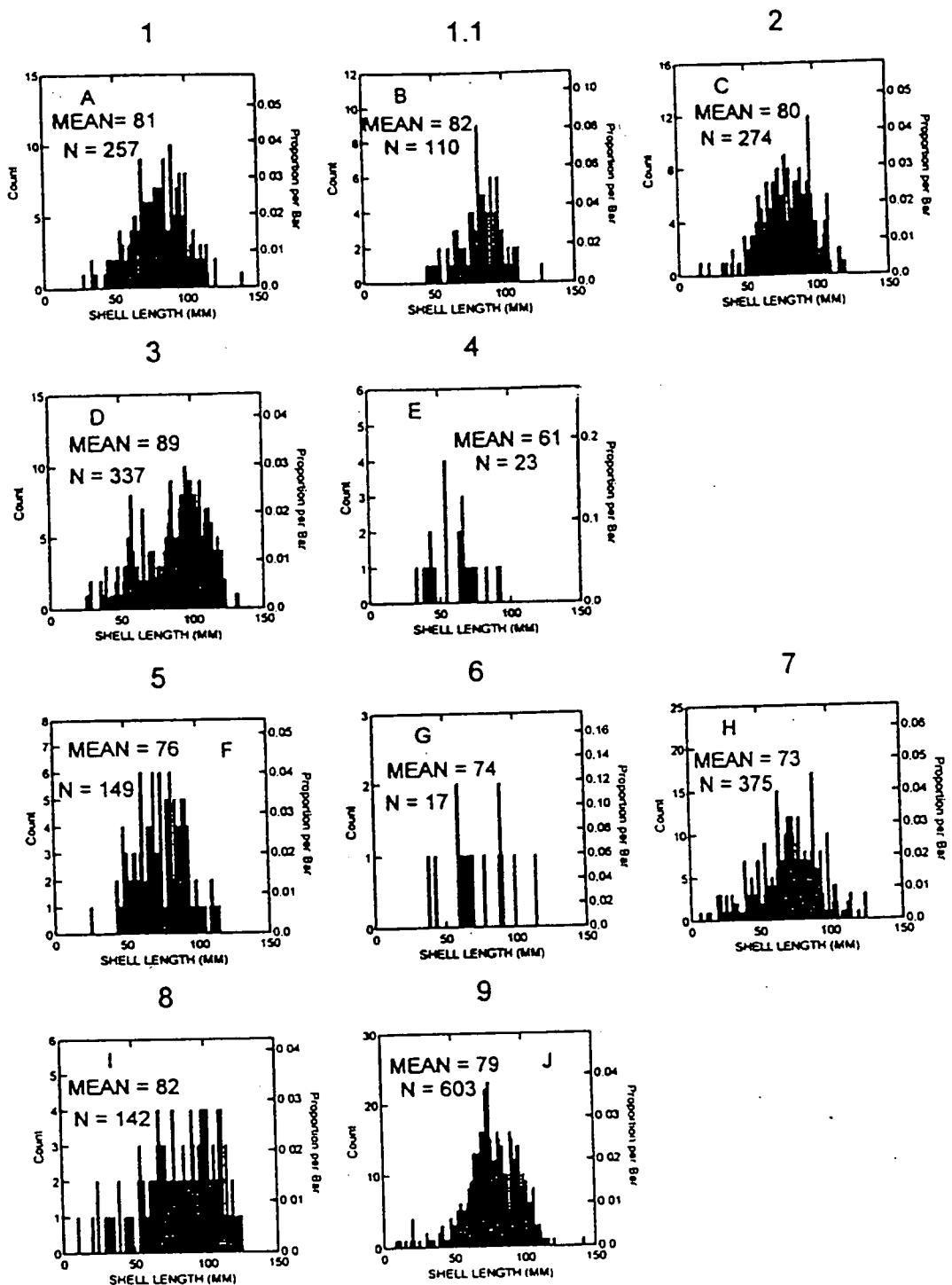


Fig. 2. Size frequencies of abalone surveyed in the central coast of British Columbia during May, 1997, for (A) 1 = North Banks Island, (B) 1.1 = South Banks Island, (C) 2 = Estevan Group of islands, (D) 3 = North Aristazabal Island, (E) 4 = South Aristazabal Island, (F) 5 = East Higgins Passage, (G) 6 = East Price Island, (H) 7 = Stryker Island, (I) 8 = Simonds Group of islands, (J) 9 = Breadner Group of islands. Data included from the 16-quadrat samples and the random collection samples.

SEIZED ABALONE S. BANKS - CALAMITY BAY 1997

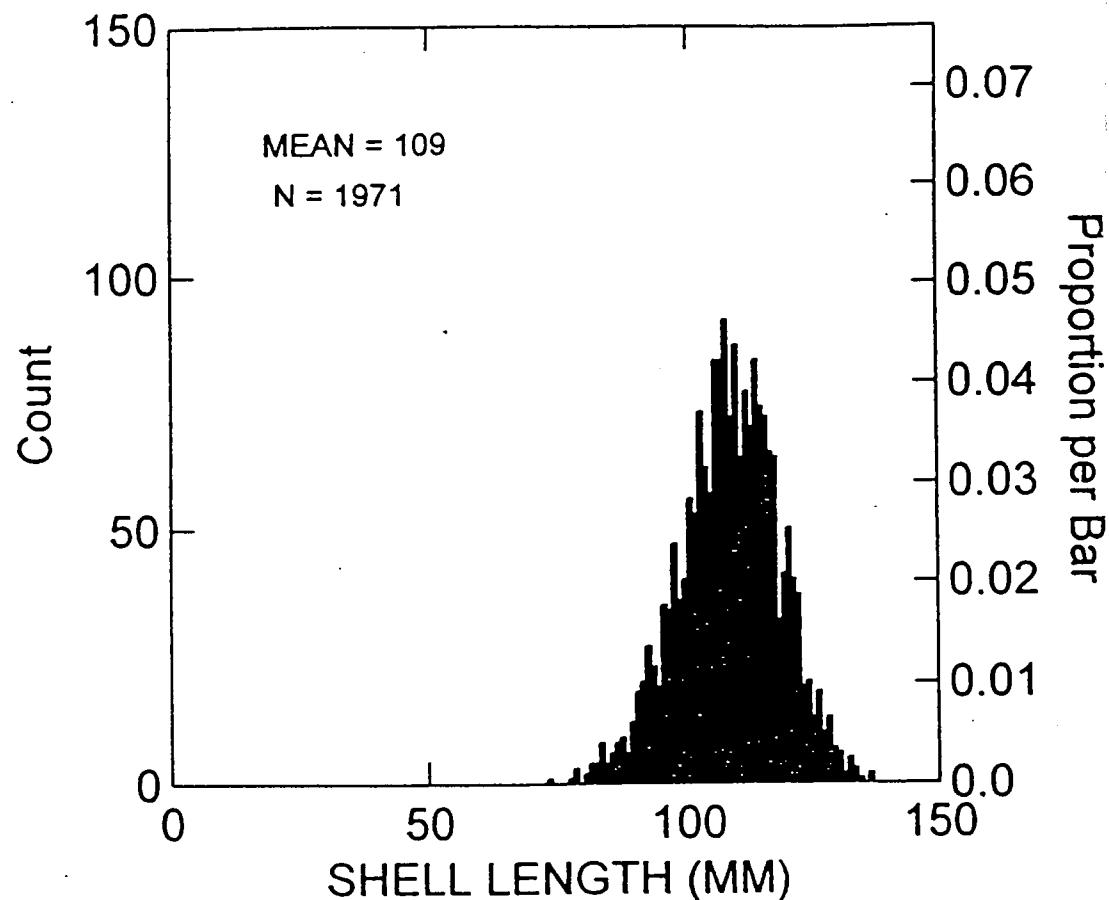


Fig. 3. Size frequency of a sample of shells from about 6,700 illegally harvested abalone found in Calamity Bay, South Banks Island, Jan.-Feb., 1997.

Table 1. Mean density (number / m<sup>2</sup>) of exposed abalone from the central coast of British Columbia, May, 1997. Sample sites are 1 = Index and 2 = random new sites. Means of densities from individual areas followed by same letter, in same row, are not significantly different ( $p>0.05$ ) and means followed by different letters, in same row, are significantly different ( $p<0.05$ ) using the Kolmogorov-Smirnov two sample test.

	N. Banks	S. Banks	Estevan	N. Aristaz.	S. Aristaz.	E Higgins	E. Price	Stryker	Simonds	Breadner	Total
Area Number	1	1.1	2	3	4	5	6	7	8	9	1-9
Sample Sites	1, 2	2	1, 2	1, 2	1, 2	2	2	2	2	2	1, 2
No. of Samples	11	3	23	13	10	22	6	26	11	28	153
Total	0.31a	0.19a	0.29a	0.54ab	0.14a	0.22a	0.18a	0.79b	0.81b	0.47a	0.44
Mature ( $\geq 70$ mm SL)	0.23a	0.12ab	0.21ab	0.33a	0.04b	0.14b	0.08a	0.51a	0.54a	0.28ab	0.28
Prerecruit (92-99 mm SL)	0.02ab	0.02a	0.04a	0.06c	0.01b	0.03a	0.00	0.06ac	0.09ac	0.06a	0.05
Recruit (100-106 mm SL)	0.05ab	0.00	0.02ab	0.04ab	0.00ab	0.01a	0.01ab	0.06ab	0.09b	0.03	0.03
Legal ( $\geq 100$ mm SL)	0.07a	0.02ab	0.06ab	0.10ab	0.00	0.02b	0.02b	0.09ab	0.24a	0.05ab	0.07

Table 2. Mean abalone densities (number/m<sup>2</sup>) from 11 comparable sites resurveyed in central British Columbia during 1979-80, 1989, 1993 and 1997. Means of densities followed by same letter, in same row, are not significantly different ( $p>0.05$ ) and means followed by different letters, in same row, are significantly different ( $p<0.05$ ) using the Wilcoxon signed rank test.

