Abalone Resurvey in South East Queen Charlotte Islands, 1998

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ABALONE RESURVEY IN SOUTH EAST QUEEN CHARLOTTE ISLANDS, 1998

by

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ABSTRACT

Campbell, A., D. Brouwer, J. Rogers, and D.C. Miller. 2000. Abalone resurvey in south east Queen Charlotte Islands, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2528: 30 p.

Northern or "Pinto" abalone, *Haliotis kamtschatkana*, fisheries in British Columbia (B.C.) have been closed since 1990 due to conservation concerns. The 1998 survey results indicated that northern abalone population densities were similar to those surveyed during 1984-94, but significantly lower than those found during 1978-79, in south east coast of the Queen Charlotte Islands, B.C. The similarity in abalone density between the new random sites and historic index sites suggested that the mean densities from all index sites were reasonably representative of adult abalone sampled in areas of the south east Queen Charlotte Islands. The common historic index sites with no "legal" exposed abalone ($\geq$ 100 mm shell length) generally increased from 25 % to over 60 % between the late 1970s and the late 1990s. In contrast, the index sites with no exposed abalone (of any size) increased from 0 % to 16 % during 1978-84, and then fluctuated between 5 and 16 % during 1984-98. Although 8 years had elapsed since closure of the abalone fishery in B.C. there was no statistical evidence of recovery of northern abalone stocks in the south east coast of the Queen Charlotte Islands by 1998.

RÉSUMÉ

Campbell, A., D. Brouwer, J. Rogers, and D.C. Miller. 2000. Abalone resurvey in south east Queen Charlotte Islands, 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2528: 30 p.

La pêche de l'ormeau nordique, *Haliotis kamtschatkana*, en Colombie-Britannique est fermée depuis 1990 par souci de la conservation de ce stock. Les résultats des relevés de 1998 indiquent que les densités des populations d'ormeau étaient semblables à celles qui avaient été relevées entre 1984 et 1994, mais nettement plus basses que les densités observées en 1978-1979 sur la côte sud-est des îles de la Reine-Charlotte (Colombie-Britannique). La similarité de la densité des ormeaux entre les nouveaux sites choisis au hasard et les sites indicateurs historiques permet de penser que les densités moyennes de tous les sites indicateurs étaient raisonnablement représentatives des populations d'ormeaux adultes échantillonnées dans certaines zones du sud-est des îles de la Reine-Charlotte. Le nombre des sites indicateurs les plus communs, ne présentant aucun ormeau exposé de taille légale ($\geq$ 100 mm de longueur de la coquille) a globalement augmenté, passant de 25 % à plus de 60 % entre la fin des années 70 et la fin des années 90. Par contre, les sites indicateurs ne présentant aucun ormeau exposé (toutes tailles confondues) a augmenté, passant de 0 % à 16 % entre 1978 et 1984, puis a fluctué entre 5 % et 16 % de 1984 à 1998. Malgré l'intervalle de 8 ans écoulé depuis la fermeture de la pêche de l'ormeau en Colombie-Britannique, nous n'avions en 1998 aucune indication statistique d'un rétablissement des stocks d'ormeau nordique sur la côte sud-est des îles de la Reine-Charlotte.

INTRODUCTION

Found from Sitka Island, Alaska to Baja California, the "northern" or "pinto" abalone, *Haliotis kamtschatkana*, generally occurs in patchy distribution on exposed and semi-exposed coasts in British Columbia (B.C.). Northern abalone has been a traditional food of first nations and a target of recreational divers and a small commercial dive fishery in B.C., until 1990. The biology and fishery of the northern abalone was reviewed by Sloan and Breen (1988) and Farlinger and Campbell (1992). Northern abalone stocks have been assessed through surveys of index sites using a standard survey design since 1978 (Breen and Adkins 1979). Much of the surveys and commercial fishery for northern abalone were conducted in areas along the south east Queen Charlotte Islands and the north central coast of B.C. (Pacific Fishery Management Areas 2, 5 and 6) during 1978-90 (Winther *et al.* 1995; Harbo 1997; Campbell *et al.* 1998). Surveys at index sites in south east Queen Charlotte Islands and the north central coast of B.C. have provided general time-series trends indicating that the abundance of northern abalone declined more than 75% between the period of 1978-84 and remained low until the last survey in 1997 (Winther *et al.* 1995; Thomas and Campbell 1996; Campbell *et al.* 1998). Faced with the possibility of abalone population collapse the northern abalone fishery has remained closed since 1990 due to conservation concerns.

The objective of this paper was to report on the results of a survey of northern abalone conducted during May 1998, and to compare estimates of abalone density with those measured in previous surveys along the south east Queen Charlotte Islands (Fig. 1) (Breen and Adkins 1979, 1981; Boutillier *et al.* 1985; Carolsfeld *et al.* 1988; Winther *et al.* 1995).

METHODS

The Coast Guard research vessel "Vector" was utilised as a live-aboard platform from which two dive tender boats were used for the survey of abalone during 8 - 21 May, 1998. 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 Fisheries and Oceans Canada (DFO).

Most of the sites previously sampled during 1994 by Winther *et al.* (1995) in south east Queen Charlotte Islands (QCI) were resurveyed during 1998 (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 1994 survey. The sites were grouped into eight general areas (A) Cumshewa Inlet, (B) Selwyn Inlet, (C) Tanu Island, (D) Upper Juan Perez Sound, (E) Lower Juan Perez Sound, (F) Skincuttle Inlet, (G) Carpenter Bay, (H) Kunghit Island (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^2 quadrat at the top of the abalone zone and then sampled 16 m^2 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 dominant vegetation, substrate type, maximum and minimum depths, and

time taken to sample the site and the number of abalone in each quadrat, underwater. The shell length (mm, SL) for each abalone in each quadrat was measured in situ under water with callipers. A sample for the density estimates was considered to be one site, with the 16 quadrats per site normally used as secondary sampling units (except for the 1994 survey, when 32-64 quadrats per site were surveyed).

In previous surveys divers collected all visible abalone and also lifted rocks to look for 'cryptic' abalone. In this survey, however, 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, the estimates are unreliable and the majority (>90%) of fully mature abalone (i.e., $\geq$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.

For the random samples, divers swam freely for 1-17 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, brought to the surface 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^2 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). Data for the youth (< 70 mm SL) size group, which includes mostly juveniles and some mature abalone, are included in this paper, but should be treated with caution and not considered representative since many individuals can be cryptic and would not have been sampled. 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 (Pi = 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 historic 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 south east QCI. A Mann-Whitney U test was used to compare abalone densities between the historic index sites and the random sites. 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 1998 using a Kolmogorov - Smirnov two - sample test. Abalone densities surveyed between two years (of each size category and historical common index sites only) were compared using the two-tailed Wilcoxon signed-rank test. Comparisons between years (data from surveys during 1978-79 were combined) were limited to 56 common

historic index sites where only total and legal-sized abalone data were available, and were limited to 25 historic common index sites where all size categories were available.

RESULTS

SURVEY SUMMARY

A total of 116 historic and random index sites (excluding 12 random swims with no abalone seen) were sampled for abalone density in 8 general areas in the south east QCI during 13 dive days in May, 1998 (Appendix 1). An average of 1.61 (minimum 0.69, maximum 2.94) minutes/quadrat, and 25.71 (minimum 11, maximum 47) minutes/site, was spent sampling per dive team.

SIZE FREQUENCY

Comparison between areas

The mean size was 76.6 mm SL for all abalone measured during the south east QCI, 1998 survey (Fig. 2, Table 1). The smallest abalone measured was 11 mm SL and the largest measured was 154 mm SL. The mean size was smallest from the sampled sites in Selwyn Inlet, with no legal-sized abalone found (Fig. 3, Table 1).

Comparison between years

The mean SL and % "legal" size have fluctuated over the last five surveys, without any clear trends (Table 2).

DENSITY

Comparison between areas

There was no difference ($p>0.05$, Mann-Whitney U test) in abalone density (total 0.49, 0.54; mature 0.23, 0.18; and legal 0.09, 0.10) between the historic index sites and the random sites (N = 66, 62), respectively, for all areas combined sampled during 1998 (Appendix 1, 2). These results suggested that the historic index sites were representative of the average abalone densities found in the sampled areas during 1998.

Total abalone densities, by area, were generally higher further south of Cumshewa Inlet (Table 3). Densities for various size groups were generally similar between areas, except for Cumshewa Inlet where there were the lowest abalone densities (Table 3).

Comparison between years

Mean density of different abalone size groups for all historic index sites and 56 and 11 comparable sites were compared (Table 4, 5, 6, 7, 8, 9, Appendix 3, 4, 5). Abalone densities declined significantly between 1978 and 1984 and subsequently fluctuated. There was a significant increase in total density from 0.33 to 0.53 abalone/m^2 between 1994 and 1998, but

no more than in 1984-90 (Table 7, 8). In all other size categories, there appears to be no significant change since 1984 (Table 8, 9).

FREQUENCY OF SITES WITH ABALONE

Comparison between areas

Overall, the percentage of sites with no exposed abalone was 15.6%, and with no exposed legal-sized abalone was 61.7%, for all random and historical index sites sampled (N=128) in 1998; between areas, these values ranged from 7.1% to 83.3% and 33.3% to 83.3%, respectively (Table 10). Taking only 56 common historic index sites, the percentage of sites with no exposed abalone was 7.1 %, or with no legal-sized exposed abalone was 69.6 %, in 1998 (Table 11).

Comparison between years

The frequency of samples indicated there were fewer sites with $\geq$1 abalone m^{-2} in the QCI between 1978 and the 1984-98 period (Fig. 4). The percentage of sites with densities of $\geq$ 1.0 or $\geq$ 0.25 total and or "legal" abalone per m^2 generally declined during 1978-94, but increased slightly by 1998 (except for the "legal" abalone with $\geq$ 1.0 density) (Fig. 5). The percent of index sites with no "legal" exposed abalone ($\geq$ 100 mm SL) generally increased from 25 to over 60 % during in the late 1970s to the late 1990s (Fig. 6, Table 10, 11). In contrast, the percent of index sites with no exposed abalone (of any size) increased from 0 to 16 % during 1978-84, and then fluctuated an average of between 5 and 16 % during 1984-98 (Fig. 6, Table 10, 11).

DISCUSSION

Although 8 years had elapsed since closure of the abalone fishery in B.C. there has been no clear evidence of recovery of northern abalone stocks in either south east QCI (this study) nor in the central coast of B.C. (Campbell et al. 1998). Mean overall densities of the total and size groups of exposed northern abalone found in the 1998 survey of south east QCI were similar (or slightly higher by 0 to 0.07 abalone / m^2) to those found in the 1997 survey of the central coast of B.C. (Campbell et al. 1998).

