Survey of Northern Abalone, *Haliotis kamtschatkana,* Populations near Kitkatla, British Columbia, March 2000

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V9R 5K6

2001

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2572

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Fisheries and Aquatic Sciences 2572

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SURVEY OF NORTHERN ABALONE, *Haliotis kamtschatkana*, POPULATIONS NEAR KITKATLA, BRITISH COLUMBIA, MARCH 2000

by

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Cat. No. Fs 97-4 /2572 ISSN 0706-6473

Correct citation for this publication:

Lucas, B.G., D. Brouwer, and A. Campbell. 2001. Survey of northern abalone, *Haliotis kamtschatkana*, populations near Kitkatla, British Columbia, March 2000. Can. Manuscr. Rep. Fish. Aquat. Sci. 2572: 11 p.

ABSTRACT

Lucas, B.G., D. Brouwer, and A. Campbell. 2001. Survey of northern abalone, *Haliotis kamtschatkana*, populations near Kitkatla, British Columbia, March 2000. Can. Manuscr. Rep. Fish. Aquat. Sci. 2572: 11 p.

A survey was conducted, during Mareh 14 to 21, 2000, to provide an estimate of population numbers of mature emergent northern abalone in areas near Kitkatla, British Columbia. Abalone shell lengths (SL) ranged from 27 to 146 mm. The estimated mean density for abalone of all sizes was 0.16/m^2 at McCauley Island and 0.05/m^2 at Goschen Island. The estimated mean density for abalone 90 – 110 mm SL was 0.05/m^2 at McCauley Island and 0.01/m^2 at Goschen Island. The estimated mean total population number (and 90% confidence interval) of emergent abalone for all sizes at McCauley Island was 34,406 (31,595 – 37,216) and at Goschen Island was 20,750 (18,114 – 23,386). The mean total population number (and 90% confidence interval) of emergent abalone in the 90 – 110 mm SL size range was estimated for McCauley Island to be 11,326 (10,363 – 12,289) and for Goschen Island to be 4,000 (3,490 – 4,510).

RÉSUMÉ

Lucas, B.G., D. Brouwer, and A. Campbell. 2001. Survey of northern abalone, *Haliotis kamtschatkana*, populations near Kitkatla, British Columbia, March 2000. Can. Manuscr. Rep. Fish. Aquat. Sci. 2572: 11 p.

Un relevé a été effectué du 14 au 21 mars 2000 pour estimer l'effectif des populations d'ormeaux nordiques émergents matures près de Kitkatla (Colombie-Britannique). La longueur des ormeaux échantillonnés variait de 27 à 146 mm. La densité moyenne des ormeaux de toutes tailles a été estimée à 0,16/m^2 à l'île McCauley et à 0,05/m^2 à l'île Goschen. La densité moyenne estimée des ormeaux faisant de 90 à 110 mm de longueur était de 0,05/m^2 à l'île McCauley et de 0,01/m^2 à l'île Goschen. L'effectif total moyen de la population d'ormeaux émergents de toutes tailles a été estimé à 34 406 (intervalle de confiance à 90 % : 31 595 – 37 216) à l'île McCauley et à 20 750 (18 114 – 23 386) à l'île Gosehen. Pour ce qui est des ormeaux faisant de 90 à 110 mm de longueur, leur effectif total estimé était de 11 326 (10 363 – 12 289) à l'île MeCauley et de 4 000 (3 490 – 4 510) à l'île Goschen.

INTRODUCTION

Northern abalone, *Haliotis kamtschatkana*, populations have declined in British Columbia (B.C.), despite complete closure of the fishery since 1990 for conservation purposes. Post-harvest surveys indicated that abalone densities were still well below levels recommended to ensure sustainable populations (Breen 1986, Campbell et al. 1998). The future of *H. kamtschatkana* was sufficiently uncertain that in April 1999 this species was declared "Threatened" by COSEWIC (Committee on the Status of Endangered Wildlife in Canada).

Fisheries and Oceans Canada (DFO), in cooperation with coastal communities and other interested stakeholders, has begun an initiative to rehabilitate abalone stocks in B.C. Collection of broodstock will be required to implement the first step in this program, which is to develop aquaculture teehnology for this species.