	1979-80	1989	1993	1997
Total	2.37a	0.75ab	0.37bc	0.23c
Legal ( $\geq 100$ mm SL)	0.58a	0.19ab	0.10bc	0.06c
Prerecruit (92-99mm SL)	0.35a	0.13a	0.06a	0.01b
Recruit (100-106 mm SL)	0.24a	0.07b	0.03bc	0.03c
Mature ( $\geq 70$ mm SL)	1.79a	0.64ab	0.27bc	0.19c

Table 3. Mean abalone densities (number/m<sup>2</sup>) from 24 comparable sites resurveyed in central British Columbia during 1989, 1993 and 1997. Means of densities followed by same letter, in same row, are not significantly different ( $p>0.05$ ) and means followed by different letters, in same row, are significantly different ( $p<0.05$ ) using the Wilcoxon signed rank test.

	1989	1993	1997
Total	0.50a	0.48a	0.27b
Legal ( $\geq 100$ mm SL)	0.11a	0.08a	0.06a
Prerecruit (92-99mm SL)	0.09a	0.06b	0.04b
Recruit (100-106 mm SL)	0.04a	0.04ab	0.02b
Mature ( $\geq 70$ mm SL)	0.41a	0.31ab	0.19b

Table 4. Summary, by year, of the number of sites where no legal abalone nor abalone of any size were found in comparable sites central coast of British Columbia during 1978-80 to 1997. Values in brackets are percentages of 24 sites.

	1979-80	1989 Legal Abalone	1993	1997
11 Common Sites	0	1	2	6
24 Common Sites	n/a	8 (33.3)	8 (33.3)	15 (62.5)
		Total Abalone		
11 Common Sites	0	0	0	3
24 Common Sites	n/a	1 (4.2)	1 (4.2)	5 (20.8)

Table 5. Percent of total sites where no legal abalone nor abalone of any size were found in the different areas in central coast of British Columbia during May, 1997.

Area No.	Area	% of sites without legal abalone	% of sites without any abalone	Total number of sites
1	N. Banks	36.36	0	11
1.1	S. Banks	66.66	33.33	3
2	Estevan	56.52	39.13	23
3	N. Aristazabal	46.15	0	13
4	S. Aristazabal	100.00	30.00	10
5	E. Higgins	86.36	36.36	22
6	E. Price	66.67	50.00	6
7	Stryker	57.69	0	26
8	Simonds	45.46	9.09	11
9	Breadner	71.43	32.14	28
Total		64.05	22.22	153

Table 6. Comparison of mean exposed abalone densities (number/m<sup>2</sup>) between common sites from the DFO 16-quadrat survey and the Heiltsuk transect survey conducted at Stryker Island (21-22 May and 28-29 May, respectively) and the Simonds Group of islands (25 May and 24-26 May, respectively) during 1997. Only sample sites that are common to both surveys are included. Data for the Heiltsuk transect survey were trimmed to include only similar depth range as that for the DFO 16-quadrat survey. Means of densities followed by same letter, in same column and area, are not significantly different ( $p>0.05$ ) and means followed by different letters, in same column and area, are significantly different ( $p<0.05$ ) using the Wilcoxon signed rank test.

Survey	Number of sample sites	Size group (mm SL)				Total
		Mature ≥ 70	Prerecruit 92-99	Recruit 100-106	Legal ≥ 100	
<b>Stryker Island</b>						
Heiltsuk	16	0.14a	0.00a	0.03a	0.03a	0.32a
DFO	16	0.06b	0.07b	0.04a	0.08a	0.84b
<b>Simonds Group</b>						
Heiltsuk	9	0.27a	0.02a	0.00a	0.00a	0.59a
DFO	9	0.51a	0.08a	0.08a	0.24a	0.66a

Table 7. Comparison of mean exposed abalone densities (number/m<sup>2</sup>) between the DFO 16-quadrat survey and the Heiltsuk transect survey conducted at Stryker Island (21-22 May and 28-29 May, respectively) and the Simonds Group of islands (25 May and 24-26 May, respectively) during 1997. All sites from both surveys are included. Data for the Heiltsuk transect survey were trimmed to include only similar depth range as that for the DFO 16-quadrat survey. Means of densities followed by same letter, in same column and area, are not significantly different ( $p>0.05$ ) and means followed by different letters, in same column and area, are significantly different ( $p<0.05$ ) using the Mann-Whitney U test.

Survey	Number of Sample sites	Size group (mm SL)				Total
		Mature ≥ 70	Prerecruit 92-99	Recruit 100-106	Legal ≥ 100	
<b>Stryker Island</b>						
Heiltsuk	20	0.42a	0.00a	0.04a	0.04a	0.70a
DFO	26	0.51b	0.06b	0.06a	0.09a	0.79a
<b>Simonds Group</b>						
Heiltsuk	32	0.39a	0.09a	0.05a	0.11a	0.69a
DFO	11	0.54a	0.08a	0.09b	0.24b	0.81a

Table 8. Summary of size frequency data for exposed abalone surveyed by DFO in the central coast of British Columbia, May, 1997. Data included from the 16-quadrat samples and the random collection samples; a = excludes area 1.1.

Area Number	Area Name	Shell Length (mm)			Number	Percent Legal ≥100 mm SL
		Mean	S.E.	Min-Max		
1	N. Banks	81.2	1.1	28-139	257	15.18
1.1	S. Banks	82.2	1.4	45-127	110	8.18
2	Estevan	80.0	1.1	16-120	274	11.68
3	N. Aristazabal	88.6	1.2	26-132	337	37.39
4	S. Aristazabal	60.9	3.4	34-93	23	0
5	E. Higgins	76.4	1.4	26-115	149	6.71
6	E. Price	73.8	4.8	39-115	17	11.76
7	Stryker	72.6	1.1	7-125	375	9.87
8	Simonds	81.5	2.1	11-125	142	29.58
9	Breadner	78.6	0.7	9-142	603	11.44
Total	all areas	79.5	0.4	7-142	2287	16.00
1 <sup>a</sup> ,2,3,4	north areas	83.1	0.7	16-139	891	22.11

Table 9. Mean shell length and percent of legal sized ( $\geq 100$  mm SL) of total exposed abalone for the 1989, 1993, and 1997 surveys in areas 1 (excluding area 1.1), 2, 3, and 4.

Year	Mean SL (mm)	Number	Percent Legal
1989	81.3	228	18.4
1993	78.4	422	17.8
1997	83.1	891	22.1

**Appendix 1 Summary of dive survey for exposed abalone in the central coast of British Columbia during May, 1997.**

Sample code: 1 = Index Breen sample (8 - 16 quadrats); 2 = Random Breen sample (16 quadrats); 3 = Random swim, no abalone seen;

4 = extra collection of abalone for additional size frequency data; 5 = Random timed swim, abalone counted.

Substrate types: B = boulders; bc = bed rock - crevices; bm = bedrock - smooth; C = cobble; S = sand. A quadrat is one square metre.

Area: 1.1 = Calamity Bay; 2 = Lotbiniere Bay; 2.1 = Pemberton Bay; 2.2 = Oswald Bay. a = samples were combined for analyses.