The 1998 survey results indicated that northern abalone population densities were similar to those surveyed during 1984-94, but significantly lower than those found during 1978-79, in south east QCI. There may have been a reduction in the decline of northern abalone densities as evidenced with the 1998 survey results compared to those observed for the previous (1978-94) surveys in south east QCI. However, densities of exposed pre-recruit and recruit abalone (0.05 and 0.04 / m^2) (Table 3) remain far below the replacement levels recommended by Breen (1986) of approximately 0.50 and 0.40 / m^2, respectively [0.55 and 0.45 / m^2 multiplied by 0.90 to remove cryptic abalone (Campbell 1996)].

Although the overall percentage of sites without any (total) abalone seemed to have stabilised, sites without "legal" ($\geq$ 100 mm SL) abalone increased to >60% (Fig. 6). Decreasing the number of patches with large mature abalone reduces the reproductive potential of the population (Campbell 1997). Increasing the frequency and size of patches, and density within

patches, may be important in maintaining sufficient brood stock and recruitment for healthy northern abalone populations in B.C. (Campbell 1997).

Caution is required in interpreting the results of this paper when using the "Breen" survey method. Sloan and Breen (1988) and Campbell (1996) suggested that to improve the statistical precision and power, (i.e., to show significant changes in density between years) sample sizes should be increased and or alternative survey methods could be explored (Campbell 1997). Caution also should be used in comparing the number (or %) of sites without abalone between years since changes in the number of secondary sampling units (quadrats) per site could potentially change the relative quantity of zero sites (Campbell 1996). 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 half of 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 logistically 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. (Campbell *et al.* 1998) and south east QCI. 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).

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Table 1. Summary of size frequency data for exposed abalone surveyed in south east QCI, 1998. Means of densities from areas followed by a common letter, in same column, are not significantly different ($p>0.05$) and means in same column with no common letters are significantly different ($p<0.05$) using the Kolmogorov - Smirnov two-sample test.
Index and random sites included.

	Shell length (mm SL)					Total	Percent Legal
Area	Mean	Median	S.E.	Minimum	Maximum	Number	≥100 mm SL
Cumshewa Inlet	61.3bcd	60.0	11.7	20	109	7	14.29
Selwyn Inlet	54.6a	55.0	2.5	13	93	50	15.29
Tanu Island	81.1bd	80.5	1.9	21	132	150	16.29
Upper Juan Perez	73.1c	76.0	1.7	11	124	202	17.29
Lower Juan Perez	77.9bc	80.5	5.0	34	123	28	18.29
Skincuttle Inlet	77.6bc	79.0	1.7	15	141	227	19.29
Carpenter Bay	78.3dc	73.5	1.8	14	154	214	20.29
Kunghit Island	80.7b	81.0	1.6	36	136	157	21.29
Total	76.6	77.0	0.8	11	154	1035	22.29

Table 2. Mean abalone length and percent of legal sized exposed abalone for all sites sampled in south east QCI in each year. Sample years 1984, 1987, 1990, and 1998 include only non cryptic abalone samples for comparison with 1978 and 1994.

	1984	1987	1990	1994	1998
Mean Length (mm)	75.4	80.8	76.3	77.6	76.6
% Legal	16.00	30.40	20.00	23.30	19.13
Sample Number	581	718	591	725	1035

Table 3. Mean density (number / square metre) of exposed abalone from the south east QCI 1998 survey. Means of densities from areas followed by a common letter, in same row, are not significantly different ($p>0.05$) and means in same row with no common letters are significantly different ($p<0.05$) using the Kolmogorov - Smirnov two sample test. Index and random sites (sample codes 1-3, Appendix 2) included.

	Cumshewa Inlet	Selwyn Inlet	Tanu Island	Upper Juan Perez	Lower Juan Perez	Skincuttle Inlet	Carpenter Bay	Kunghit Island	Total
No. of Sites	6	10	15	37	4	24	18	14	128
Total	0.07a	0.31abcd	0.63b	0.35d	0.47abcd	0.59bcd	0.75bcd	0.73bc	0.51
Youth (<70 mm SL)	0.04a	0.25ab	0.19ab	0.17b	0.20ab	0.20ab	0.31ab	0.22ab	0.21
Mature (≥70 mm SL)	0.03a	0.06ad	0.44bc	0.18cd	0.26abc	0.39bcd	0.43bc	0.50b	0.31
Pre-Recruit (92-99 mm SL)	0.00	0.01ab	0.05abcd	0.03c	0.06abcd	0.08cd	0.04abcd	0.07d	0.05
New Recruit (100-106 mm SL)	0.00	0.00e	0.05ab	0.01a	0.06ab	0.05ab	0.03ab	0.10b	0.04
Legal (≥100 mm SL)	0.01a	0.00e	0.14abd	0.04c	0.11acd	0.12abcd	0.18abcd	0.15d	0.10

Table 4. Total and legal abalone counts and estimated mean densities (number / square metre) (number / square m) by survey year from total sites and total quadrats sampled in south east QCI. Historical index sites only.

Year	Sites Sampled	Total Quadrats	Total Abalone	Legal Abalone	Total Density	Legal Density
1978	65	1044	2788	427	2.75	0.40
1984	70	1044	587	103	0.53	0.09
1987	71	1091	724	216	0.64	0.19
1990	69	1144	576	116	0.46	0.10
1994	70	2492	747	172	0.29	0.06
1998	66	1056	519	93	0.49	0.09

Table 5. Mean abalone density estimates (number / square metre) for 1990, 1994 and 1998. Historical index sites only.

Abalone Size	Year		
	1990	1994	1998
Total	0.46	0.29	0.49
Legal (≥ 100 mm SL)	0.10	0.06	0.09
Mature (≥ 70 mm SL)	0.27	0.18	0.26
Pre - Recruit (92-99 mm SL)	0.05	0.03	0.04
New Recruit (100-106 mm SL)	0.04	0.02	0.03

Table 6. Mean total and legal abalone density estimates (number / square metre) from 56 common survey index sites.

Year	Number of Quadrats	Total Abalone	Legal Abalone	Total Density	Legal Density
1978	900	2553	364	2.93	0.40
1984	848	503	85	0.56	0.09
1987	871	595	126	0.66	0.14
1990	944	527	90	0.51	0.09
1994	1980	658	134	0.33	0.06
1998	896	474	70	0.53	0.08

Table 7.Wilcoxon signed rank probabilities that abalone density estimates were the same when compared between sample years for 56 common sample sites in south east QCI. Comparisons were made for density estimates of total abalone and legal sized abalone.
* indicates a difference at the 0.05 level of significance.

	Year				
Year	1978	1984	1987	1990	1994
Total Abalone					
1984	<0.001*				
1987	<0.001*	0.272			
1990	<0.001*	0.569	0.039*		
1994	<0.001*	0.004*	0.001	0.06	
1998	<0.001*	0.894	0.097	0.728	0.005*
Legal Sized Abalone (≥ 100 mm SL)					
1984	<0.001*				
1987	<0.001*	0.085			
1990	<0.001*	0.628	0.054		
1994	<0.001*	0.134	0.001*	0.174	
1998	<0.001*	0.505	0.019	0.602	0.734

Table 8. Mean density estimates (number / square m) for total abalone and size categories of legal, mature, pre - recruit, and new recruit abalone from 25 sites with length data in all years sampled in south east QCI.

	Year					
	1978	1984	1987	1990	1994	1998
Number of Quadrats	404	376	399	392	860	400
Total	3.78	0.71	0.79	0.46	0.35	0.61
Legal (≥ 100 mm SL)	0.32	0.09	0.13	0.06	0.06	0.08
Mature (≥70 mm SL)	1.70	0.36	0.38	0.24	0.19	0.32
Pre - Recruit (92-99 mm S	0.29	0.08	0.06	0.04	0.03	0.04
New Recruit (100-106 mm	0.15	0.04	0.05	0.04	0.02	0.03

Table 9. Wilcoxon signed rank probabilities that estimates of exposed abalone density was the same when compared between sample years for 25 common sites in south east QCI. Probabilities are presented for total abalone and size categories of legal, mature, pre-recruit and new recruit abalone. * indicates a difference in density at the 0.05 level of significance.

	Year				
Year	1978	1984	1987	1990	1994
Total Abalone					
1984	<0.001*				
1987	<0.001*	0.903			
1990	<0.001*	0.107	0.009*		
1994	<0.001*	0.019*	0.012*	0.415	
1998	<0.001*	0.553	0.236	0.609	0.069
Legal Sized Abalone (≥ 100 mm SL)					
1984	<0.001*				
1987	0.009*	0.489			
1990	0.002*	0.277	0.083		
1994	0.001*	0.463	0.131	0.752	
1998	0.001*	0.551	0.189	0.721	0.530
Mature Sized Abalone (≥70 mm SL)					
1984	0.001*				
1987	<0.001*	.770			
1990	<0.001*	0.140	0.049*		
1994	<0.001*	0.088	0.070	0.594	
1998	<0.001*	0.779	0.553	0.444	0.085
Pre - Recruit Sized Abalone (92-99 mm SL)					
1984	0.014*				
1987	0.003*	0.700			
1990	0.005*	0.119	0.107		
1994	<0.001*	0.132	0.275	0.593	
1998	0.001*	0.509	0.380	0.752	0.795
New Recruit Sized Abalone (100-106 mm SL)					
1984	0.022*				
1987	0.008*	0.570			
1990	0.017*	0.475	0.377		
1994	<0.001*	0.363	0.026*	0.583	
1998	0.001*	0.331	0.1132	0.721	0.582

Table 10. Percent of total sites where no exposed (total) abalone, nor "legal" (> 100 mm SL) exposed abalone, were found in all historical and random index sites south east QCI, 1998.

Area	Percent of zero site		Total number of sites
	Total Abalone	Legal Abalone	
Cumshewa Inlet	83.30	83.30	6
Selwyn Inlet	20.00	100.00	10
Tanu Island	13.30	33.30	15
Upper Juan Pere	16.20	75.70	37
Lower Juan Pere	25.00	50.00	4
Skincuttle Inlet	8.30	50.00	24
Carpenter Bay	11.10	66.70	18
Kunghit Island	7.10	35.70	14
Total	15.60	61.70	128

Table 11. Summary by year of the number and percent of sites where no exposed abalone, or no "legal" (≥ 100 mm SL) exposed abalone, were found using 56 common index sites in south east QCI.