To estimate the abundance of abalone stocks in areas of interest, an independent assessment using conventional survey methodology was required. Only emergent (visible) abalone were surveyed to provide a minimum estimate of mature adult population numbers; cryptic abalone were not surveyed in this census.

The objectives of this study were to determine densities, size frequencies, and population numbers of emergent northern abalone at two locations near Kitkatla, B.C.

MATERIALS AND METHODS

FIELD METHODS

This survey was conducted during March 14 to 21, 2000 at McCauley Island and Goschen Island, B.C. (Figure 1). On McCauley Island, the area between Hankin Point and Baird Point was surveyed. On Goschen Island, thc Joachim Spit area near Joachim Point was surveyed. Survey locations were selected, in consultation with Kitkatla First Nation's representatives, to include areas where abalone were most abundant. The transect survey method (Cripps and Campbell 1998) was used for this study. Transects were randomly placed along the lengths of shoreline where populations were to be estimated. To avoid bias, these transect positions were determined in advance. The primary sampling unit was a "transect", made up of a cluster of secondary units. Each transect was one meter wide and variable in length, depending on the slope of the substrate. Prior to entering the water, a lead line was laid perpendicular to shore from the boat in depths of approximately 12 m to 0 m from datum. Where negligible slope would have resulted in excessively long transects, a 100 m section within the 0 – 12 m depth range was haphazardly selected for surveying. The secondary sampling unit consisted of a 1 m x 1 m square quadrat that was placed along the transect, 1 m away, to avoid sampling areas disturbed by the lead line placement. Divers flipped the quadrat parallel to the transect line, from deep to shallow, and the number of "emergent" or "exposed" abalone, shell length (SL in mm) of each abalone, depth, substrate type, slope, and algal cover was recorded. Algal cover, sea

urchins and starfish were removed from the quadrat to ensure all emergent abalone were detected. Boulders were not moved to search for cryptic abalone, since the majority of mature abalone (i.e., ≥ 70 mm SL) are exposed (Campbell 1996).

ANALYTICAL METHODS

All gauge depths were converted to depth (m) at chart datum. The survey results were analyzed according to Fisheries and Oceans Canada methodology (Campbell et al. 1999). To determine the size frequency distribution for a location, the number of abalone in each 5 mm SL size class was divided by the total number of abalone in each location.

The estimated mean density, $\bar{d}$ (number/m^2), of abalone was calculated as:

$$\bar{d} = \frac{\sum_t (d_t * L_t)}{\sum_t L_t} \tag{1}$$

The standard error of the mean density, s_d, was calculated as:

$$s_d = \sqrt{1 - \frac{n}{T}} * \sqrt{\frac{\sum_t (d_t * L_t - \bar{d} * L_t)^2}{n * (n-1) * \bar{L}^2}} \tag{2}$$

where n is the number of transects, d_t is the density at transect t, L_t is the length of transect t (or area in square metres since each transect is one metre wide), $\bar{L} = \frac{\sum_t L_t}{n}$ is the mean transect length (or mean area in square metres), and T is the total possible number of transects that can be sampled in the surveyed area. The expression $\sqrt{1 - \frac{n}{T}}$ is approximately one, because the sample size n is small compared to T. This method accounts for the variable length of transects and for the variable proportion of quadrats surveyed along each transect.

To estimate the mean density (number/m^2) for a specific size group (J), (e.g., 90 – 110 mm SL) the value d_t was substituted with densities ($P_{t,J}$) in equations 1 and 2. The mean density $P_{t,J}$ (number/m^2) of abalone of size group J in transect t was calculated as:

$$P_{t,J} = \frac{\left(N_t * \frac{\sum_{i \in J} m_{t,i}}{M_t} \right)}{S_t} \tag{3}$$

where J is a subset (e.g., 90 – 110 mm SL) of possible i values representing a range of shell lengths (SL_i), S_t is the number of quadrats surveyed for density estimates in transect t, N_t is the number of abalone counted in transect t, $M_t = \sum_i m_{t,i}$ the total number of abalone measured for size in transect t, and $m_{t,i}$ is the number of abalone in size range J of transect t.

The approximate lower 90% confidence interval of the mean density (L90CI) was calculated as:

$$L90CI = \bar{d} - t_{\alpha/2} (s_d / \sqrt{n}) \quad (4)$$

where $t_{\alpha/2}$ is the critical t-distribution value at degrees of freedom of n-1.