General Area		Site	Sample	No. of	Time		Bottom	Sub-	Canopy	Bottom	Abalone	Density	Depth (m)			
No	Group	No	Day	Code	Quads	Start	Finish	time	strate	%Cover	%Cover	Slope	Count	No./sq. m	Min	Max
1	NBanks	44	11	1	16	9:17	10:05	0:48	B	75	100	.	3	0.1875	-1.25	-0.45
1	NBanks	45	11	1	16	9:30	10:02	0:32	B	60	100	10	2	0.1250	-0.34	0.88
1	NBanks	46.1a	11	1	16	15:02	15:41	0:39	bm/B	100	.	20	1	0.0625	1.65	3.14
1	NBanks	46.2a	11	1	16	15:02	15:41	0:39	bm/B	100	.	20	7	0.4375	1.28	5.85
1	NBanks	47	11	1	16	15:10	15:30	0:20	bc/B	4	95	20	7	0.4375	1.52	4.88
1	NBanks	R10	11	2	16	11:42	12:04	0:22	bm	10	10	15	6	0.3750	4.27	6.74
1	NBanks	R27	11	2	16	10:27	11:01	0:34	B	60	130	20	2	0.1250	1.22	2.35
1	NBanks	R27	11	4	0	11:02	11:17	0:15	B	60	130	20	88	.	.	.
1	NBanks	R39	11	2	16	15:47	16:10	0:23	B	15	10	30	2	0.1250	.	.
1	NBanks	R45	11	2	16	16:35	17:07	0:32	B	5	35	5	1	0.0625	1.31	1.31
1	NBanks	R46	11	2	16	10:20	10:45	0:25	B	10	.	40	5	0.3125	0.98	3.75
1	NBanks	R47	11	2	16	11:15	11:45	0:30	bc	10	.	.	12	0.7500	-0.34	2.10
1	NBanks	R77	11	2	16	16:10	16:50	0:40	B	75	90	10	10	0.6250	7.32	9.14
1	NBanks	R77	11	4	0	16:51	17:05	0:14	B	75	90	10	39	.	.	.
1.1	SBanks	CB1	12	2	16	8:54	9:20	0:26	bc	35	100	10	6	0.3750	2.56	5.73
1.1	SBanks	CB1	12	4	0	9:21	9:40	0:19	bc	35	100	10	50	.	.	.
1.1	SBanks	CB10	12	4	0	9:26	9:50	0:24	B	.	.	.	9	.	-2.83	4.75
1.1	SBanks	CB11	12	2	16	8:30	8:55	0:25	B/C	25	25	20	0	0.0000	.	7.32
1.1	SBanks	CB2	12	2	16	10:08	10:50	0:42	bm	20	30	45	3	0.1875	-1.52	1.74
1.1	SBanks	CB7	12	4	0	10:37	11:01	0:24	B	10	.	20	43	.	3.47	5.18
2	Estevan	21	14	1	16	9:20	9:57	0:37	B/C	10	160	5	0	0.0000	-0.94	2.04
2	Estevan	22	13	1	16	16:25	17:00	0:35	B/C	100	.	.	0	0.0000	.	.
2	Estevan	23	14	1	16	9:24	9:57	0:33	bm	0	60	75	17	1.0625	1.49	4.72
2	Estevan	24	14	1	8	10:24	10:41	0:17	bm	40	100	0	0	0.0000	.	.
2	Estevan	25	14	1	16	8:23	8:49	0:26	bm	0	110	0	1	0.0625	5.73	5.73
2	Estevan	27	14	1	16	8:23	8:58	0:35	bm	10	90	0	3	0.1875	0.30	0.91
2	Estevan	29	14	1	16	11:03	11:28	0:25	bm	20	50	60	3	0.1875	0.55	3.61
2	Estevan	30	13	1	16	14:10	14:40	0:30	bm/B	20	.	25	8	0.5000	.	.
2	Estevan	R119	13	5	0	14:05	14:25	0:20	bm/B	15	5	.	4	.	.	.
2	Estevan	R159	13	2	16	14:47	15:30	0:43	bm/B	10	20	70	15	0.9375	0.64	2.26
2	Estevan	R159	13	4	0	15:31	15:47	0:16	bm/B	10	20	70	49	.	.	.
2	Estevan	R172	13	2	8	15:13	15:27	0:14	B	50	10	.	0	0.0000	.	.
2	Estevan	R172	13	5	0	13:28	15:42	0:14	B	50	10	.	20	.	.	.
2	Estevan	R177	13	5	0	16:10	16:21	0:11	bm	20	100	.	1	.	.	.
2	Estevan	R188	13	5	0	16:44	16:52	0:08	B	30	120	.	3	.	.	.
2	Estevan	R196	14	3	0	10:22	10:36	0:14	bm	20	100	0	0	.	.	.
2	Estevan	R223	14	2	16	11:58	12:37	0:39	bm/B	15	80	30	7	0.4375	-0.03	3.38
2	Estevan	R250	14	5	0	13:12	13:30	0:18	B	.	90	.	3	.	.	.
2	Estevan	R265	14	5	0	13:50	14:06	0:16	bm	20	20	60	1	.	.	.
2	Estevan	R292	14	5	0	14:24	14:40	0:16	bm	.	10	75	12	.	.	.
2	Estevan	R295	14	2	16	13:04	13:45	0:41	bm	10	20	60	4	0.2500	-0.12	3.5
2.1	Estevan	33	13	1	16	9:18	10:05	0:47	bm	5	15	30	5	0.3125	2.80	4.61
2.1	Estevan	33	13	4	0	10:05	10:25	0:20	bm	5	15	30	13	.	.	.
2.1	Estevan	34	13	1	16	9:35	10:01	0:36	bm	40	.	.	0	0.0000	.	.
2.1	Estevan	35	13	1	16	10:27	11:01	0:34	bc	100	.	15	7	0.4375	.	.
2.1	Estevan	35	13	4	0	11:12	11:30	0:18	bc	100	.	15	35	.	.	.
2.1	Estevan	36	13	1	16	10:36	11:07	0:31	bc	5	5	30	13	0.8125	1.77	3.51
2.1	Estevan	R69	13	3	0	13:32	13:38	0:06	bc	10	2	20	0	.	.	.
2.1	Estevan	R70	13	3	0	13:19	13:25	0:06	bc	0	.	50	0	.	.	.
2.1	Estevan	R770	13	2	16	11:21	11:45	0:24	bm	5	5	25	6	0.3750	5.61	7.55
2.2	Estevan	38	12	1	16	14:58	15:43	0:45	bm	20	20	10	9	0.5625	-1.52	1.62
2.2	Estevan	39	12	1	16	15:37	16:15	0:38	bm/B	50	50	.	7	0.4375	-0.73	2.07
2.2	Estevan	39	12	4	0	16:16	16:41	0:25	.	.	.	72	.	.	.	
2.2	Estevan	40	12	1	8	15:15	15:36	0:21	B	10	20	5	0	0.0000	-1.46	1.31
2.2	Estevan	CB8	12	5	0	16:41	16:52	0:11	bc	70	30	30	1	.	.	.
2.2	Estevan	CB9	12	5	0	16:14	16:31	0:17	bc	40	30	35	15	.	.	.
2.2	Estevan	R14	12	5	0	17:06	17:31	0:25	B	30	10	30	37	.	-3.02	3.25
2.2	Estevan	R38	12	4	0	15:45	16:15	0:30	bm	20	20	10	76	.	.	.
3	NorthArz	13	15	1	16	8:14	8:37	0:23	B/C	20	10	60	3	.	.	.
3	NorthArz	15	15	1	16	10:10	10:42	0:32	bm/B	5	25	60	3	0.1875	-0.73	3.11
3	NorthArz	15A	15	1	16	11:06	11:26	0:20	bm/B	15	20	30	2	0.1250	0.37	1.77