	Year					
	1978	1984	1987	1990	1994	1998
Number of zero sites						
Total Abalone	0	9	4	5	3	4
Legal Abalone	14	32	26	33	30	39
Percent zero sites						
Total Abalone	0.00	16.07	7.14	8.93	5.36	7.14
Legal Abalone	25.00	57.14	46.43	58.93	53.57	69.64

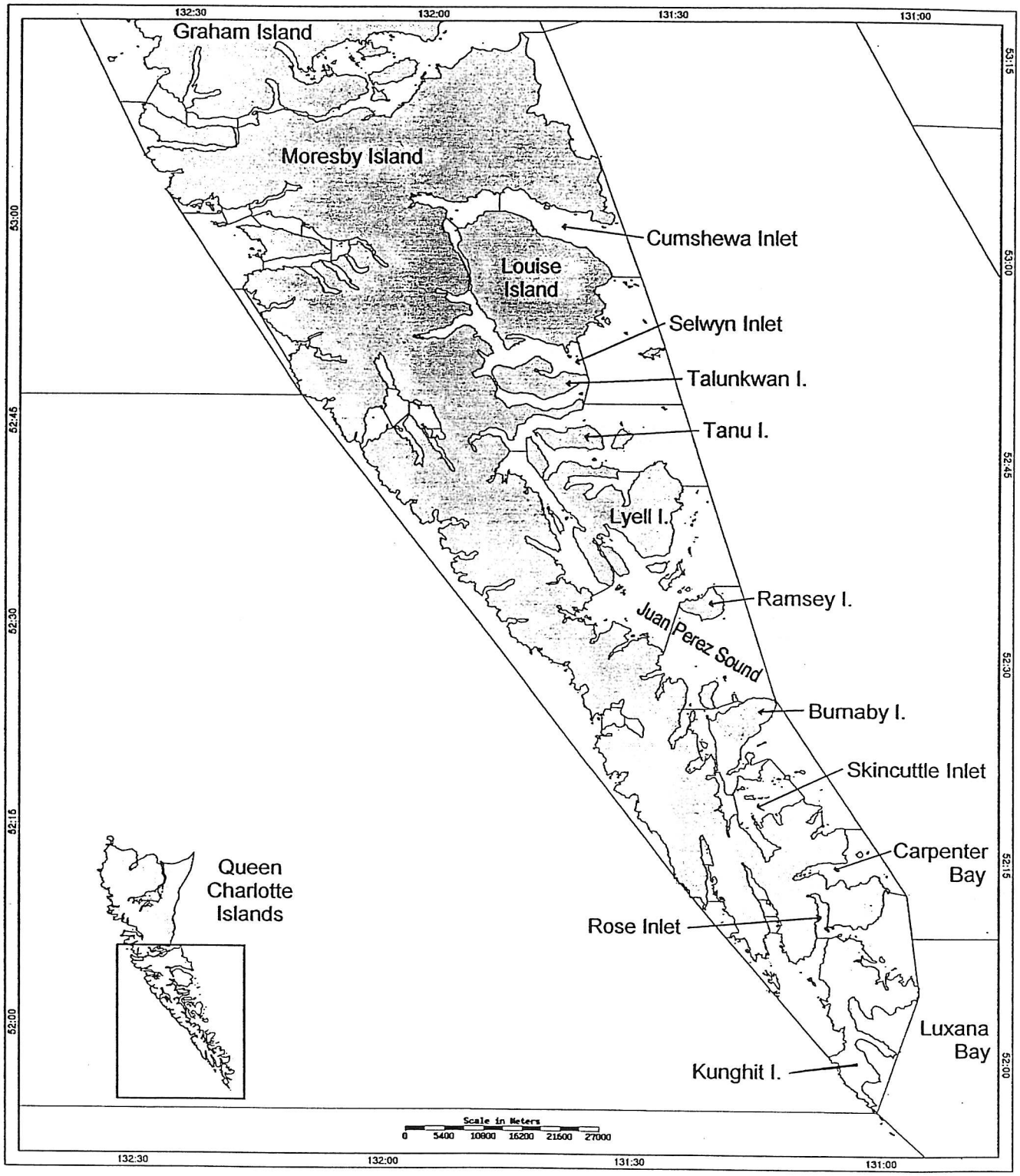

Fig. 1. General abalone survey area in southern Queen Charlotte Islands.

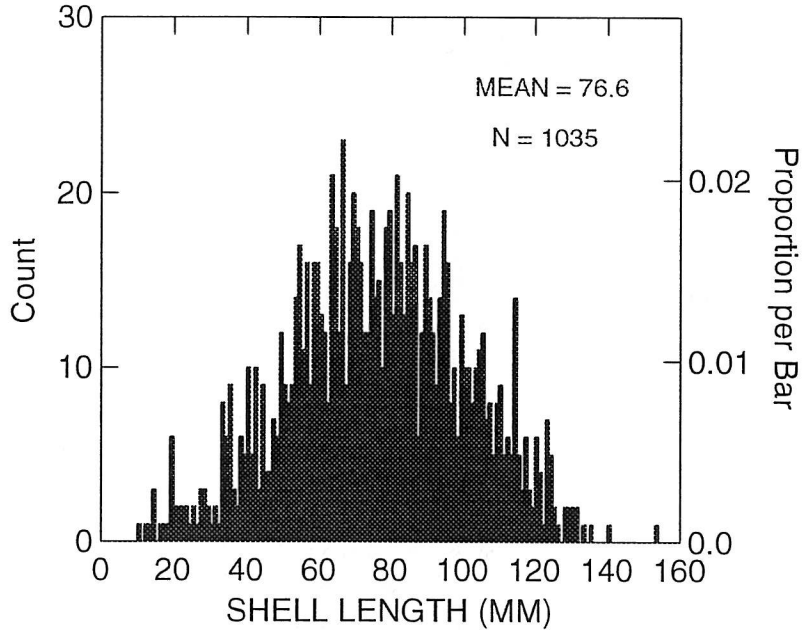

Fig. 2. Size frequency of exposed abalone measured from all survey index and random sites of the south east Queen Charlotte Islands during May, 1998. N = number of abalone measured.

Exposed Abalone - QCI 1998

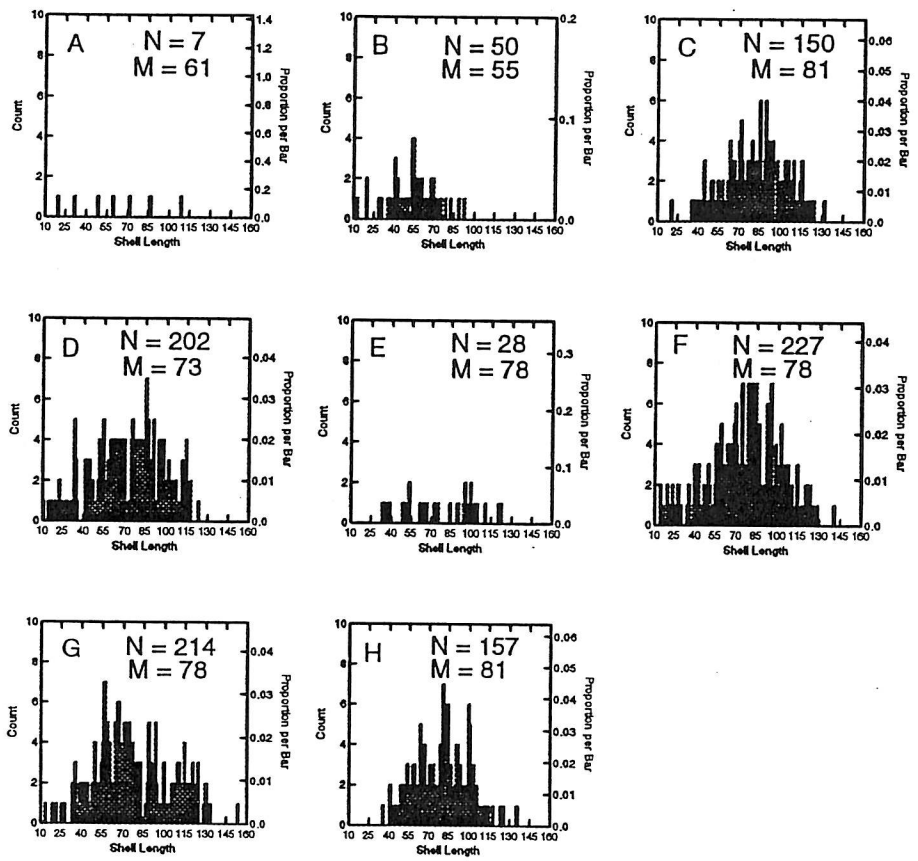

Fig. 3. Size frequency of exposed abalone shell length (mm) measured from all survey index and random sites of each general survey area (A) Cumshewa Inlet, (B) Selwyn Inlet, (C) Tanu Island, (D) Upper Juan Perez Sound, (E) Lower Juan Perez Sound, (F) Skincuttle Inlet, (G) Carpenter Bay, (H) Kunghit Island of the south east Queen Charlotte Islands during May, 1998. N = number of abalone measured, M = mean shell length (mm).

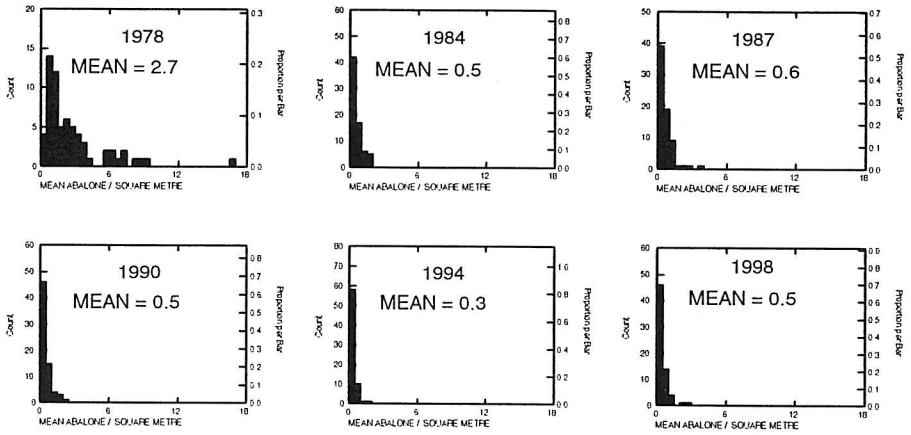

Fig. 4. Frequency distributions of different densities (number per square metre) of total exposed abalone from index sample sites from south east Queen Charlotte Islands during the 1978-98 surveys.