The total number of abalone (X) in each location was calculated as:

$$X = \bar{d} * A \quad \text{or} \quad X = L90CI * A \quad (5)$$

where L90CI is the lower 90% confidence interval of the mean density for all sizes or for a particular size group of abalone, and A is the estimated area (m^2) of the surveyed location. The area of the location surveyed was calculated as the product of the mean transect length (since transects generally covered the breadth of suitable abalone habitat) and the length of the location as measured by the distance the between the two furthest shoreline points used when generating random transects.

RESULTS

The area surveyed on McCauley Island was primarily well-sheltered shoreline and nearshore reefs. A few sites had moderate exposure to wind and storms. The substrate consisted of bedrock, boulders and sand (Table 1). The slope (angle from horizontal) was estimated to be from 1° to 70°. The area surveyed near Goschen Island was moderately exposed with strong tidal currents flowing through the area. A few sites were highly exposed to wind and storms. There was little slope to the substrate, which was mostly sand, with boulders, cobble and gravel near the spit and reef. High winds and rough seas during the survey period prevented surveying at Goschen Island on most days and in the most exposed areas. There was very little algal canopy in either area, because spring algal growth had only just begun in mid March when these surveys were conducted. The predominant canopy species was *Nereocystis*, with *Laminaria* dominating the understory. *Agarum*, *Alaria*, *Costaria* and *Fucus* were also present. Sea grass was found in patches, and rock substrates had a moderate cover of encrusted and articulated coralline algae. Few red sea urchins (*Strongylocentrotus franciscanus*) or sunflower starfish (*Pycnopodia*) were sighted during the survey.

The depths surveyed ranged from –3.4 to 15.7 m from datum (Table 2). Thirty-three transects, with a mean length of 59 m, were surveyed near McCauley Island (Tables 2, 3).

Sixteen transects were surveyed near Goschen Island, with a mean transect length of 110 m. Three hundred twenty-two abalone were found in quadrats near McCauley Island and 83 in quadrats near Goschen Island, for a total of 405 abalone. Ten transects (20%) surveyed had no abalone. The maximum density for a transect was 1.07 abalone/m^2. Sizes of abalone surveyed at McCauley Island ranged from 27 to 146 mm SL (Figure 2A) and from 28 to 128 mm SL at Goschen Island (Figure 2B). The mean size of abalone at McCauley Island was 86 mm SL and at Goschen Island was 80 mm SL. The size frequency histogram shows peaks at 45, 75, and 105 mm SL for McCauley Island, and at 65, 95, and 120 mm SL for Goschen Island.

Estimated mean total density of emergent abalone from McCauley Island was 0.16/m^2 and from Goschen Island was 0.05/m^2 (Table 4). The mean population estimate was 34,406 emergent abalone from McCauley Island and 20,750 from Goschen Island. Mean estimates of the number of abalone in the 90 – 110 mm SL size range were 11,326 for McCauley Island and 4,000 for Goschen Island.

DISCUSSION

The abalone found in this survey had a wide range of sizes, with those at Goschen Island being evenly distributed throughout the range of sizes, and those at McCauley Island being normally distributed, with the majority in the 80 to 120 mm SL size range. The three peaks in each size frequency histogram, at evenly spaced 30 mm SL intervals, may be evidence of some natural recruitment to the populations in those areas. A conservative estimate of the total population numbers of emergent abalone of all sizes was provided by the lower 90% confidence interval (L90CI), which was 31,595 abalone for McCauley Island and 18,114 abalone for Goschen Island. The L90CI for mature emergent abalone 90 – 110 mm SL was 10,303 for McCauley Island and 3,490 for Goschen Island.

This survey provides no evidence of recovery of abalone populations since the province-wide closure in 1990. The abalone densities found during this survey were low at McCauley Island and at Goschen Island compared to most recent surveys in B.C. (Campbell et al. 1998, Lucas et al. 2000a, b, 2001). Since these low densities were well below those recommended to ensure sustainable populations (Breen 1986), the removal of any abalone from these areas must be considered with caution.

ACKNOWLEDGMENTS

We thank the Kitkatla First Nation for their assistance in conducting this study. K. Innes and B. Watkinson assisted with planning and E. Bolton, B. Bolton, and M. Tolme tended the dive boats. J. Disbrow and R. Gurr from the Tsimpsian Tribal Council assisted with diving. Thanks also to C. Hand for reviewing the manuscript.