General Area No	Site Group	Site No	Day	Sample Code	No. of Quads	Time Start	Time Finish	Bottom time	Sub- strate	Canopy	Bottom %Cover	Abalone Slope	Abalone Count	Depth (m)		
														Min	Max	
3	NorthArz	16	15	1	16	9:16	9:38	0:22	bm/B	80	5	10	10	0.6250	-0.27	2.71
3	NorthArz	17	15	1	16	14:42	15:19	0:37	bm	.	.	15	3	0.1875	0.06	0.70
3	NorthArz	19	15	1	16	9:41	10:12	0:31	.	10	.	0	1	0.0625	-0.82	0.06
3	NorthArz	20	15	4	0	9:07	9:17	0:10	B/C	50	.	5	24	.	.	.
3	NorthArz	20	15	1	16	8:28	9:06	0:49	B/C	50	.	5	12	0.7500	0.49	1.16
3	NorthArz	AR10	15	2	16	13:11	13:31	0:20	B/C	.	50	25	14	0.8750	0.46	1.74
3	NorthArz	AR10	15	4	0	13:32	14:05	0:33	B/C	.	50	25	158	.	.	.
3	NorthArz	AR106	15	2	16	13:27	14:05	0:38	B	10	10	.	15	0.9375	1.74	3.96
3	NorthArz	AR106	15	4	0	14:06	14:14	0:08	B	10	10	.	43	.	.	.
3	NorthArz	AR15	15	2	16	14:47	15:10	0:23	B/C	.	.	90	18	1.1250	1.31	4.02
3	NorthArz	AR2	15	2	16	15:39	16:06	0:27	B/C	.	50	15	25	1.5625	1.74	3.66
3	NorthArz	AR20	15	2	16	15:41	16:07	0:26	B	.	10	0	5	0.3125	0.21	2.13
3	NorthArz	AR91	15	2	16	10:37	11:15	0:38	B/C	80	15	12	2	0.1250	-0.43	0.52
4	SouthArz	4	16	5	0	10:52	11:07	0:15	bm	10	10	0	3	.	.	.
4	SouthArz	6	17	1	16	8:06	8:26	0:20	bm	15	2	50	2	0.1250	2.68	2.83
4	SouthArz	8	16	1	8	11:38	11:54	0:16	bm	0	0	.	0	0.0000	0.52	3.14
4	SouthArz	9	16	1	16	10:13	10:56	0:43	B	0	0	30	1	0.0625	-0.40	4.02
4	SouthArz	10	16	1	16	15:35	16:19	0:44	bm	2.5	2.5	.	2	0.1250	3.69	6.77
4	SouthArz	11	16	1	16	15:21	15:44	0:23	bm/B	.	.	15	4	0.2500	1.28	4.33
4	SouthArz	12	16	1	16	14:19	14:47	0:28	bm	1	1	60	4	0.2500	-0.40	2.68
4	SouthArz	WR104	17	5	0	8:59	9:10	0:11	bm	5	5	60	10	.	0.00	1.28
4	SouthArz	WR120	17	3	0	8:23	8:36	0:13	B/C	30	30	10	0	.	.	.
4	SouthArz	WR128	17	5	0	8:57	9:10	0:13	bm/B	10	10	80	2	.	.	.
4	SouthArz	WR151	16	3	0	16:00	16:31	0:31	B	.	.	2	0	.	.	.
4	SouthArz	WR166	17	5	0	9:28	9:42	0:14	bm	70	40	20	1	.	.	.
4	SouthArz	WR178	17	2	16	10:12	10:44	0:32	bm/B	.	20	15	4	0.2500	-1.16	3.75
4	SouthArz	WR97	17	2	16	9:31	9:56	0:25	bm	2.5	2.5	90	6	0.3750	3.17	5.97
5	EastHiggins	EH0	19	2	16	7:56	8:48	0:52	bm	12	27	5	21	1.3125	1.43	2.74
5	EastHiggins	EH16	19	2	16	9:50	10:30	0:40	bm	100	100	10	0	0.0000	1.34	3.08
5	EastHiggins	EH17	19	2	16	10:37	11:15	0:38	bm	.	5	30	4	0.2500	1.01	5.00
5	EastHiggins	EH22	19	2	8	13:04	13:30	0:26	bm	50	60	20	0	0.0000	1.80	1.86
5	EastHiggins	EH24	19	2	8	13:35	13:57	0:22	bm	90	10	90	0	0.0000	-0.34	5.00
5	EastHiggins	EH25	19	2	16	14:16	14:38	0:22	bm	50	10	60	3	0.1875	-0.15	6.13
5	EastHiggins	EH29	19	2	16	14:44	15:10	0:26	bm	.	.	90	1	0.0625	1.74	8.84
5	EastHiggins	EH32	19	2	16	15:51	16:20	0:29	bm	20	30	80	0	0.0000	2.26	7.04
5	EastHiggins	EH33	20	2	16	7:58	8:55	0:57	bm	30	20	80	0	0.0000	-0.88	4.18
5	EastHiggins	EH35	20	2	16	8:55	9:34	0:39	bm	75	40	60	2	0.1250	-0.46	3.87
5	EastHiggins	EH36	20	2	16	9:15	9:33	0:18	bm	50	20	20	1	0.0625	1.71	5.52
5	EastHiggins	EH37	20	2	11	8:41	9:01	0:20	bm	80	10	20	6	0.5455	0.61	4.39
5	EastHiggins	EH40	20	2	16	8:03	8:31	0:28	bm	70	30	20	0	0.0000	-0.76	3.57
5	EastHiggins	EH45	20	2	16	10:09	10:29	0:20	bm	70	40	20	0	0.0000	-1.46	4.85
5	EastHiggins	EH49	19	2	16	14:51	15:20	0:29	bm/B	70	5	5	12	0.7500	0.58	1.77
5	EastHiggins	EH49	19	4	0	15:20	15:40	0:20	bm/B	70	5	5	74	.	.	.
5	EastHiggins	EHS1	19	2	16	14:11	14:37	0:26	bm	10	50	45	3	0.1875	-1.92	2.44
5	EastHiggins	EH54	19	2	16	13:12	13:50	0:38	bm/C	.	80	60	10	0.6250	-2.65	2.47
5	EastHiggins	EH57	19	2	16	8:26	9:12	0:46	bm	50	10	50	1	0.0625	-0.85	3.29
5	EastHiggins	EH61	19	2	16	9:27	9:51	0:24	bm	.	50	45	0	0.0000	-1.95	1.49
5	EastHiggins	EH63	19	2	16	10:35	11:12	0:37	bm	10	50	35	6	0.3750	-2.71	3.63
5	EastHiggins	EH68	19	2	16	7:57	8:14	0:17	bm	10	.	80	2	0.1250	-1.01	4.60
5	EastHiggins	EH9	19	2	16	9:09	9:30	0:21	bm	30	.	5	3	0.1875	3.41	4.11
6	EastPrice	EP116	26	3	0	8:17	8:28	0:11	bm	.	.	5	0	.	-1.71	4.54
6	EastPrice	EP22	26	2	16	10:58	11:28	0:30	bm	30	.	20	3	0.1875	2.74	5.46
6	EastPrice	EP227	26	5	0	8:49	9:05	0:16	bm/B	.	.	6	.	.	-1.31	6.80
6	EastPrice	EP253	26	5	0	10:45	11:00	0:15	bm	.	.	80	4	.	0.94	10.73
6	EastPrice	EP266	26	2	16	9:42	10:27	0:45	bm/B	5	5	0	10	0.6250	0.73	2.35
6	EastPrice	EP59	26	5	0	10:23	10:33	0:10	bm	50	.	45-60	1	.	2.47	7.04
6	EastPrice	EP60	26	3	0	10:22	10:32	0:10	bm	50	.	45-60	0	.	2.47	7.04
6	EastPrice	EP71	26	5	0	8:59	9:21	0:22	bm	50	.	30	2	.	5.21	5.73
6	EastPrice	EP76	26	2	16	8:59	9:21	0:22	bm	.	.	20	4	0.2500	2.16	5.39
6	EastPrice	EP84	26	3	0	8:28	8:39	0:11	bm	50	20	.	0	.	1.80	7.71
7	Stryker	ST121	21	2	16	8:04	8:57	0:53	bm	40	40	45	41	2.5625	-0.34	3.47
7	Stryker	ST129	21	2	16	9:25	10:03	0:38	bm	30	30	45	21	1.3125	1.25	4.15
7	Stryker	ST133	21	2	16	10:29	11:01	0:32	bm	10	10	45	4	0.2500	0.43	3.60
7	Stryker	ST150	21	2	16	13:32	14:16	0:44	bm	37	37	45	20	1.2500	0.49	4.85
7	Stryker	ST190	21	2	16	8:11	8:49	0:38	bm	10	10	30	10	0.6250	-0.52	3.23
7	Stryker	ST214	21	2	16	9:03	9:34	0:31	bm	.	10	60	13	0.8125	-1.13	3.63
7	Stryker	ST214	21	4	0			0:16					48			