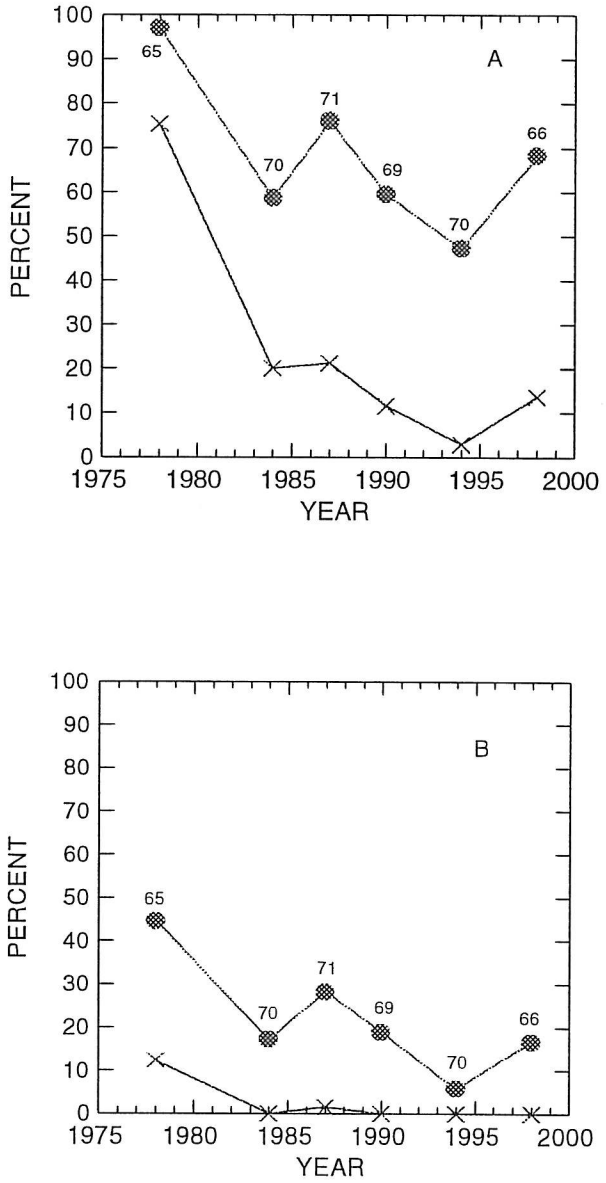

Fig. 5. Percent of all historical index sites that had densities ≥ 1.0 (cross) and ≥ 0.25 (dot) for (A) total and (B) "legal" (≥ 100 mm SL) exposed northern abalone per square metre from surveys in south east QCI, 1978–98. Numbers are samples sizes.

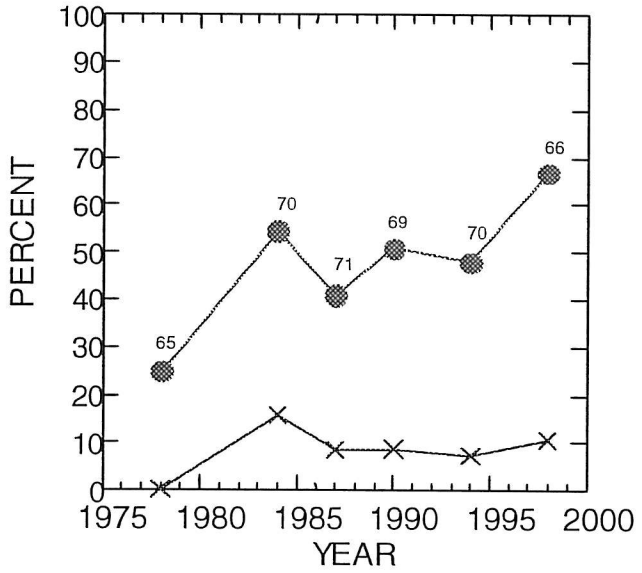

Fig. 6. Percent of all historical index sites that did not have legal-sized (≥ 100 mm SL) (dot) or any size (total) (cross) exposed northern abalone from surveys in south east QCI, 1978–98. Numbers are samples sizes.

Appendix 1. Dive survey summary for abalone per site, south east Queen Charlotte Islands, May 1998. Sample Codes: 1. Historical index sample; 2. Random index sample; 3. Random swim, no abalone seen; 4. Extra abalone collection for size frequency data; 5. Random swim, abalone counted; 6. Surface examination. Substrate Codes: 1. Bedrock - Smooth; 2. Bedrock - Crevices; 3. Boulders (> 13 cm); 4. Cobble (8-13 cm); 5. Gravel (2-8 cm); 6. Pea Gravel (0.3-2 cm); 7. Sand; 8. Shell; 9. Mud
Site No. with alpha-numeric codes are unique codes for each new random sample.

		Sample	No. of	Dive Time			Substrate	Depth (m)		Abalone	
Site No.	Day	Code	Quads	Start	Finish	Minutes	Type	Min	Max	Number	Density
Cumshewa Inlet											
98-75	21	1	16	10:01	10:35	34	57	3.15	3.81	0	0.00
98-77	21	1	16	10:11	10:31	20	57	2.03	2.03	0	0.00
98-78	21	1	16	11:02	11:22	20	543	2.99	3.64	0	0.00
RR-01	21	3	0	10:55	11:03	8	75	-1.74	2.20	0	0.00
RR-02	21	3	0	15:02	15:10	8	3	5.12	6.76	0	0.00
SR-02	21	2	16	15:24	15:55	31	13	1.31	3.94	7	0.44
Selwyn Inlet											
98-65	20	1	16	13:57	14:20	23	2	1.38	3.35	5	0.31
98-66	20	1	16	12:41	13:10	29	3	-1.05	1.57	14	0.88
98-67	20	1	16	13:22	13:40	18	2	2.00	5.28	4	0.25
98-68	20	1	16	9:41	10:06	25	2	-1.38	1.90	8	0.50
98-69	20	1	16	9:49	10:20	31	3	-1.31	3.61	0	0.00
98-69B	20	5	0	10:25	10:32	7	3			1	
98-70	20	1	16	10:46	11:17	31	13	-1.54	1.74	4	0.25
BR-01	20	2	16	14:28	14:41	13	347	2.56	2.89	0	0.00
BR-02	20	5	0	9:29	9:40	11	3	-3.38	4.82	2	
BR-03	20	5	0	10:47	10:55	8	23	-3.02	5.18	4	
BR-07	20	2	16	12:41	13:01	20	12	3.51	7.12	8	0.50
BR-08	20	2	16	13:38	14:06	28	32	0.56	3.51	2	0.13
BR-09	20	2	16	14:21	14:50	29	3	-1.35	0.95	5	0.31
Tanu Island											
98-59	19	1	16	13:20	13:43	23	23	2.99	4.95	15	0.94
98-60	19	1	16	14:28	14:52	24	34	-0.03	1.61	22	1.38
98-61	19	1	16	10:53	11:15	22	23	-2.36	0.26	2	0.13
98-62	19	1	16	15:50	16:10	20	34	0.03	1.02	3	0.19
98-63	19	1	16	14:05	14:27	22	3	0.59	2.56	18	1.13
98-64	19	1	16	12:48	13:35	47	4	0.23	1.54	6	0.38
98-73	19	1	16	9:27	9:48	21	43	1.90	2.89	1	0.06
98-74	19	1	16	9:47	10:08	21	489	0.72	2.69	1	0.06
AR-01	19	2	16	15:13	15:30	17	32	0.56	5.48	3	0.19
AR-02	19	3	0	15:58	16:02	4	4	0.03	4.95	0	0.00
AR-03	19	2	16	10:25	10:47	22	3	0.95	1.94	15	0.94
AR-04	19	2	16	14:35	14:58	23	23	1.28	4.56	26	1.63
AR-05	19	2	16	16:17	16:45	28	3	0.75	5.02	20	1.25
AR-06	19	2	16	12:38	12:57	19	37	0.03	1.02	20	1.25
AR-08	19	5	0	15:44	15:50	6	3	-0.89	6.99	6	
AR-09	19	3	0	10:10	10:15	5	7			0	0.00
Upper Juan Perez											
98-36	14	1	16	9:48	10:17	29	2	3.28	9.19	5	0.31
98-37	14	1	16	13:03	13:30	27	123	-0.39	1.90	4	0.25
98-38	14	1	16	13:02	13:33	31	32	-0.75	1.54	16	1.00
98-39	14	1	16	14:05	14:40	35	2	-1.44	2.49	6	0.38
98-40	14	1	16	15:02	15:33	31	1	-0.79	2.17	0	0.00
98-41	14	1	16	14:45	15:06	21	2	0.75	5.68	2	0.13
98-44	16	1	16	9:26	9:51	25	23	2.89	5.18	3	0.19
98-45	16	1	16	8:58	9:15	17	1	-1.12	1.18	1	0.06
98-46	15	1	16	11:20	11:44	24	123	5.77	8.73	6	0.38
98-48	15	1	16	9:22	10:03	41	37	-0.39	0.92	0	0.00

Appendix 1. (cont'd)