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Table 1. Habitat summary for abalone transects surveyed in the Kitkatla area, March 14 – 21, 2000. The most common substrates are listed (1 = first, 2 = second, 3 = third) where substrate code 1 = smooth bedrock, 2 = bedrock with crevices, 3 = boulders, 4 = eobble, 5 = gravel, 6 = pea gravel, 7 = sand, 8 = shell, and 9 = mud. The average slope of the transect is estimated in degrees from horizontal. The algae present are listed by height strata (canopy = tall shading surface reaching, understory = 30 cm – 2 m, turf = 5 cm – 30 cm and bottom cover = < 5 cm) for the most common species (Sp 1) and second most common species (Sp 2) with the estimated percentage of cover (%) for each. AC = articulated coralline, AG = *Agarum*, AL = *Alaria*, B = unknown brown, CO = *Costaria*, EN = encrusting corraline, FU = *Fucus*, GR = sea grass, H = unknown filamentous, LA = *Laminaria*, MA = *Macrocystis*, NT = *Nereocystis*, PT = *Pterygophora*, and R = unknown red.

						Algae											
		Substrate			Slope	Canopy		Understory				Turf				Bottom Cover	
Transect	Date	1	2	3	degrees	Sp	%	Sp 1	%	Sp 2	%	Sp 1	%	Sp 2	%	Sp	%
McCauley Island																	
BB17	Mar 20	4	3		5			AG	70	LA	10	H	30				
BB50	Mar 20	2			25			LA	5	B	2			AC	2	EN	75
BB60	Mar 20	2	3	4	30			B	5	LA	2	GR	2	AC	40	EN	50
BB116	Mar 20	7	2	4	45			LA	20							EN	20
BB130	Mar 20	2	3	4	45			LA	5	B	1			AC	2	EN	50
BB171	Mar 20	2	1	3	5			LA	5							EN	95
BB187	Mar 20	2	4	5	2			LA	90							EN	90
BR305	Mar 15	1														EN	100
BR307	Mar 15	1	7		30			LA	2					AC	5	EN	75
HN1	Mar 21	2	8	3	45	NT	1	LA	10	R	2					EN	40
HN2	Mar 21	2	3	8	30	NT	10	LA	50					AC	5	EN	80
HN3	Mar 21	2	1		60			AG	90							EN	100
HN4	Mar 21	2	1		60							AC	5			EN	90
HP6	Mar 15	1			20											EN	100
HP56	Mar 17	1	3		10			LA	2			AC	2	H	90	EN	10
HP75	Mar 15	1	5	7	5			LA	10			AC	5			EN	2
HP96	Mar 17	3	7	1	5			LA	2							EN	70
HP127	Mar 15	7	1	3	25			LA	5					AC	2	EN	15
HP131	Mar 17	2	7		40			LA	10					AC	5	EN	50
HP141	Mar 17	1	3	7	5									H	95		
HP167	Mar 17	1	2		5			AG	70							EN	90
HP169	Mar 17	1	2	7	5			AG	70							EN	70
HP173	Mar 15	1	7		30			AG	5							EN	30
HP181	Mar 17	7	3	2	20			AG	40	R	5					EN	50
HP182	Mar 17	1	7	3	15			AG	40							EN	60
SI1	Mar 18	1	2		70							GR	20			EN	70
SI10	Mar 18	1			70			AG	2			LA	2	AC	5	EN	80
SI30	Mar 18	3	1	4	5			LA	2			GR	2			EN	100
SI50	Mar 18	3	1	4	1			LA								EN	90
SI60	Mar 18	1	3	5	30			FU	30	LA	5	GR	2			EN	50
SI72	Mar 18	2			30			LA	90							EN	80
SI88	Mar 18	3	7	4	5			LA	10	B	5	GR	2	AC	10	EN	20
SI90	Mar 16	3	4	1	10			LA	5	AG	1					EN	5
Goschen Island																	
JP141	Mar 19	3	4	5	0			PT	50	LA	20	GR	2				
JP143	Mar 19	3	5	4	1							GR	2			EN	20
JP160	Mar 19	3	4	5	20	NT	5	R	25	LA	10	GR	5	AC	1	EN	2
JP166	Mar 19	3	4	7	15	NT	10	LA	20	AL	5	GR	5	AC	10	EN	30
JP183	Mar 16	3	7	5	5							LA	20	AC	20	EN	100
JP200	Mar 16	7	4	3	1			LA	1			GR	1	AC	2	EN	2
JP22	Mar 14	3	7	4	3	NT	10	LA	25			GR	1	AC	1	EN	25
JP265	Mar 19	4	5	3	0			LA	10					H	30		
JP291	Mar 19	7	4	3	2	NT	1	LA	10	B	5	GR	1	AC	15	EN	5
JP31	Mar 16	3	4	5	5	NT	1	LA	40	CO	2	GR	5			EN	50
JP365	Mar 19	3	4	5	0			LA	80							EN	80
JP58	Mar 14	7	4	5	2			LA	5			AC	10			EN	20
JP71	Mar 14	7	4		2											EN	2
JP72	Mar 14	7			1							GR	2				
JP73	Mar 14	7	4		2			LA	20			AC	60	GR	5		
JP90	Mar 16	3	7	4	10			LA	30	AL	5	GR	30			EN	25