General Area	Site	Sample	No. of	Time	Bottom	Sub-	Canopy	Bottom	Abalone	Density	Depth (m)					
No	Group	No	Day	Code	Quads	Start	Finish	time	substrate	%Cover	%Cover	Slope	Count	No./sq. m	Min	Max
7	Stryker	ST220	21	2	16	10:07	10:35	0:28	bm	10	10	10	11	0.6875	-1.95	2.10
7	Stryker	ST228	21	2	16	10:50	11:17	0:27	bm	10	10	10	8	0.5000	0.76	4.30
7	Stryker	ST238	21	2	16	15:56	16:21	0:25	bm	.	.	.	11	0.6875	2.99	5.94
7	Stryker	ST263	22	2	16	14:40	15:46	1:06	bm	10	90	5	27	1.6875	-1.77	1.74
7	Stryker	ST284	22	2	16	13:40	14:13	0:33	bm	95	.	25	7	0.4375	0.46	5.00
7	Stryker	ST298	22	2	16	9:27	10:03	0:36	bm	50	45	30	22	1.3750	1.07	5.03
7	Stryker	ST304	22	2	16	16:27	17:00	0:33	bm	60	75	25	5	0.3125	1.80	4.69
7	Stryker	ST316	22	2	16	10:25	10:45	0:20	bm	.	.	50	5	0.3125	-1.40	3.99
7	Stryker	ST345	22	2	16	14:42	14:57	0:15	bm	5	30	45	1	0.0625	0.49	3.60
7	Stryker	ST359	22	2	16	15:19	15:38	0:19	bm	20	20	45	3	0.1875	-0.12	5.39
7	Stryker	ST411	21	2	16	14:57	15:20	0:23	bm	.	.	60	3	0.1875	4.02	8.26
7	Stryker	ST4113	21	2	16	13:27	14:05	0:38	bm	100	40	10	10	0.6250	-0.03	3.84
7	Stryker	ST4142	21	2	16	14:32	15:18	0:46	bm	20	.	5	17	1.0625	0.09	3.51
7	Stryker	ST444	22	2	16	8:24	8:54	0:30	bm	60	.	70	8	0.5000	0.98	8.60
7	Stryker	ST483	21	2	16	15:36	16:08	0:32	bm	15	80	45	7	0.4375	0.03	4.27
7	Stryker	ST518	22	2	16	13:32	14:16	0:44	bm	80	40	10	22	1.3750	0.73	4.15
7	Stryker	ST531	22	2	16	10:58	11:22	0:24	bm/B	40	80	.	19	1.1875	-0.46	2.10
7	Stryker	ST552	22	2	16	9:37	10:27	0:50	bm	20	100	5	11	0.6875	0.73	3.63
7	Stryker	ST556	22	2	16	8:52	9:23	0:31	bm	20	20	10	18	1.1250	1.77	3.84
7	Stryker	ST560	22	2	16	8:11	8:40	0:29	bm	10	40	35	6	0.3750	1.65	5.85
8	Simonds	SI12	25	2	16	14:17	14:42	0:25	bm	20	15	30	10	0.6250	-0.18	4.33
8	Simonds	SI13	25	3	0	15:28	15:42	0:14	bm	.	.	80	0	.	0.27	6.74
8	Simonds	SI16	25	2	16	15:46	16:18	0:32	B/C	.	90	15	12	0.7500	-1.28	1.71
8	Simonds	SI2	25	2	16	8:23	8:49	0:26	bm	.	35	45	24	1.5000	-0.37	3.66
8	Simonds	SI20	25	2	16	8:50	9:20	0:30	bm/B	12	.	10	11	0.6875	-0.40	3.72
8	Simonds	SI21	25	2	16	10:04	10:22	0:18	bm	.	.	80	6	0.3750	0.18	5.06
8	Simonds	SI23	25	2	16	13:31	14:26	0:55	bm	10	50	15	13	0.8125	-0.91	3.02
8	Simonds	SI25	25	2	16	10:43	11:15	0:32	bm	.	.	80	19	1.1875	0.06	6.13
8	Simonds	SI3	25	2	16	9:17	9:49	0:32	bm	40	20	10	15	0.9375	-0.21	2.01
8	Simonds	SI30	25	5	0	14:51	15:06	0:15	bm	.	.	30	4	.	-0.70	8.56
8	Simonds	SI5	25	2	16	10:28	11:00	0:32	bm	30	30	20	24	1.5000	0.43	3.14
8	Simonds	SI9	25	2	16	13:22	13:52	0:30	bm	.	.	60	8	0.5000	0.58	4.82
9	Breadner	SP1	24	2	16	11:06	11:33	0:27	bm	.	.	5	7	0.4375	-0.40	16.18
9	Breadner	SP10	23	2	16	15:16	15:35	0:19	bm	.	.	20	18	1.1250	0.79	2.65
9	Breadner	SP10	23	4	0	15:36	15:56	0:20	bm	.	.	20	106	.	.	.
9	Breadner	SP11	24	2	16	9:55	10:20	0:25	B/C/S	5	80	10	1	0.0625	3.72	6.22
9	Breadner	SP12	23	2	16	10:40	11:15	0:35	bm	40	40	0	39	2.4375	-2.93	-1.07
9	Breadner	SP12	23	4	0	14:53	15:17	0:24	bm	40	40	0	127	.	.	.
9	Breadner	SP13	23	2	16	13:59	14:35	0:36	bm	.	.	0	3	0.1875	-1.34	-0.40
9	Breadner	SP14	23	3	0	9:03	9:10	0:07	bm	.	.	45	0	.	1.07	7.19
9	Breadner	SP15	23	2	16	15:40	16:05	0:25	bm/B	5	10	50	11	0.6875	0.34	3.44
9	Breadner	SP16	23	2	16	10:55	11:19	0:24	bm	3	2	20	9	0.5625	1.65	6.64
9	Breadner	SP17	24	2	16	10:54	11:24	0:30	bm	.	50	30	25	1.5625	0.40	3.63
9	Breadner	SP18	24	2	16	14:15	14:39	0:24	bm/B	.	5	0	4	0.2500	-1.71	1.89
9	Breadner	SP19	23	2	16	14:13	14:34	0:21	bm	10	5	30	10	0.6250	0.52	4.42
9	Breadner	SP2	23	2	16	9:04	9:25	0:21	bm	10	15	90	8	0.5000	4.15	7.80
9	Breadner	SP20	23	2	16	9:59	10:22	0:23	bm	40	20	60	3	0.1875	3.75	7.15
9	Breadner	SP21	23	3	0	8:44	8:51	0:07	bm	.	.	90	0	.	1.13	7.25
9	Breadner	SP22	23	3	0	9:46	10:00	0:14	bm	.	.	0	0	.	0.67	8.44
9	Breadner	SP23	24	3	0	10:41	10:54	0:13	C/S	.	.	0	0	.	3.14	3.14
9	Breadner	SP24	23	2	16	13:23	13:47	0:24	bm	.	.	10	10	0.6250	0.91	3.02
9	Breadner	SP26	23	3	0	10:12	10:27	0:15	bm	.	.	5	0	.	0.37	6.64
9	Breadner	SP27	24	2	16	8:31	9:03	0:32	bm/B	.	.	5	21	1.3125	0.43	3.29
9	Breadner	SP28	24	2	16	13:27	13:52	0:25	bm	20	30	50	1	0.0625	0.18	4.21
9	Breadner	SP3	23	3	0	9:23	9:33	0:10	bm	.	.	45	0	.	0.91	6.80
9	Breadner	SP30	24	5	0	14:03	14:11	0:08	bm	30	.	60	1	.	-3.69	2.47
9	Breadner	SP31	24	3	0	14:28	14:38	0:10	S	100	.	20	0	.	-3.93	1.05
9	Breadner	SP4	24	2	16	9:17	9:41	0:24	bm	.	.	20	18	1.1250	1.74	3.29
9	Breadner	SP4	24	4	0	9:42	10:23	0:41	bm	.	.	20	160	.	.	.
9	Breadner	SP5	24	3	0	13:28	13:37	0:09	bm	40	.	30	0	.	-3.32	1.07
9	Breadner	SP6	24	2	16	14:55	15:22	0:27	B	.	5	.	8	0.5000	1.10	3.57
9	Breadner	SP7	24	2	16	8:20	8:50	0:30	bm	5	5	30	11	0.6875	1.13	5.58
9	Breadner	SP8	23	3	0	13:29	13:38	0:09	bm/B	.	.	80	0	.	-3.81	0.05
9	Breadner	SP9	24	2	16	9:19	9:42	0:23	bm/B	.	.	5	3	0.1875	-0.09	1.17

## Appendix 2.

Proportion of total size frequency (SF) and density of different size groups of exposed abalone in the central coast of British Columbia during May, 1997.

Sample code: 1 = Index Breen sample (8 - 16 quadrats); 2 = Random Breen sample (16 quadrats);  
 3 = Random swim, no abalone seen; 4 = extra collection of abalone for additional size frequency data;  
 5 = Random timed swim, abalone counted.

General Area		Site No.	Sample Code	No. of Quads	No. of Abalone	Proportion of total SF (mm SL)				Density by size group (mm SL)						
						Density	SF	≥70	92-99	100-106	≥100	≥70	92-99	100-106	≥100	
1	NBANKS	44	1	16	3	3	1.00				0.33	0.19	0.00	0.00	0.06	0.19
1	NBANKS	45	1	16	2	2	1.00		0.50	1.00	0.13	0.00	0.06	0.13	0.13	
1	NBANKS	46	1	32	8	8	1.00	0.13			0.25	0.03	0.00	0.00	0.25	
1	NBANKS	47	1	16	7	7	0.71		0.29	0.29	0.31	0.00	0.13	0.13	0.44	
1	NBANKS	R10	2	16	6	6	0.17				0.06	0.00	0.00	0.00	0.00	0.38
1	NBANKS	R27	2	16	2	2	1.00		0.50	0.50	0.13	0.00	0.06	0.06	0.13	
1	NBANKS	R27	4		88	0.91	0.23	0.08	0.18							
1	NBANKS	R39	2	16	2	2					0.00	0.00	0.00	0.00	0.00	0.13
1	NBANKS	R45	2	16	1	1	1.00			1.00	0.06	0.00	0.00	0.06	0.06	
1	NBANKS	R46	2	16	5	5	0.60				0.19	0.00	0.00	0.00	0.00	0.31
1	NBANKS	R47	2	16	12	12	0.75	0.08	0.08	0.17	0.56	0.06	0.06	0.13	0.75	
1	NBANKS	R77	2	16	10	10	1.00	0.20	0.30	0.40	0.63	0.13	0.19	0.25	0.63	
1	NBANKS	R77	4		39	0.69	0.18	0.08	0.13							
1.1	SBANKS	CB1	2	16	6	5	0.60				0.23	0.00	0.00	0.00	0.00	0.38
1.1	SBANKS	CB1	4		50	0.76	0.20									
1.1	SBANKS	CB10	4		9	0.44		0.11	0.22							
1.1	SBANKS	CB11	2	16	0	0					0.00	0.00	0.00	0.00	0.00	
1.1	SBANKS	CB2	2	16	3	3	0.67	0.33			0.33	0.13	0.06	0.00	0.06	0.19
1.1	SBANKS	CB7	4		43	0.93	0.21	0.07	0.14							
2	ESTEVAN	21	1	16	0	0					0.00	0.00	0.00	0.00	0.00	
2	ESTEVAN	22	1	16	0	0					0.00	0.00	0.00	0.00	0.00	
2	ESTEVAN	23	1	16	17	17	0.82		0.12	0.18	0.88	0.00	0.13	0.19	1.06	
2	ESTEVAN	24	1	8	0	0					0.00	0.00	0.00	0.00	0.00	
2	ESTEVAN	25	1	16	1	1	1.00				0.06	0.00	0.00	0.00	0.06	
2	ESTEVAN	27	1	16	3	3	1.00				1.00	0.19	0.00	0.00	0.19	0.19
2	ESTEVAN	29	1	16	3	3	1.00	0.33	0.33	0.33	0.33	0.19	0.06	0.06	0.06	0.19
2	ESTEVAN	30	1	16	8	8	1.00	0.25			0.50	0.50	0.13	0.00	0.25	0.50
2	ESTEVAN	35	1	16	7	7	1.00	0.29	0.14	0.43	0.44	0.13	0.06	0.19	0.44	
2	ESTEVAN	35	4		35	0.77	0.17		0.03							
2	ESTEVAN	R159	2	16	15	15	0.40	0.07	0.13	0.13	0.38	0.06	0.13	0.13	0.94	
2	ESTEVAN	R159	4		49	0.71	0.22									
2	ESTEVAN	R172	2	8	0	0					0.00	0.00	0.00	0.00	0.00	
2	ESTEVAN	R223	2	16	7	7	0.29		0.14	0.14	0.13	0.00	0.06	0.06	0.44	
2	ESTEVAN	R295	2	16	4	4	0.50				0.13	0.00	0.00	0.00	0.25	
2.1	ESTEVAN	33	1	16	5	5	0.20				0.06	0.00	0.00	0.00	0.31	
2.1	ESTEVAN	33	4		13	0.92	0.31	0.08	0.15							
2.1	ESTEVAN	34	1	16	0	0					0.00	0.00	0.00	0.00	0.00	
2.1	ESTEVAN	36	1	16	13	13	0.85	0.23			0.08	0.69	0.19	0.00	0.06	0.81
2.1	ESTEVAN	R770	2	16	6	6	0.50				0.19	0.00	0.00	0.00	0.38	
2.2	ESTEVAN	38	1	16	9	9	1.00	0.33	0.22	0.44	0.56	0.19	0.13	0.25	0.56	
2.2	ESTEVAN	39	1	16	7	7	0.86	0.29		0.14	0.38	0.13	0.00	0.06	0.44	
2.2	ESTEVAN	39	4		72	0.57	0.11	0.06	0.07							
2.2	ESTEVAN	40	1	8	0	0					0.00	0.00	0.00	0.00	0.00	
2.2	ESTEVAN	R38	4		74	0.66	0.14	0.07	0.08							
3	NORTHARZ	13	1	16	3	3	1.00	0.33		0.67	0.19	0.06	0.00	0.13	0.19	
3	NORTHARZ	15	1	16	3	3	0.33	0.33			0.06	0.06	0.00	0.00	0.19	
3	NORTHARZ	15A	1	16	2	2					0.00	0.00	0.00	0.00	0.13	
3	NORTHARZ	16	1	16	10	10	0.10	0.10			0.06	0.06	0.00	0.00	0.63	