		Sample	No. of	Dive Time			Substrate	Depth (m)		Abalone	
Site No.	Day	Code	Quads	Start	Finish	Minutes	Type	Min	Max	Numbe	Density
98-48	15	1	16	9:22	10:03	41	37	-0.39	0.92	0	0.00
98-49	15	1	16	10:21	10:38	17	23	-0.13	4.46	2	0.13
98-50	15	1	16	14:25	14:45	20	347	-0.33	0.98	1	0.06
98-51	15	1	16	14:30	14:42	12	34	0.30	1.94	8	0.50
98-52	15	1	16	10:24	10:53	29	1	0.56	4.49	6	0.38
98-53	17	1	16	10:46	11:20	34	2	2.13	3.44	13	0.81
98-55	17	1	16	9:33	9:53	20	23	-0.72	1.90	16	1.00
98-56	16	1	16	10:58	11:24	26	34	2.33	3.31	4	0.25
98-57	17	1	16	9:20	9:55	35	23	-1.48	0.49	1	0.06
98-58	17	1	16	8:17	8:53	36	2	-1.31	5.58	6	0.38
CR-01	17	2	16	10:00	10:20	20	23	0.92	3.54	14	0.88
CR-02	16	3	0	8:59	9:07	8	1	-0.52	7.68	0	0.00
CR-03A	15	2	16	15:00	15:16	16	3	-0.82	3.44	10	0.63
CR-03B	16	2	16	11:07	11:30	23	13	0.07	5.64	6	0.38
CR-04	15	2	16	15:21	15:44	23	234	-0.13	1.84	13	0.81
CR-05	15	2	16	11:02	11:26	24	234	0.89	3.18	10	0.63
CR-06	15	2	16	9:44	10:12	28	328	0.03	1.67	13	0.81
CR-07	17	2	16	10:24	10:47	23	234	-0.43	1.54	6	0.38
CR-08	16	3	0	10:45	10:46	1	78	-1.05	-1.05	0	0.00
CR-09	15	2	16	9:10	9:28	18	34	-0.62	2.99	6	0.38
CR-10	16	2	16	10:20	10:40	20	314	-0.20	2.10	7	0.44
CR-11	17	3	0	8:14	8:25	11	2	-1.87	5.02	0	0.00
CR-12	16	2	16	9:35	9:50	15	137	-0.98	4.27	2	0.13
CR-13	15	2	16	15:35	15:56	21	23	0.36	2.00	7	0.44
CR-14	16	2	16	9:59	10:19	20	2	2.59	6.53	2	0.13
DR-01	14	2	16	14:06	14:25	19	1	-0.36	3.58	7	0.44
DR-02	14	3	0	13:46	13:54	8	3	-1.28	3.64	0	0.00
DR-03	14	5	0	15:12	15:18	6	18	-0.79	5.77	1	
DR-04	14	2	16	15:23	15:39	16	2	0.72	6.96	5	0.31
Lower Juan Perez											
98-42	14	1	16	8:30	8:50	20	2	-0.56	4.04	6	0.38
98-43	14	1	16	9:13	9:45	32	1	-0.13	2.82	7	0.44
ER-01	14	2	16	10:11	10:45	34	3	0.33	4.59	12	0.75
ER-01B	14	5	0	9:22	9:35	13	23	0.20	4.46	7	
ER-02	14	2	16	8:23	9:08	45	34	-0.49	-0.16	5	0.31
ER-03	14	6	0	10:20	10:21	1	73	-0.66	5.91	0	
ER-04	14	5	0	8:04	8:09	5	23	0.00	8.20	4	
Skincuttle Inlet											
98-22	11	1	16	13:44	14:27	43	2	0.62	4.23	17	1.06
98-23	11	1	16	15:55	16:20	25	34	-0.66	1.64	2	0.13
98-24	11	1	16	15:13	15:32	19	1	0.00	1.64	2	0.13
98-26	11	1	16	10:31	11:10	39	23	-1.31	2.95	9	0.56
98-27	11	5	0	14:18	14:38	20	23	3.84	5.48	1	
98-28	11	1	16	10:10	10:31	21	23	-0.59	6.63	4	0.25
98-29	11	1	16	8:40	9:07	27	1	0.82	2.13	6	0.38
98-30	11	1	16	8:05	8:41	36	2	1.51	3.81	11	0.69
98-31	12	1	16	14:09	14:34	25	342	2.03	4.99	2	0.13
98-32	12	1	16	14:14	14:48	34	24	-2.59	2.33	0	0.00
98-33	12	1	16	10:40	11:21	41	23	0.43	2.40	16	1.00
98-34	13	1	16	9:53	10:19	26	13	1.64	4.59	15	0.94
98-35	12	1	16	15:30	15:54	24	3	-0.72	1.57	4	0.25
FR-01	12	2	16	14:46	14:59	13	234	-2.17	0.46	4	0.25
FR-03	13	3	0	8:55	9:01	6	237	6.56	8.20	0	0.00
FR-06	13	5	0	8:27	8:36	9	2	0.13	1.77	4	

Appendix 1. (cont'd)

		Sample	No. of	Dive Time			Substrate	Depth (m)		Abalone	
Site No.	Day	Code	Quads	Start	Finish	Minutes	Type	Min	Max	Numbe	Density
GR-01	13	2	16	9:20	9:31	11	3	1.02	7.91	7	0.44
GR-02	13	2	16	8:55	9:22	27	345	2.62	4.59	15	0.94
GR-03	13	2	16	8:13	8:41	28	3	0.43	2.40	13	0.81
HR-01	11	2	16	13:49	14:06	17	21	-1.87	-0.56	5	0.31
HR-02	11	2	16	9:27	9:51	24	234	3.15	5.45	27	1.69
HR-03	11	5	0	8:04	8:13	9	14	0.85	2.49	2	
HR-04	11	2	16	9:30	10:08	38	2	0.43	5.35	20	1.25
HR-05	11	5	0	8:52	9:10	18	23	-0.20	1.77	4	
IR-01	12	2	16	8:36	9:09	33	27	0.82	5.09	17	1.06
IR-02	11	2	16	14:51	15:25	34	324	-2.40	-0.43	8	0.50
IR-03	11	2	16	15:48	16:18	30	12	-0.36	1.94	12	0.75
IR-05	12	2	16	8:36	8:55	19	237	2.46	7.05	11	0.69
Carpenter Bay											
98-10	9	1	16	14:05	14:40	35	23	-0.20	4.40	8	0.50
98-11	9	1	16	15:00	15:23	23	1	0.16	2.79	17	1.06
98-12	9	1	16	14:23	15:06	43	34	2.56	3.54	14	0.88
98-14	10	1	16	7:51	8:12	21	238	2.33	5.94	6	0.38
98-15	10	1	16	8:03	8:32	29	1	0.00	3.61	48	3.00
98-17	10	1	16	8:40	9:02	22	238	1.48	5.41	10	0.63
98-18	10	1	16	10:25	10:50	25	3	2.00	2.99	5	0.31
98-19	10	1	16	9:34	9:47	13	1	1.71	4.33	8	0.50
98-20	10	1	16	14:10	14:40	30	13	0.30	2.26	40	2.50
98-21	10	1	16	14:35	15:04	29	13	1.02	3.31	7	0.44
JR-01	10	5	0	14:59	15:17	18		-2.72	-0.43	12	
JR-02	10	3	0	13:45	14:00	15	37			0	0.00
JR-03	10	3	0	13:15	13:32	17	1			0	0.00
JR-04	10	2	16	13:26	13:53	27	23	-2.33	5.87	10	0.63
JR-05	10	2	16	10:10	10:33	23	1	4.49	5.81	8	0.50
JR-06	10	2	16	9:30	9:48	18	23	1.05	4.66	3	0.19
KR-01	9	2	16	15:33	15:54	21	23	0.39	4.66	3	0.19
KR-02	9	2	16	15:41	16:10	29	3	2.20	3.84	3	0.19
KR-03	10	2	16	8:45	9:05	20	124	0.46	4.07	25	1.56
Kunghit Island											
98-01	8	1	16	16:02	16:21	19	23	0.82	2.79	5	0.31
98-02	8	1	16	15:00	15:35	35	23	-1.02	1.94	15	0.94
98-03	9	1	16	8:34	8:57	23	23	-0.23	1.41	14	0.88
98-04	9	3	0	7:51	8:07	16	237			0	0.00
98-07	8	1	16	9:44	9:56	12	745	-0.13	1.51	2	0.13
98-71	8	1	16	14:12	14:50	38	435	-0.49	0.82	11	0.69
98-79	8	1	16	8:57	9:21	24	23	1.38	6.30	5	0.31
LR-01	8	5	0	13:42	13:57	15	135	-0.98	0.00	5	
LR-02	8	5	0	15:17	15:29	12	135	-0.95	5.28	2	
MR-01	8	5	0	8:37	8:47	10	231	0.92	6.50	3	
NR-01	8	2	16	8:40	9:15	35	439	-0.52	7.68	11	0.69
NR-02	8	2	16	9:35	10:01	26	23	-0.43	1.87	2	0.13
OR-01	9	2	16	8:14	8:51	37	32	-1.28	2.00	20	1.25
OR-02	9	2	16	9:14	9:38	24	23	-0.95	1.35	35	2.19
PR-01	8	2	16	16:00	16:30	30	34	-0.89	2.40	14	0.88
PR-02	9	2	16	9:18	9:48	30	12	0.72	3.02	27	1.69
PR-03	9	5	0	10:13	10:20	7	1	0.10	1.08	1	
PR-04	9	2	16	7:50	8:10	20	234			3	0.19

Appendix 2. Density for exposed abalone by size group surveyed per site, south east Queen Charlotte Islands, May 1998. Sample Codes: 1. Historic index sample; 2. Random index sample; 3. Random swim, no abalone seen; 4. Extra abalone collection for size frequency data; 5. Random swim, abalone counted; 6. Surface examination. D = density samples; SF = size frequency samples.
Site No. with alpha-numeric codes are unique codes for each new random sample.

	Sample	No. of	No. of Abalone		Exposed Density by Size Group (mm SL)					
Site No.	Code	Quads	D	SF	<70	≥70	92-99	100-106	≥100	Total
Cumshewa Inlet										
98-75	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
98-77	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
98-78	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
RR-01	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
RR-02	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
SR-02	2	16	7	7	0.25	0.19	0.00	0.00	0.06	0.44
Selwyn Inlet										
98-65	1	16	5	5	0.25	0.06	0.00	0.00	0.00	0.31
98-66	1	16	14	14	0.63	0.25	0.06	0.00	0.00	0.88
98-67	1	16	4	4	0.13	0.13	0.00	0.00	0.00	0.25
98-68	1	16	8	8	0.50	0.00	0.00	0.00	0.00	0.50
98-69	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
98-69B	5	0	1							
98-70	1	16	4	4	0.19	0.06	0.00	0.00	0.00	0.25
BR-01	2	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
BR-02	5	0	2							
BR-03	5	0	4							
BR-07	2	16	8	8	0.44	0.06	0.00	0.00	0.00	0.50
BR-08	2	16	2	2	0.13	0.00	0.00	0.00	0.00	0.13
BR-09	2	16	5	5	0.25	0.06	0.00	0.00	0.00	0.31
Tanu Island										
98-59	1	16	15	15	0.06	0.88	0.13	0.19	0.38	0.94
98-60	1	16	22	22	0.13	1.25	0.25	0.13	0.69	1.38
98-61	1	16	2	2	0.06	0.06	0.00	0.00	0.00	0.13
98-62	1	16	3	3	0.06	0.13	0.00	0.00	0.06	0.19
98-63	1	16	18	17	0.40	0.73	0.07	0.07	0.07	1.13
98-64	1	16	6	6	0.00	0.38	0.00	0.06	0.25	0.38
98-73	1	16	1	1	0.00	0.06	0.06	0.00	0.00	0.06
98-74	1	16	1	1	0.00	0.06	0.00	0.00	0.06	0.06
AR-01	2	16	3	3	0.00	0.19	0.00	0.00	0.06	0.19
AR-02	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
AR-03	2	16	15	15	0.13	0.81	0.06	0.06	0.19	0.94
AR-04	2	16	26	26	1.25	0.38	0.00	0.00	0.00	1.63
AR-05	2	16	20	19	0.33	0.92	0.13	0.20	0.26	1.25
AR-06	2	16	20	20	0.44	0.81	0.13	0.06	0.13	1.25
AR-08	5	0	6							
AR-09	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Upper Juan Perez										
98-36	1	16	5	5	0.31	0.00	0.00	0.00	0.00	0.31
98-37	1	16	4	4	0.25	0.00	0.00	0.00	0.00	0.25
98-38	1	16	16	15	0.53	0.47	0.00	0.00	0.13	1.00
98-39	1	16	6	6	0.19	0.19	0.06	0.00	0.00	0.38
98-40	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
98-41	1	16	2	2	0.06	0.06	0.06	0.00	0.00	0.13
98-44	1	16	3	3	0.06	0.13	0.00	0.00	0.00	0.19
98-45	1	16	1	1	0.00	0.06	0.00	0.00	0.00	0.06
98-46	1	16	6	6	0.38	0.00	0.00	0.00	0.00	0.38
98-48	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 2. (cont'd)