Table 2. Dive summary for abalone transects surveyed in the Kitkatla area, March 14 – 21, 2000.

		Time			Depth (m)		Number of	Number of Abalone		Density (#/m2)	
Transect	Date	Start	Finish	Bottom	Min	Max	Quadrats	all sizes	90-110mm	all sizes	90-110mm
McCauley Island											
BB-17	Mar 20	14:33	15:15	0:42	-0.9	5.2	60	11	4	0.18	0.07
BB-50	Mar 20	14:04	14:35	0:31	1.3	4.0	9	8	3	0.89	0.33
BB-60	Mar 20	13:14	13:46	0:32	-1.8	4.3	60	6	3	0.10	0.05
BB-116	Mar 20	11:27	11:43	0:16	-1.0	10.3	43	2	0	0.05	0.00
BB-130	Mar 20	10:45	11:10	0:25	0.0	7.9	26	3	0	0.12	0.00
BB-171	Mar 20	13:00	14:00	1:00	-2.7	4.6	75	38	10	0.51	0.13
BB-187	Mar 20	10:30	11:38	1:08	-0.6	2.0	80	69	28	0.86	0.35
BR-305	Mar 15	10:55	11:40	0:45	-0.6	7.0	60	0	0	0.00	0.00
BR-307	Mar 15	10:58	11:40	0:42	1.2	11.0	96	0	0	0.00	0.00
HN-1	Mar 21	10:40	11:11	0:31	1.0	9.4	46	6	1	0.13	0.02
HN-2	Mar 21	11:37	12:30	0:53	0.8	6.5	45	48	11	1.07	0.24
HN-3	Mar 21	10:30	11:10	0:40	-1.1	8.4	25	8	1	0.32	0.04
HN-4	Mar 21	11:45	12:00	0:15	-1.4	6.3	13	8	4	0.62	0.31
HP-6	Mar 15	14:00	14:40	0:40	-0.5	12.2	71	12	6	0.17	0.08
HP-56	Mar 17	10:30	11:10	0:40	-0.6	5.4	90	3	2	0.03	0.02
HP-75	Mar 15	13:14	13:40	0:26	-1.2	3.4	68	0	0	0.00	0.00
HP-96	Mar 17	15:08	15:50	0:42	-1.0	6.4	85	9	2	0.11	0.02
HP-127	Mar 15	13:28	13:50	0:22	2.5	15.7	60	4	3	0.07	0.05
HP-131	Mar 17	13:32	14:25	0:53	1.7	11.7	53	24	7	0.45	0.13
HP-141	Mar 17	11:35	12:00	0:25	-2.2	4.7	120	5	3	0.04	0.03
HP-167	Mar 17	13:15	13:50	0:35	-3.4	5.7	67	10	4	0.15	0.06
HP-169	Mar 17	14:13	14:45	0:32	-2.6	8.3	65	1	0	0.02	0.00
HP-173	Mar 15	14:30	14:54	0:24	3.0	13.5	49	2	1	0.04	0.02
HP-181	Mar 17	10:45	11:14	0:29	-3.0	3.2	72	1	1	0.01	0.01
HP-182	Mar 17	11:38	11:58	0:20	1.7	6.8	23	0	0	0.00	0.00
SI-1	Mar 18	13:00	13:30	0:30	-1.4	4.9	11	0	0	0.00	0.00
SI-10	Mar 18	14:00	14:20	0:20	-0.9	7.0	13	9	1	0.69	0.08
SI-38	Mar 18	10:50	11:40	0:50	-2.0	6.4	75	14	6	0.19	0.08
SI-50	Mar 18	14:50	15:25	0:35	-0.5	1.3	70	9	3	0.13	0.04
SI-60	Mar 18	11:05	11:42	0:37	-3.1	2.0	100	0	0	0.00	0.00
SI-72	Mar 18	15:08	15:48	0:40	1.3	8.4	54	11	2	0.20	0.04
SI-88	Mar 18	13:15	13:37	0:22	-1.3	1.9	77	1	0	0.01	0.00
SI-90	Mar 18	14:09	14:38	0:29	-1.3	2.7	100	0	0	0.00	0.00
Goschen Island											
JP-22	Mar 14	14:55	15:57	1:02	0.9	4.2	100	20	1	0.20	0.01
JP-31	Mar 16	13:45	15:02	1:17	-0.7	1.6	120	12	3	0.10	0.03
JP-58	Mar 14	16:00	16:45	0:45	-1.7	2.7	130	1	0	0.01	0.00
JP-71	Mar 14	13:35	14:10	0:35	0.8	1.7	135	2	1	0.01	0.01
JP-72	Mar 14	13:35	13:57	0:22	3.1	3.7	100	0	0	0.00	0.00
JP-73	Mar 14	14:45	15:35	0:50	-1.1	1.5	120	4	1	0.03	0.01
JP-90	Mar 16	13:46	14:44	0:58	-1.7	1.4	147	1	1	0.01	0.01
JP-141	Mar 19	10:30	11:30	1:00	-0.6	2.1	100	5	3	0.05	0.03
JP-143	Mar 19	11:48	12:34	0:46	-1.5	1.9	100	10	2	0.10	0.02
JP-160	Mar 19	12:18	13:12	0:54	-1.2	4.4	90	3	0	0.03	0.00
JP-166	Mar 19	10:48	11:48	1:00	-1.2	4.7	117	4	1	0.03	0.01
JP-183	Mar 16	11:00	11:57	0:57	-2.1	2.6	120	3	0	0.03	0.00
JP-200	Mar 16	11:15	11:35	0:20	3.7	4.3	100	0	0	0.00	0.00
JP-265	Mar 19	15:15	15:45	0:30	5.7	7.9	115	4	0	0.03	0.00
JP-291	Mar 19	14:48	15:08	0:20	3.1	4.4	85	0	0	0.00	0.00
JP-365	Mar 19	14:00	14:45	0:45	3.9	4.8	95	14	3	0.15	0.03