General Area		Site No.	Sample No	No. of Quads	No. of Abalone Density	Proportion of total SF (mm SL)				Density by size group (mm SL)				Total	
No	Group					Code	SF	≥70	92-99	100-106	≥100	≥70	92-99	100-106	
3	NORTHARZ	17	1	16	3	3	0.67	0.33				0.13	0.06	0.00	0.00 0.19
3	NORTHARZ	19	1	16	1	1	1.00		1.00	1.00		0.06	0.00	0.06	0.06 0.06
3	NORTHARZ	20	1	16	12	12	1.00	0.08	0.08	0.50	0.75	0.06	0.06	0.38	0.75
3	NORTHARZ	20	4		24	1.00	0.25	0.29	0.67						
3	NORTHARZ	AR10	2	16	14	14	0.93	0.29	0.14	0.36	0.81	0.25	0.13	0.31	0.88
3	NORTHARZ	AR10	4		158	0.89	0.16	0.22	0.56						
3	NORTHARZ	AR106	2	16	14	14	0.71	0.07	0.14	0.14	0.63	0.06	0.13	0.13	0.88
3	NORTHARZ	AR106	4		43	0.70	0.21	0.02	0.02						
3	NORTHARZ	AR15	2	16	18	18	0.39	0.06			0.44	0.06	0.00	0.00	1.13
3	NORTHARZ	AR2	2	16	25	25	0.48	0.04			0.75	0.06	0.00	0.00	1.56
3	NORTHARZ	AR20	2	16	5	5	1.00	0.20	0.20	0.60	0.31	0.06	0.06	0.19	0.31
3	NORTHARZ	AR91	2	16	2	2	1.00		0.50	1.00	0.13	0.00	0.06	0.13	0.13
4	SOUTHARZ	10	1	16	2	2					0.00	0.00	0.00	0.00	0.13
4	SOUTHARZ	11	1	16	4	4	0.25				0.06	0.00	0.00	0.00	0.25
4	SOUTHARZ	12	1	16	4	4	1.00	0.25			0.25	0.06	0.00	0.00	0.25
4	SOUTHARZ	6	1	16	2	2					0.00	0.00	0.00	0.00	0.13
4	SOUTHARZ	8	1	8	0	0					0.00	0.00	0.00	0.00	0.00
4	SOUTHARZ	9	1	16	1	1	1.00				0.06	0.00	0.00	0.00	0.06
4	SOUTHARZ	WR151	3	0	0	0					0.00	0.00	0.00	0.00	0.00
4	SOUTHARZ	WR178	2	16	4	4					0.00	0.00	0.00	0.00	0.25
4	SOUTHARZ	WR97	2	16	6	6					0.00	0.00	0.00	0.00	0.38
5	EHIGGINS	EH0	2	16	21	21	0.90	0.24	0.05	0.24	1.19	0.31	0.06	0.31	1.31
5	EHIGGINS	EH16	2	16	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH17	2	16	4	4	0.50	0.25	0.25	0.25	0.13	0.06	0.06	0.06	0.25
5	EHIGGINS	EH22	2	8	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH24	2	8	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH25	2	16	3	3	0.33				0.06	0.00	0.00	0.00	0.19
5	EHIGGINS	EH29	2	16	1	1					0.00	0.00	0.00	0.00	0.06
5	EHIGGINS	EH32	2	16	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH33	2	16	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH35	2	16	2	2					0.00	0.00	0.00	0.00	0.13
5	EHIGGINS	EH36	2	16	1	1					0.00	0.00	0.00	0.00	0.06
5	EHIGGINS	EH37	2	11	6	6	0.67	0.17	0.17	0.17	0.36	0.09	0.09	0.09	0.55
5	EHIGGINS	EH40	2	16	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH45	2	16	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH49	2	16	12	12	0.75	0.17			0.56	0.13	0.00	0.00	0.75
5	EHIGGINS	EH49	4		74	0.64	0.12	0.01	0.04						
5	EHIGGINS	EH51	2	16	3	3					0.00	0.00	0.00	0.00	0.19
5	EHIGGINS	EH54	2	16	10	10	0.60				0.38	0.00	0.00	0.00	0.63
5	EHIGGINS	EH57	2	16	1	1					0.00	0.00	0.00	0.00	0.06
5	EHIGGINS	EH61	2	16	0	0					0.00	0.00	0.00	0.00	0.00
5	EHIGGINS	EH63	2	16	6	6	0.67				0.25	0.00	0.00	0.00	0.38
5	EHIGGINS	EH68	2	16	2	2	1.00	0.50			0.13	0.06	0.00	0.00	0.13
5	EHIGGINS	EH9	2	16	3	3	0.67				0.13	0.00	0.00	0.00	0.19
6	EPRICE	EP116	3	0	0	0					0.00	0.00	0.00	0.00	0.00
6	EPRICE	EP22	2	16	3	3	0.33				0.06	0.00	0.00	0.00	0.19
6	EPRICE	EP266	2	16	10	10	0.50		0.10	0.10	0.31	0.00	0.06	0.06	0.63
6	EPRICE	EP60	3	0	0	0					0.00	0.00	0.00	0.00	0.00
6	EPRICE	EP76	2	16	4	4	0.50				0.25	0.13	0.00	0.06	0.25
6	EPRICE	EP84	3	0	0	0					0.00	0.00	0.00	0.00	0.00
7	STRYKER	ST121	2	16	41	41	0.83	0.17	0.12	0.20	2.13	0.44	0.31	0.50	2.56
7	STRYKER	ST129	2	16	21	21	0.57				0.75	0.00	0.00	0.00	1.31
7	STRYKER	ST133	2	16	4	4	0.75				0.50	0.19	0.00	0.13	0.25
7	STRYKER	ST150	2	16	20	20	0.40				0.50	0.00	0.00	0.00	1.25