Site No.	Sample Code	No. of Quads	No. of Abalone D	SF	Exposed Density by Size Group (mm SL) <70	≥70	92-99	100-106	≥100	Total
98-49	1	16	2	2	0.13	0.00	0.00	0.00	0.00	0.13
98-50	1	16	1	1	0.06	0.00	0.00	0.00	0.00	0.06
98-51	1	16	8	8	0.00	0.50	0.06	0.19	0.38	0.50
98-52	1	16	6	6	0.38	0.00	0.00	0.00	0.00	0.38
98-53	1	16	13	13	0.81	0.00	0.00	0.00	0.00	0.81
98-55	1	16	16	16	0.19	0.81	0.06	0.19	0.25	1.00
98-56	1	16	4	4	0.00	0.25	0.06	0.00	0.06	0.25
98-57	1	16	1	1	0.06	0.00	0.00	0.00	0.00	0.06
98-58	1	16	6	6	0.13	0.25	0.00	0.00	0.00	0.38
CR-01	2	16	14	14	0.13	0.75	0.13	0.00	0.13	0.88
CR-02	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
CR-03A	2	16	10	10	0.63	0.00	0.00	0.00	0.00	0.63
CR-03B	2	16	6	6	0.38	0.00	0.00	0.00	0.00	0.38
CR-04	2	16	13	13	0.13	0.69	0.00	0.00	0.19	0.81
CR-05	2	16	10	8	0.55	0.08	0.00	0.00	0.00	0.63
CR-06	2	16	13	13	0.00	0.81	0.38	0.06	0.19	0.81
CR-07	2	16	6	5	0.08	0.30	0.15	0.00	0.00	0.38
CR-08	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
CR-09	2	16	6	6	0.06	0.31	0.06	0.00	0.06	0.38
CR-10	2	16	7	7	0.13	0.31	0.00	0.00	0.00	0.44
CR-11	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
CR-12	2	16	2	2	0.06	0.06	0.06	0.00	0.00	0.13
CR-13	2	16	7	5	0.18	0.26	0.00	0.00	0.00	0.44
CR-14	2	16	2	2	0.13	0.00	0.00	0.00	0.00	0.13
DR-01	2	16	7	7	0.19	0.25	0.00	0.00	0.06	0.44
DR-02	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
DR-03	5	0	1							
DR-04	2	16	5	5	0.06	0.25	0.06	0.00	0.00	0.31
Lower Juan Perez										
98-42	1	16	6	6	0.31	0.06	0.06	0.00	0.00	0.38
98-43	1	16	7	5	0.44	0.00	0.00	0.00	0.00	0.44
ER-01	2	16	12	12	0.06	0.69	0.13	0.19	0.25	0.75
ER-01B	5	0	7							
ER-02	2	16	5	5	0.00	0.31	0.06	0.06	0.19	0.31
ER-03	6	0	0							
ER-04	5	0	4							
Skincuttle Inlet										
98-22	1	16	17	17	1.00	0.06	0.00	0.00	0.00	1.06
98-23	1	16	2	2	0.00	0.13	0.00	0.00	0.06	0.13
98-24	1	16	2	2	0.06	0.06	0.00	0.00	0.00	0.13
98-26	1	16	9	9	0.06	0.50	0.06	0.06	0.25	0.56
98-27	5	0	1							
98-28	1	16	4	4	0.25	0.00	0.00	0.00	0.00	0.25
98-29	1	16	6	6	0.31	0.06	0.00	0.00	0.00	0.38
98-30	1	16	11	11	0.69	0.00	0.00	0.00	0.00	0.69
98-31	1	16	2	2	0.06	0.06	0.00	0.00	0.00	0.13
98-32	1	16	0	0	0.00	0.00	0.00	0.00	0.00	0.00
98-33	1	16	16	16	0.06	0.94	0.38	0.25	0.50	1.00
98-34	1	16	15	15	0.25	0.69	0.06	0.00	0.00	0.94
98-35	1	16	4	4	0.00	0.25	0.00	0.00	0.19	0.25
FR-01	2	16	4	4	0.06	0.19	0.00	0.00	0.00	0.25
FR-03	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
FR-06	5	0	4							
GR-01	2	16	7	7	0.38	0.06	0.00	0.00	0.00	0.44

Appendix 2. (cont'd)

Site No.	Sample Code	No. of Quads	No. of Abalone D	SF	Exposed Density by Size Group (mm SL) <70	≥70	92-99	100-106	≥100	Total
GR-02	2	16	15	15	0.00	0.94	0.25	0.06	0.19	0.94
GR-03	2	16	13	13	0.00	0.81	0.13	0.25	0.50	0.81
HR-01	2	16	5	5	0.00	0.31	0.00	0.00	0.06	0.31
HR-02	2	16	27	27	0.31	1.38	0.56	0.13	0.13	1.69
HR-03	5	0	2							
HR-04	2	16	20	20	0.63	0.63	0.06	0.00	0.06	1.25
HR-05	5	0	4							
IR-01	2	16	17	17	0.06	1.00	0.25	0.31	0.44	1.06
IR-02	2	16	8	8	0.06	0.44	0.06	0.06	0.13	0.50
IR-03	2	16	12	12	0.25	0.50	0.06	0.06	0.31	0.75
IR-05	2	16	11	11	0.38	0.31	0.00	0.00	0.00	0.69
Carpenter Bay										
98-10	1	16	8	8	0.06	0.44	0.00	0.00	0.44	0.50
98-11	1	16	17	17	0.56	0.50	0.06	0.00	0.00	1.06
98-12	1	16	14	14	0.00	0.88	0.00	0.13	0.81	0.88
98-14	1	16	6	6	0.38	0.00	0.00	0.00	0.00	0.38
98-15	1	16	48	48	1.56	1.44	0.31	0.00	0.00	3.00
98-17	1	16	10	10	0.19	0.44	0.13	0.06	0.13	0.63
98-18	1	16	5	5	0.00	0.31	0.00	0.06	0.25	0.31
98-19	1	16	8	8	0.44	0.06	0.00	0.00	0.00	0.50
98-20	1	16	40	40	1.38	1.13	0.00	0.13	0.13	2.50
98-21	1	16	7	7	0.44	0.00	0.00	0.00	0.00	0.44
JR-01	5	0	12							
JR-02	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
JR-03	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
JR-04	2	16	10	10	0.31	0.31	0.00	0.00	0.00	0.63
JR-05	2	16	8	8	0.19	0.31	0.06	0.00	0.00	0.50
JR-06	2	16	3	3	0.00	0.19	0.06	0.00	0.00	0.19
KR-01	2	16	3	3	0.00	0.19	0.13	0.00	0.00	0.19
KR-02	2	16	3	2	0.19	0.00	0.00	0.00	0.00	0.19
KR-03	2	16	25	25	0.00	1.56	0.00	0.13	1.50	1.56
Kunghit Island										
98-01	1	16	5	5	0.25	0.06	0.00	0.00	0.00	0.31
98-02	1	16	15	14	0.27	0.67	0.13	0.00	0.00	0.94
98-03	1	16	14	14	0.31	0.56	0.06	0.06	0.13	0.88
98-04	3	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
98-07	1	16	2	2	0.00	0.13	0.00	0.06	0.13	0.13
98-71	1	16	11	11	0.00	0.69	0.13	0.25	0.50	0.69
98-79	1	16	5	5	0.06	0.25	0.06	0.00	0.00	0.31
LR-01	5	0	5							
LR-02	5	0	2							
MR-01	5	0	3							
NR-01	2	16	11	11	0.06	0.63	0.13	0.13	0.25	0.69
NR-02	2	16	2	2	0.00	0.13	0.00	0.06	0.06	0.13
OR-01	2	16	20	20	0.50	0.75	0.06	0.31	0.44	1.25
OR-02	2	16	35	31	0.49	1.69	0.07	0.42	0.42	2.19
PR-01	2	16	14	13	0.40	0.47	0.07	0.07	0.07	0.88
PR-02	2	16	27	27	0.75	0.94	0.19	0.06	0.13	1.69
PR-03	5	0	1							
PR-04	2	16	3	2	0.09	0.09	0.09	0.00	0.00	0.19

Appendix 3. Total exposed abalone density by site and number of quadrats sampled per site for all sample years. Blanks indicate no samples taken. Historic index sites only

	Total abalone density (number / square metre)						Total number of quadrats / site					
SITE	1978	1984	1987	1990	1994	1998	1978	1984	1987	1990	1994	1998
Cumshewa Inlet												
75	1.13		0.44	0.06	0.00	0.00	16		16	16	32	16
76	2.88		0.13	0.38	0.19		16		16	16	32	
77	1.44		0.00		0.06	0.00	16		4		32	16
78	0.88		1.50	0.75	0.06	0.00	16		16	16	32	16
Selwyn Inlet												
65	1.06	0.13	0.50	0.06	0.25	0.31	16	16	16	16	32	16
66	0.63	0.13	0.31	0.06	0.34	0.88	16	16	16	16	32	16
67	0.94	0.00	0.56	0.31	0.09	0.25	16	8	16	16	32	16
68	1.13	0.19	1.19	0.63	0.13	0.50	16	16	16	16	32	16
69	3.88	0.06	0.19	0.13	0.19	0.00	16	16	16	16	32	16
70	3.63	0.31	0.25	0.06	0.06	0.25	16	16	16	16	32	16
Tanu Island												
59	1.44	0.88	1.06	0.63	0.81	0.94	16	16	16	16	64	16
60		1.25	0.63	0.00	0.19	1.38		16	16	8	64	16
61	1.53	0.31	0.00	0.00	0.28	0.13	32	16	16	8	32	16
62		0.56	0.81	0.63	0.16	0.19		16	16	16	32	16
63	1.44	0.19	0.19	0.56	0.31	1.13	16	16	16	16	32	16
64	2.19	0.06	0.75	0.06	0.03	0.38	16	16	16	16	32	16
73			1.00	0.13	0.38	0.06			16	16	32	16
74			0.13	0.06	0.59	0.06			16	16	32	16
Upper Juan Perez Sound												
36	2.44	0.00	0.00	0.00	0.22	0.31	16	8	16	16	32	16
37	1.13	0.00	0.38	0.19	0.06	0.25	16	8	16	16	32	16
38	2.44	1.00	0.69	0.94	0.41	1.00	16	16	16	16	32	16
39	6.38	1.81	0.88	0.31	0.28	0.38	13	16	16	16	32	16
40	1.00	0.13	0.06	0.08	0.03	0.00	16	16	16	48	32	16
41	0.25	0.06	0.06	0.00	0.06	0.13	16	16	16	16	32	16
44	6.56	0.13	0.44	0.06	0.06	0.19	16	16	16	16	32	16
45	4.25	0.75	0.63	0.81	0.13	0.06	16	16	16	16	32	16
46	7.06	0.50	4.00	1.44	0.22	0.38	16	16	16	16	32	16
47		0.00						8				
48	3.63	1.19	0.81	0.44	0.19	0.00	16	16	16	16	48	16
49	1.81	0.56	0.88	2.10	0.25	0.13	16	16	16	48	64	16
50	0.63	1.19	0.38	0.56	0.22	0.06	16	16	16	16	32	16
51	0.75	0.00	0.50	0.38	0.23	0.50	16	16	16	16	64	16
52	8.86	2.00	0.50	0.69	0.06	0.38	7	16	16	16	32	16
53	8.13	0.31	0.75	0.94	0.00	0.81	16	16	16	16	32	16
54	0.63	1.00	1.50	0.50	0.27		16	16	16	16	64	
55	5.88	0.88	2.56	1.19	0.38	1.00	16	16	16	16	32	16
56	7.25	1.75	1.13	1.75	0.59	0.25	16	16	16	16	32	16
57	2.63	1.00	0.25	0.00	0.00	0.06	16	16	16	16	32	16
58	3.38	0.06	0.25	0.25	0.00	0.38	16	16	16	16	32	16
Lower Juan Perez Sound												
42	16.56	0.06	1.56	0.63	0.52	0.38	16	16	16	16	64	16
43	9.38	0.31	0.81	0.69	0.27	0.44	16	16	16	16	64	16

Appendix 3. (cont'd)

	Total abalone density (number / square metre)						Total number of quadrats / site					
SITE	1978	1984	1987	1990	1994	1998	1978	1984	1987	1990	1994	1998
Skincuttle Inlet												
22	1.63	0.06	0.00	0.63	0.09	1.06	16	16	0	16	32	16
23	1.13	0.69	0.63	0.31	0.03	0.13	16	16	16	16	32	16
24	0.75	0.81	1.13	0.38	0.25	0.13	16	16	16	16	48	16
25	2.25	0.75					16	16				
26	0.56	2.00	2.13	1.25	0.34	0.56	16	16	16	16	32	16
27	0.63	0.00	0.06	0.06	0.06		16	8	16	16	32	
28	3.06	1.13	1.13	0.31	0.88	0.25	16	16	16	16	32	16
29	0.94	0.69	0.38	0.19	0.34	0.38	16	16	16	16	32	16
30	3.31	1.25	0.44	0.88	0.53	0.69	16	16	16	16	32	16
31	1.75	0.50	0.94	0.25	0.31	0.13	16	16	16	16	32	16
32	5.75	0.00	0.50	0.13	0.09	0.00	16	8	16	16	32	16
33	3.00	0.81	0.75	0.06	1.16	1.00	16	16	16	16	32	16
34	6.13	0.94	0.44	0.19	0.25	0.94	16	16	16	16	28	16
35	0.31	0.38	0.50	0.06	0.34	0.25	16	16	16	16	32	16
72			1.00						16			
Carpenter Bay												
10	1.06	0.69	0.56	0.31	0.34	0.50	16	16	16	16	32	16
11	0.19	0.00	0.19	0.06	0.16	1.06	16	8	16	16	32	16
12	0.13	0.19	0.19	0.31	0.22	0.88	16	16	16	16	32	16
13	2.31	0.42					16	12				
14	2.31	0.56	0.63	1.56	0.31	0.38	16	16	16	16	32	16
15	3.38	0.50	0.44	0.38	0.97	3.00	16	16	16	16	32	16
16	2.56	0.06					16	16				
17	1.19	0.06	0.56	0.13	0.41	0.63	16	16	16	16	32	16
18	1.44	0.81	0.25	0.25	0.63	0.31	16	16	16	16	32	16
19	1.00	0.00	0.38	0.31	0.91	0.50	16	16	16	16	32	16
20	1.13	1.63	0.07	0.31	0.72	2.50	16	16	15	16	32	16
21	0.94	0.00	0.00	0.00	0.03	0.44	16	8	8	8	32	16
Kunghit Island												
1	2.63	1.06	1.06	1.94	0.47	0.31	16	16	16	16	32	16
2	0.69	0.38	1.06	1.50	0.22	0.94	16	16	16	16	32	16
3	1.63	0.38	0.38	0.94	1.63	0.88	16	16	16	16	32	16
4		0.13	0.44	0.13	0.00			16	16	16	32	
5		0.00						8				
6		0.50	0.00					16	8			
7		0.19	0.13	0.19	0.16	0.13		16	16	16	32	16
8		0.06						16				
9		0.44						16				
71			0.31	0.19	0.19	0.69			16	16	32	16
79				0.31	0.03	0.31				16	32	16

Appendix 4. Legal and mature exposed abalone density (number / square metre) by site for all sample years. Blanks indicate no samples taken. Historic index sites only.

	Legal (≥100 mm SL) abalone density						Mature (≥ 70 mm SL) abalone density					
SITE	1978	1984	1987	1990	1994	1998	1978	1984	1987	1990	1994	1998
Cumshewa Inlet												
75	0.84		0.44	0.06	0.00	0.00	1.05		0.44	0.06	0.00	0.00
76	1.44		0.06	0.13			2.16		0.13	0.25		
77	0.44		0.00		0.06	0.00	0.81		0.00		0.06	0.00
78	0.75		1.50	0.69	0.03	0.00	0.88		1.50	0.69	0.06	0.00
Selwyn Inlet												
65	0.11	0.00	0.13	0.00	0.06	0.00		0.06	0.44	0.06	0.09	0.06
66	0.31	0.06	0.13	0.00	0.03	0.00		0.13	0.25	0.06	0.17	0.25
67	0.14	0.00	0.19	0.06	0.00	0.00		0.00	0.44	0.06	0.00	0.13
68	0.40	0.00	0.25	0.25	0.00	0.00	0.99	0.00	0.63	0.38	0.03	0.00
69	0.39	0.00	0.06	0.00	0.06	0.00		0.00	0.13	0.06	0.19	0.00
70	0.54	0.05	0.00	0.06	0.03	0.00		0.16	0.00	0.06	0.03	0.06
Tanu Island												
59	0.72	0.13	0.69	0.25	0.29	0.38		0.75	1.00	0.50	0.63	0.88
60		0.36	0.49	0.00	0.14	0.69		1.25	0.63	0.00	0.16	1.25
61	0.40	0.19	0.00	0.00	0.00	0.00	1.43	0.25	0.00	0.00	0.06	0.06
62		0.25	0.25	0.13	0.03	0.06		0.56	0.44	0.38	0.09	0.13
63	0.21	0.00	0.00	0.00	0.00	0.07	0.68	0.00	0.09	0.44	0.24	0.73
64	1.42	0.00	0.44	0.06	0.00	0.25	2.12	0.06	0.71	0.06	0.03	0.38
73			0.94	0.13	0.25	0.00			1.00	0.13	0.34	0.06
74			0.13	0.06	0.16	0.06			0.13	0.06	0.22	0.06
Upper Juan Perez Sound												
36	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.21	0.00	0.03	0.00
38	0.37	0.00	0.06	0.25	0.10	0.13		0.44	0.44	0.75	0.20	0.47
39	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.13	0.00	0.19	0.07	0.19
40	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
41	0.00	0.06	0.00	0.00	0.06	0.00		0.06	0.06	0.00	0.06	0.06
44	0.06	0.00	0.13	0.00	0.00	0.00	3.13	0.06	0.31	0.00	0.03	0.13
45	0.13	0.19	0.06	0.25	0.00	0.00	1.55	0.31	0.31	0.50	0.06	0.06
46	0.00	0.00	0.00	0.00	0.00	0.00	1.67	0.06	0.31	0.00	0.03	0.00
47		0.00						0.00				
48	0.54	0.38	0.13	0.06	0.13	0.00	1.63	0.94	0.38	0.25	0.15	0.00
49	1.63	0.42	0.70	0.33	0.14	0.00		0.49	0.82	1.71	0.23	0.00
50	0.56	0.75	0.31	0.44	0.09	0.00		1.13	0.38	0.56	0.22	0.00
51	0.68	0.00	0.44	0.31	0.23	0.38		0.00	0.50	0.38	0.23	0.50
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
53	1.22	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
54	0.00	0.08	0.41	0.19	0.08		0.25	0.77	1.16	0.44	0.20	
55	3.53	0.06	0.26	0.56	0.09	0.25		0.56	2.18	0.88	0.34	0.81
56	0.36	0.13	0.50	0.44	0.09	0.06		1.19	1.00	1.25	0.47	0.25
57	0.13	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
58	0.12	0.00	0.00	0.00	0.00	0.00	1.66	0.00	0.08	0.00	0.00	0.25
Lower Juan Perez Sound												
42	1.25	0.00	0.13	0.06	0.02	0.00	11.52	0.00	0.69	0.19	0.03	0.06
43	0.94	0.00	0.00	0.00	0.00	0.00		0.19	0.06	0.13	0.02	0.00