General Area		Site No.	Sample No.	Code	Quads	No. of Abalone		Proportion of total SF (mm SL)				Density by size group (mm SL)				
No	Group					Density	SF	≥70	92-99	100-106	≥100	≥70	92-99	100-106	>100	Total
7	STRYKER	ST190	2	16	10	10	0.80	0.10				0.50	0.06	0.00	0.00	0.63
7	STRYKER	ST214	2	16	13	13	0.38					0.31	0.00	0.00	0.00	0.81
7	STRYKER	ST214	4			48	0.44									
7	STRYKER	ST220	2	16	11	11	1.00	0.18	0.36	0.45	0.69	0.13	0.25	0.31	0.69	
7	STRYKER	ST228	2	16	8	8	0.63		0.13	0.25	0.31	0.00	0.06	0.13	0.50	
7	STRYKER	ST238	2	16	11	11	0.73				0.50	0.00	0.00	0.00	0.69	
7	STRYKER	ST263	2	16	27	26	0.65		0.04	0.08	1.10	0.00	0.06	0.13	1.69	
7	STRYKER	ST284	2	16	7	7	0.86	0.14		0.14	0.38	0.06	0.00	0.06	0.44	
7	STRYKER	ST298	2	16	22	22	0.91	0.32	0.18	0.18	1.25	0.44	0.25	0.25	1.38	
7	STRYKER	ST304	2	16	5	5	0.60				0.19	0.00	0.00	0.00	0.31	
7	STRYKER	ST316	2	16	5	5	0.40				0.13	0.00	0.00	0.00	0.31	
7	STRYKER	ST345	2	16	1	1	1.00			1.00	0.06	0.00	0.00	0.06	0.06	
7	STRYKER	ST359	2	16	3	3	0.67				0.13	0.00	0.00	0.00	0.19	
7	STRYKER	ST411	2	16	3	3					0.00	0.00	0.00	0.00	0.19	
7	STRYKER	ST4113	2	16	10	10	0.30				0.19	0.00	0.00	0.00	0.63	
7	STRYKER	ST4142	2	16	17	15	0.33	0.07			0.35	0.07	0.00	0.00	1.06	
7	STRYKER	ST444	2	16	8	8	0.13				0.06	0.00	0.00	0.00	0.50	
7	STRYKER	ST483	2	16	7	7					0.00	0.00	0.00	0.00	0.44	
7	STRYKER	ST518	2	16	22	22	0.91	0.05	0.23	0.23	1.25	0.06	0.31	0.31	1.38	
7	STRYKER	ST531	2	16	19	19	0.84	0.16	0.16	0.16	1.00	0.19	0.19	0.19	1.19	
7	STRYKER	ST552	2	16	11	11	0.82	0.09	0.09	0.36	0.56	0.06	0.06	0.25	0.69	
7	STRYKER	ST556	2	16	18	18	0.56	0.06			0.63	0.06	0.00	0.00	1.13	
7	STRYKER	ST560	2	16	6	6	0.50				0.19	0.00	0.00	0.00	0.38	
8	SIMONDS	SI12	2	16	10	10	0.20				0.13	0.00	0.00	0.00	0.63	
8	SIMONDS	SI13	3	0	0	0					0.00	0.00	0.00	0.00	0.00	
8	SIMONDS	SI16	2	16	12	12	1.00	0.17	0.17	0.67	0.75	0.13	0.13	0.50	0.75	
8	SIMONDS	SI2	2	16	24	24	0.92	0.13	0.13	0.38	1.38	0.19	0.19	0.56	1.50	
8	SIMONDS	SI20	2	16	11	11	0.82	0.18	0.18	0.45	0.56	0.13	0.13	0.31	0.69	
8	SIMONDS	SI21	2	16	6	6	0.17				0.06	0.00	0.00	0.00	0.38	
8	SIMONDS	SI23	2	16	13	13	0.38	0.08	0.15	0.15	0.31	0.06	0.13	0.13	0.81	
8	SIMONDS	SI25	2	16	19	19	0.32				0.38	0.00	0.00	0.00	1.19	
8	SIMONDS	SI3	2	16	15	15	0.73	0.13	0.13	0.40	0.69	0.13	0.13	0.38	0.94	
8	SIMONDS	SI5	2	16	24	24	0.83	0.21	0.21	0.50	1.25	0.31	0.31	0.75	1.50	
8	SIMONDS	SI9	2	16	8	8	0.88				0.44	0.00	0.00	0.00	0.50	
9	BREADNER	SP1	2	16	7	7	0.43	0.14			0.14	0.19	0.06	0.00	0.06	0.44
9	BREADNER	SP10	2	16	18	18	0.72	0.22			0.81	0.25	0.00	0.00	1.13	
9	BREADNER	SP10	4			106	0.93	0.25	0.08	0.11						
9	BREADNER	SP11	2	16	1	1	1.00				1.00	0.06	0.00	0.00	0.06	0.06
9	BREADNER	SP12	2	16	39	39	0.79	0.26	0.15	0.18	1.94	0.63	0.38	0.44	2.44	
9	BREADNER	SP12	4			127	0.98	0.26	0.16	0.28						
9	BREADNER	SP13	2	16	3	3	1.00		0.67	1.00	0.19	0.00	0.13	0.19	0.19	
9	BREADNER	SP14	3	0	0	0					0.00	0.00	0.00	0.00	0.00	
9	BREADNER	SP15	2	16	11	11	0.73	0.27			0.50	0.19	0.00	0.00	0.69	
9	BREADNER	SP16	2	16	9	9	0.33	0.11			0.19	0.06	0.00	0.00	0.56	
9	BREADNER	SP17	2	16	25	25	0.32	0.12			0.50	0.19	0.00	0.00	1.56	
9	BREADNER	SP18	2	16	4	4	0.75		0.50	0.50	0.19	0.00	0.13	0.13	0.25	
9	BREADNER	SP19	2	16	10	10	0.60				0.38	0.00	0.00	0.00	0.63	
9	BREADNER	SP2	2	16	8	8	0.38		0.25	0.25	0.19	0.00	0.13	0.13	0.50	
9	BREADNER	SP20	2	16	3	3	0.33				0.06	0.00	0.00	0.00	0.19	
9	BREADNER	SP21	3	0	0	0					0.00	0.00	0.00	0.00	0.00	
9	BREADNER	SP22	3	0	0	0					0.00	0.00	0.00	0.00	0.00	
9	BREADNER	SP23	3	0	0	0					0.00	0.00	0.00	0.00	0.00	
9	BREADNER	SP24	2	16	10	10	0.60	0.20			0.38	0.13	0.00	0.00	0.63	
9	BREADNER	SP26	3	0	0	0					0.00	0.00	0.00	0.00	0.00	

General Area		Site No.	Code	Sample No of Quads	No. of Abalone	Proportion of total SF (mm SL)				Density by size group (mm SL)				Total	
No	Group					SF	≥70	92-99	100-106	≥100	≥70	92-99	100-106	≥100	
9	BREADNER	SP27	2	16	21	21	0.86	0.19	0.14	0.19	1.13	0.25	0.19	0.25	1.31
9	BREADNER	SP28	2	16	1	1	1.00				0.06	0.00	0.00	0.00	0.06
9	BREADNER	SP3	3	0	0	0					0.00	0.00	0.00	0.00	0.00
9	BREADNER	SP31	3	0	0	0					0.00	0.00	0.00	0.00	0.00
9	BREADNER	SP4	2	16	18	18	0.56				0.63	0.00	0.00	0.00	1.13
9	BREADNER	SP4	4			160	0.60								
9	BREADNER	SP5	3	0	0	0					0.00	0.00	0.00	0.00	0.00
9	BREADNER	SP6	2	16	8	8	0.38				0.19	0.00	0.00	0.00	0.50
9	BREADNER	SP7	2	16	11	11	0.27				0.19	0.00	0.00	0.00	0.69
9	BREADNER	SP8	3	0	0	0					0.00	0.00	0.00	0.00	0.00
9	BREADNER	SP9	2	16	3	3	1.00	0.33		0.33	0.19	0.06	0.00	0.06	0.19

## Appendix 3a

Total exposed abalone density and number of quadrats per site for comparable sites in the Central Coast of B.C. during 1979-80, 1989, 1993 and 1997. Blanks indicate no sample.

Site Number	Density (number per square m)					Number of quadrats				
	1979-80	1989	1979-80	1989	1993	1997	1979-80	1989	1993	1997
	Site	1993								
	1997									
<b>North Banks Isl.</b>										
79-02	44	3.37		0.04	0.19	16		24	16	
79-01	45	1.72		0.25	0.13	16		24	16	
79-26	46	3.06		1.03	0.25	16		32	32	
79-21	47	4.94		0.21	0.44	16		24	16	
<b>Estevan group (Lotbinerie Bay)</b>										
79-18	21	1.38	0.13	0.25	0.00	16	16	32	16	
79-20	22	0.31	0.38	0.09	0.00	16	16	32	16	
79-08	23	4.40	1.38	0.63	1.06	16	16	32	16	
79-09	24	1.63	0.19	0.19	0.00	16	16	16	8	
80-70	25	1.98	0.63	0.31	0.06	80	16	32	16	
80-06	27	1.31	0.19	0.53	0.19	16	16	32	16	
	29		0.13	0.66	0.19		16	32	16	
	30		0.63	1.81	0.50		16	32	16	
<b>Estevan group (Pemberton Bay)</b>										
	33		0.50	1.25	0.31		16	32	16	
	34		0.00	0.00	0.00		8	8	16	
	35		0.06	0.41	0.44		16	32	16	
	36		1.44	0.17	0.81		16	24	16	
<b>Estevan group (Oswald Bay)</b>										
	38			0.59	0.56			32	16	
	39			0.38	0.44			32	16	
	40			0.47	0.00			32	8	
<b>Aristazabal Isl. North</b>										
	13		0.19	0.19	0.19		16	32	16	
79-12	15	1.94	2.38	0.50	0.19	50	16	16	16	
	15A			0.44	0.13			16	16	
	16		0.25	0.88	0.63		16	32	16	
	17		0.94	0.44	0.19		16	32	16	
	19		0.44	0.41	0.06		16	32	16	
	20		0.38	0.44	0.75		16	32	16	
<b>Aristazabal Isl. South</b>										
	4		1.25	0.13			16	24		
	6		0.06	0.33	0.13		16	24	16	
	8		0.50	0.22	0.00		16	32	8	
	9		0.19	0.04	0.06		16	24	16	
	10		0.44	0.28	0.13		16	32	16	
	11		0.38	0.63	0.25		16	16	16	
	12		0.25	0.88	0.25		8	16	16	

**Appendix 3b. Total exposed Mature ( $\geq 70$  mm SL), PreRecruit (92-99 mm SL), Recruit (100-106 mm SL) and Legal ( $\geq 100$  mm SL) abalone density for comparable sites in the Central Coast of B.C. during 1979-80, 1989, 1993 and 1997. Dots indicate no sample.**