Appendix 4. (cont'd)

	Legal (≥100 mm SL) abalone density						Mature (≥ 70 mm SL) abalone density					
SITE	1978	1984	1987	1990	1994	1998	1978	1984	1987	1990	1994	1998
Skincuttle Inlet												
22	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.03	0.06
23	0.11	0.28	0.21	0.13	0.03	0.06		0.69	0.63	0.31	0.03	0.13
24	0.40	0.07	0.19	0.00	0.04	0.00	0.75	0.68	1.00	0.38	0.25	0.06
25	0.11	0.29						0.52				
26	0.51	0.45	0.86	0.25	0.00	0.25	0.56	1.81	2.06	1.00	0.25	0.50
27	0.16	0.00	0.06	0.06	0.03		0.42	0.00	0.06	0.06	0.06	
28	0.07	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.06	0.00	0.06	0.00
29	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.06	0.06	0.03	0.06
30	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.13	0.00
31	0.09	0.28	0.69	0.06	0.19	0.00		0.50	0.88	0.19	0.22	0.06
32	0.45	0.00	0.00	0.00	0.00	0.00	4.28	0.00	0.13	0.06	0.00	0.00
33	1.10	0.31	0.38	0.00	0.59	0.50	2.51	0.75	0.63	0.06	1.03	0.94
34	0.26	0.19	0.06	0.00	0.00	0.00	1.74	0.81	0.31	0.06	0.18	0.69
35	0.03	0.31	0.13	0.00	0.19	0.19		0.38	0.50	0.00	0.31	0.25
72			0.88						1.00			
Carpenter Bay												
10	0.06	0.06	0.28	0.19	0.31	0.44	0.69	0.52	0.51	0.31	0.34	0.44
11	0.06	0.00	0.00	0.00	0.03	0.00	0.19	0.00	0.13	0.06	0.16	0.50
12	0.10	0.06	0.09	0.06	0.00	0.81		0.19	0.19	0.31	0.13	0.88
13	0.00	0.00					0.31	0.00				
14	0.93	0.06	0.00	0.00	0.00	0.00		0.44	0.19	0.81	0.28	0.00
15	0.13	0.00	0.00	0.00	0.00	0.00	2.04	0.19	0.06	0.06	0.53	1.44
16	0.20	0.00					1.31	0.00				
17	0.06	0.00	0.00	0.00	0.00	0.13		0.06	0.21	0.00	0.28	0.44
18	0.44	0.38	0.04	0.06	0.20	0.25	1.19	0.81	0.21	0.19	0.36	0.31
19	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.06	0.06	0.22	0.06
20	0.00	0.00	0.00	0.00	0.06	0.13	0.50	0.75	0.07	0.25	0.44	1.13
21	0.23	0.00	0.00	0.00	0.03	0.00		0.00	0.00	0.00	0.03	0.00
Kunghit Island												
1	0.00	0.12	0.19	0.38	0.13	0.00	0.81	1.00	0.75	1.63	0.34	0.06
2	0.00	0.11	0.11	0.31	0.00	0.00		0.38	0.84	0.69	0.00	0.67
3	1.22	0.21	0.05	0.13	0.16	0.13		0.38	0.27	0.81	1.27	0.56
4		0.00	0.15	0.00	0.00			0.00	0.29	0.00	0.00	
5		0.00						0.00				
6		0.07	0.00					0.21	0.00			
7		0.06	0.00	0.06	0.06	0.13		0.13	0.00	0.19	0.16	0.13
8		0.00						0.06				
9		0.06						0.31				
71			0.31	0.13	0.13	0.50			0.31	0.19	0.19	0.69
79				0.13	0.00	0.00				0.25	0.03	0.25

Appendix 5. Pre-recruit and new recruit exposed abalone density (number / square metre) by site for all sample years. Blanks indicate no samples taken. Historic index sites only.

	Pre - recruit (92-99 mm SL) abalone density						New recruit (100-106 mm SL) abalone density					
SITE	1978	1984	1987	1990	1994	1998	1978	1984	1987	1990	1994	1998
Cumshewa Inlet												
75	0.07		0.00	0.00	0.00	0.00	0.14		0.00	0.00	0.00	0.00
76	0.13		0.00	0.06			0.39		0.00	0.06		
77	0.13		0.00		0.00	0.00	0.06		0.00		0.00	0.00
78	0.13		0.00	0.00	0.03	0.00	0.00		0.00	0.00	0.00	0.00
Selwyn Inlet												
65		0.00	0.13	0.06	0.00	0.00		0.00	0.00	0.00	0.00	0.00
66		0.06	0.06	0.00	0.00	0.06		0.00	0.00	0.00	0.03	0.00
67		0.00	0.00	0.00	0.00	0.00		0.00	0.13	0.06	0.00	0.00
68	0.13	0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.13	0.06	0.00	0.00
69		0.00	0.00	0.00	0.00	0.00		0.00	0.06	0.00	0.00	0.00
70		0.00	0.00	0.00	0.00	0.00		0.05	0.00	0.06	0.00	0.00
Tanu Island												
59		0.25	0.19	0.06	0.11	0.13		0.00	0.50	0.06	0.07	0.19
60		0.30	0.07	0.00	0.00	0.25		0.06	0.07	0.00	0.00	0.13
61	0.37	0.00	0.00	0.00	0.03	0.00	0.17	0.06	0.00	0.00	0.00	0.00
62		0.13	0.00	0.19	0.00	0.00		0.00	0.06	0.00	0.03	0.00
63	0.07	0.00	0.00	0.00	0.07	0.07	0.21	0.00	0.00	0.00	0.00	0.07
64	0.39	0.00	0.09	0.00	0.03	0.00	0.39	0.00	0.09	0.00	0.00	0.06
73			0.06	0.00	0.03	0.06			0.18	0.06	0.00	0.00
74			0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00
Upper Juan Perez Sound												
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
38		0.00	0.06	0.13	0.03	0.00		0.00	0.00	0.13	0.00	0.00
39	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
40		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
41		0.00	0.00	0.00	0.00	0.06		0.00	0.00	0.00	0.06	0.00
44	0.31	0.00	0.13	0.00	0.00	0.00	0.06	0.00	0.06	0.00	0.00	0.00
45	0.19	0.06	0.06	0.06	0.00	0.00	0.00	0.19	0.00	0.19	0.00	0.00
46	0.38	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
47		0.00						0.00				
48	0.24	0.31	0.00	0.00	0.02	0.00	0.24	0.13	0.06	0.00	0.04	0.00
49		0.07	0.00	0.31	0.06	0.00		0.14	0.18	0.17	0.05	0.00
50		0.19	0.06	0.06	0.03	0.00		0.13	0.06	0.00	0.06	0.00
51		0.00	0.06	0.06	0.00	0.06		0.00	0.06	0.00	0.02	0.19
52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
53		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
54	0.00	0.08	0.27	0.00	0.02		0.00	0.00	0.14	0.13	0.02	
55		0.06	0.45	0.19	0.06	0.06		0.00	0.19	0.31	0.06	0.19
56		0.13	0.13	0.38	0.06	0.06		0.00	0.25	0.19	0.09	0.00
57		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
58	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lower Juan Perez Sound												
42	2.49	0.00	0.06	0.13	0.00	0.06	0.93	0.00	0.13	0.00	0.02	0.00
43		0.06	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00

Appendix 5. (cont'd)

	Pre - recruit (92-99 mm SL) abalone density						New recruit (100-106 mm SL) abalone density					
SITE	1978	1984	1987	1990	1994	1998	1978	1984	1987	1990	1994	1998
Skincuttle Inlet												
22		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
23		0.34	0.21	0.06	0.00	0.00		0.07	0.07	0.00	0.00	0.00
24	0.00	0.07	0.13	0.00	0.06	0.00	0.23	0.07	0.06	0.00	0.02	0.00
25		0.00						0.12				
26	0.00	0.65	0.66	0.25	0.09	0.06	0.11	0.26	0.20	0.13	0.00	0.06
27	0.16	0.00	0.00	0.00	0.03		0.05	0.00	0.00	0.00	0.03	
28	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
29		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
30		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
31		0.22	0.13	0.00	0.00	0.00		0.11	0.25	0.06	0.03	0.00
32	0.89	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00
33	0.31	0.19	0.13	0.00	0.19	0.38	0.55	0.06	0.25	0.00	0.22	0.25
34	0.19	0.06	0.06	0.00	0.00	0.06	0.06	0.19	0.06	0.00	0.00	0.00
35		0.00	0.19	0.00	0.03	0.00		0.06	0.06	0.00	0.03	0.00
72			0.06						0.06			
Carpenter Bay												
10	0.06	0.06	0.11	0.00	0.03	0.00	0.00	0.00	0.06	0.13	0.03	0.00
11	0.06	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.03	0.00
12		0.06	0.00	0.00	0.03	0.00		0.06	0.00	0.06	0.00	0.13
13	0.06	0.00					0.00	0.00				
14		0.19	0.00	0.00	0.03	0.00		0.00	0.00	0.00	0.00	0.00
15	0.32	0.06	0.00	0.00	0.06	0.31	0.13	0.00	0.00	0.00	0.00	0.00
16	0.39	0.00					0.20	0.00				
17		0.00	0.00	0.00	0.06	0.13		0.00	0.00	0.00	0.00	0.06
18	0.19	0.00	0.00	0.00	0.03	0.00	0.19	0.06	0.00	0.06	0.07	0.06
19		0.00	0.00	0.06	0.00	0.00		0.00	0.00	0.00	0.00	0.00
20	0.06	0.19	0.00	0.06	0.16	0.00	0.00	0.00	0.00	0.00	0.03	0.13
21		0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.03	0.00
Kunghit Island												
1	0.06	0.24	0.06	0.50	0.06	0.00	0.00	0.00	0.19	0.31	0.06	0.00
2		0.05	0.22	0.13	0.00	0.13		0.00	0.06	0.31	0.00	0.00
3		0.11	0.00	0.50	0.35	0.06		0.11	0.05	0.13	0.13	0.06
4		0.00	0.00	0.00	0.00			0.00	0.15	0.00	0.00	
5		0.00						0.00				
6		0.00	0.00					0.07	0.00			
7		0.06	0.00	0.00	0.03	0.00		0.00	0.00	0.00	0.00	0.06
8		0.06						0.00				
9		0.13						0.06				
71			0.00	0.00	0.03	0.13			0.00	0.00	0.00	0.25
79				0.00	0.00	0.06				0.13	0.00	0.00