Site Number	Mature Density (no. / sq. m)					Prerecruit Density (no. / sq. m)				Recruit Density (no. / sq. m)				Legal Density (no. / sq. m)				
	1979-8	1989	1979-80	1989	1993	1997	1979-80	1989	1993	1997	1979-8	1989	1993	1997	1979-8	1989	1993	1997
	1993						1993				1993				1993			
	1997																	
<b>North Banks Isl.</b>																		
79-02	44	2.45	.	0.00	0.19	0.46	.	0.00	0.00	0.31	.	0.00	0.00	0.77	.	0.00	0.06	
79-01	45	1.32	.	0.25	0.13	0.30	.	0.04	0.00	0.10	.	0.13	0.06	0.10	.	0.21	0.13	
79-26	46	2.36	.	0.87	0.25	0.61	.	0.16	0.03	0.48	.	0.13	0.00	1.18	.	0.26	0.00	
79-21	47	3.68	.	0.16	0.31	0.80	.	0.05	0.00	0.46	.	0.00	0.13	0.92	.	0.00	0.13	
<b>Estevan group (Lotbiniere Bay)</b>																		
79-18	21	.	0.13	0.25	0.00	.	0.00	0.00	0.00	.	0.06	0.06	0.00	0.84	0.13	0.22	0.00	
79-20	22	0.19	0.38	0.06	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.03	0.00	0.07	0.31	0.06	0.00	
79-08	23	3.24	1.25	0.41	0.88	0.52	0.19	0.06	0.00	0.39	0.13	0.00	0.13	1.04	0.25	0.03	0.19	
79-09	24	1.28	0.19	0.19	0.00	0.14	0.06	0.06	0.00	0.14	0.06	0.00	0.00	0.43	0.06	0.13	0.00	
80-70	25	1.09	0.56	0.25	0.06	0.23	0.13	0.13	0.00	0.11	0.13	0.00	0.00	0.30	0.25	0.03	0.00	
80-06	27	0.74	0.19	0.41	0.19	0.00	0.00	0.12	0.00	0.16	0.06	0.03	0.00	0.33	0.19	0.16	0.19	
.	29	.	0.13	0.31	0.19	.	0.00	0.06	0.06	.	0.00	0.00	0.06	.	0.00	0.00	0.06	
.	30	.	0.63	1.59	0.50	.	0.19	0.25	0.13	.	0.06	0.19	0.00	.	0.19	0.25	0.25	
<b>Estevan group (Pemberton Bay)</b>																		
.	33	.	0.38	0.94	0.06	.	0.13	0.30	0.00	.	0.00	0.00	0.00	.	0.00	0.03	0.00	
.	34	.	0.00	0.00	0.00	.	0.00	0.00	0.00	.	0.00	0.00	0.00	.	0.00	0.00	0.00	
.	35	.	0.00	0.13	0.44	.	0.00	0.03	0.13	.	0.00	0.00	0.06	.	0.00	0.00	0.19	
.	36	.	1.06	0.08	0.69	.	0.31	0.00	0.19	.	0.13	0.04	0.00	.	0.13	0.04	0.06	
<b>Estevan group (Oswald Bay)</b>																		
.	38	.	.	0.53	0.56	.	.	0.13	0.19	.	.	0.09	0.13	.	.	0.22	0.25	
.	39	.	.	0.19	0.38	.	.	0.06	0.13	.	.	0.00	0.00	.	.	0.00	0.06	
.	40	.	.	0.38	0.00	.	.	0.03	0.00	.	.	0.03	0.00	.	.	0.03	0.00	

Appendix 3b (continued).

Site Number	Mature Density (no. / sq. m)				Prerecruit Density (no. / sq. m)				Recruit Density (no. / sq. m)				Legal Density (no. / sq. m)				
	1979-8 1989	1979-80 1993	1989 1997	1993 1997	1979-80	1989	1993	1997	1979-8	1989	1993	1997	1979-8	1989	1993	1997	
<b>Aristazabal Isl. North</b>																	
13	.	0.19	0.06	0.19	.	0.00	0.00	0.06	.	0.00	0.00	0.00	.	0.00	0.00	0.13	
79-12	15	1.53	1.81	0.13	0.06	0.36	0.50	0.00	0.06	0.23	0.06	0.00	0.00	0.45	0.13	0.00	0.00
	15A	.	.	0.38	0.00	.	.	0.00	0.00	.	.	0.00	0.00	.	.	0.06	0.00
	16	.	0.25	0.53	0.06	.	0.06	0.13	0.06	.	0.00	0.06	0.00	.	0.06	0.06	0.00
	17	.	0.63	0.13	0.13	.	0.13	0.03	0.06	.	0.06	0.03	0.00	.	0.06	0.03	0.00
	19	.	0.31	0.30	0.06	.	0.00	0.10	0.00	.	0.06	0.10	0.06	.	0.19	0.15	0.06
	20	.	0.38	0.41	0.75	.	0.13	0.03	0.06	.	0.06	0.22	0.06	.	0.19	0.38	0.38
<b>Aristazabal Isl. South</b>																	
	4	.	0.38	0.00	.	0.06	0.00	.	.	0.00	0.00	.	.	0.06	0.00	.	.
	6	.	0.00	0.13	0.00	.	0.00	0.04	0.00	.	0.00	0.04	0.00	.	0.00	0.04	0.00
	8	.	0.31	0.00	0.00	.	0.00	0.00	0.00	.	0.06	0.00	0.00	.	0.19	0.00	0.00
	9	.	0.06	0.04	0.06	.	0.00	0.00	0.00	.	0.00	0.00	0.00	.	0.00	0.00	0.00
	10	.	0.44	0.28	0.00	.	0.00	0.13	0.00	.	0.06	0.09	0.00	.	0.13	0.13	0.00
	11	.	0.38	0.25	0.06	.	0.00	0.00	0.00	.	0.06	0.00	0.00	.	0.13	0.00	0.00
	12	.	0.25	0.50	0.25	.	0.25	0.13	0.06	.	0.00	0.00	0.00	.	0.00	0.13	0.00

**Appendix 4** Abalone density data from the Heiltsuk transect survey during 24-29 May, 1997 (after Campbell and Cripps 1998). Only data in quadrats similar to the depth range of the DFO 16-quadrat survey were included for analysis (Simonds Group within -0.21 to 4.41 m depth at datum, and Stryker Island within 0.46 to 4.34 m).

Area	Site No.	DFO Site No.	Number of quadrats	Density by size group (mm SL)				
				≥ 70	92-99	100-106	≥100	Total
Simonds	201	SI2	7	0.00	0.00	0.00	0.00	0.00
Simonds	202	SI5	13	0.46	0.00	0.00	0.00	1.00
Simonds	203		21	0.52	0.05	0.10	0.38	0.52
Simonds	204		6	1.67	0.50	0.33	0.67	2.00
Simonds	205		7	0.00	0.00	0.00	0.00	0.29
Simonds	206		4	0.75	0.25	0.00	0.00	1.00
Simonds	207		6	0.17	0.00	0.00	0.17	0.17
Simonds	208		6	0.50	0.00	0.00	0.00	0.50
Simonds	209	SI9	4	0.00	0.00	0.00	0.00	0.75
Simonds	210		5	0.20	0.00	0.00	0.00	1.20
Simonds	211		9	0.11	0.00	0.00	0.00	1.11
Simonds	212	SI12	11	0.27	0.00	0.00	0.00	0.91
Simonds	213	SI13	4	0.00	0.00	0.00	0.00	0.00
Simonds	214		9	2.78	0.44	0.67	1.67	2.89
Simonds	215		4	0.25	0.25	0.00	0.00	0.25
Simonds	216	SI16	4	0.00	0.00	0.00	0.00	0.25
Simonds	217		4	0.50	0.25	0.25	0.25	0.50
Simonds	218		5	0.00	0.00	0.00	0.00	0.00
Simonds	219		4	0.00	0.00	0.00	0.00	0.75
Simonds	220	SI20	7	0.86	0.14	0.00	0.00	1.00
Simonds	221	SI21	4	0.00	0.00	0.00	0.00	0.00
Simonds	222		6	0.00	0.00	0.00	0.00	0.83
Simonds	223		10	2.30	0.60	0.30	0.30	2.30
Simonds	224	SI23	5	0.80	0.00	0.00	0.00	1.80
Simonds	225		8	0.25	0.25	0.00	0.00	0.38
Simonds	226		3	0.00	0.00	0.00	0.00	0.00
Simonds	227		3	0.00	0.00	0.00	0.00	0.00
Simonds	228		2	0.00	0.00	0.00	0.00	0.00
Simonds	229		3	0.00	0.00	0.00	0.00	0.00
Simonds	230		9	0.00	0.00	0.00	0.00	0.78
Simonds	231		4	0.00	0.00	0.00	0.00	0.25
Simonds	232		5	0.00	0.00	0.00	0.00	0.80
Stryker	301	ST359	3	0.33	0.00	0.00	0.00	0.33
Stryker	302	ST345	9	0.11	0.00	0.11	0.11	0.11
Stryker	303	ST304	3	0.33	0.00	0.00	0.00	-0.67
Stryker	304	ST316	6	0.00	0.00	0.00	0.00	0.00
Stryker	305	ST298	4	1.00	0.00	0.50	0.50	1.50
Stryker	306	ST284	3	0.00	0.00	0.00	0.00	0.00
Stryker	311		7	0.71	0.00	0.14	0.14	0.71
Stryker	312	ST4142	2	0.00	0.00	0.00	0.00	0.00
Stryker	314		7	0.43	0.00	0.00	0.00	0.86
Stryker	316	ST129	5	0.00	0.00	0.00	0.00	1.00
Stryker	317	ST121	4	0.00	0.00	0.00	0.00	0.00
Stryker	318	ST133	3	0.00	0.00	0.00	0.00	1.00
Stryker	319	ST150	3	0.00	0.00	0.00	0.00	0.00
Stryker	320	ST190	3	0.00	0.00	0.00	0.00	0.00
Stryker	321	ST214	2	0.00	0.00	0.00	0.00	0.00
Stryker	322	ST228	12	0.92	0.00	0.08	0.08	1.50
Stryker	323		4	0.00	0.00	0.00	0.00	0.50
Stryker	324		5	4.60	0.00	0.00	0.00	5.40
Stryker	325	ST263	5	0.00	0.00	0.00	0.00	0.00
Stryker	326	ST4113	2	0.00	0.00	0.00	0.00	0.50