Table 3. Summary statistics and area surveyed for transect survey of emergent abalone from the Kitkatla area, March 14 - 21, 2000. Values in brackets are standard errors.

Details per transect	McCauley Island	Goschen Island
Number of transects	33	16
Number of abalone	405	122
Mean transect length (m) & number of quadrats	59.42 (4.90)	109.63 (4.96)
Mean depth (m)	3.46 (0.09)	1.80 (0.05)
Mean minutes	34.88 (2.18)	46.31 (4.21)
Mean minutes/quadrat	0.81 (0.12)	0.42 (0.04)
Length of shoreline or reef surveyed (m)	3,526	2,000
Area surveyed (m^2)	209,530	438,500

Table 4. Mean densities (number/m^2) and population estimates of emergent abalone from the Kitkatla area, March 14 – 21, 2000. Values in brackets are 90% confidence intervals.

Details per location	McCauley Island	Goschen Island
Mean density all sizes	0.16 (0.15 - 0.18)	0.05 (0.04 - 0.05)
Mean density 90-110 mm SL	0.05 (0.05 - 0.06)	0.01 (0.01 - 0.01)
Total population all sizes	34,406 (31,595 - 37,216)	20,750 (18,114 - 23,386)
Population 90-110 mm SL	11,326 (10,363 - 12,289)	4,000 (3,490 - 4,510)

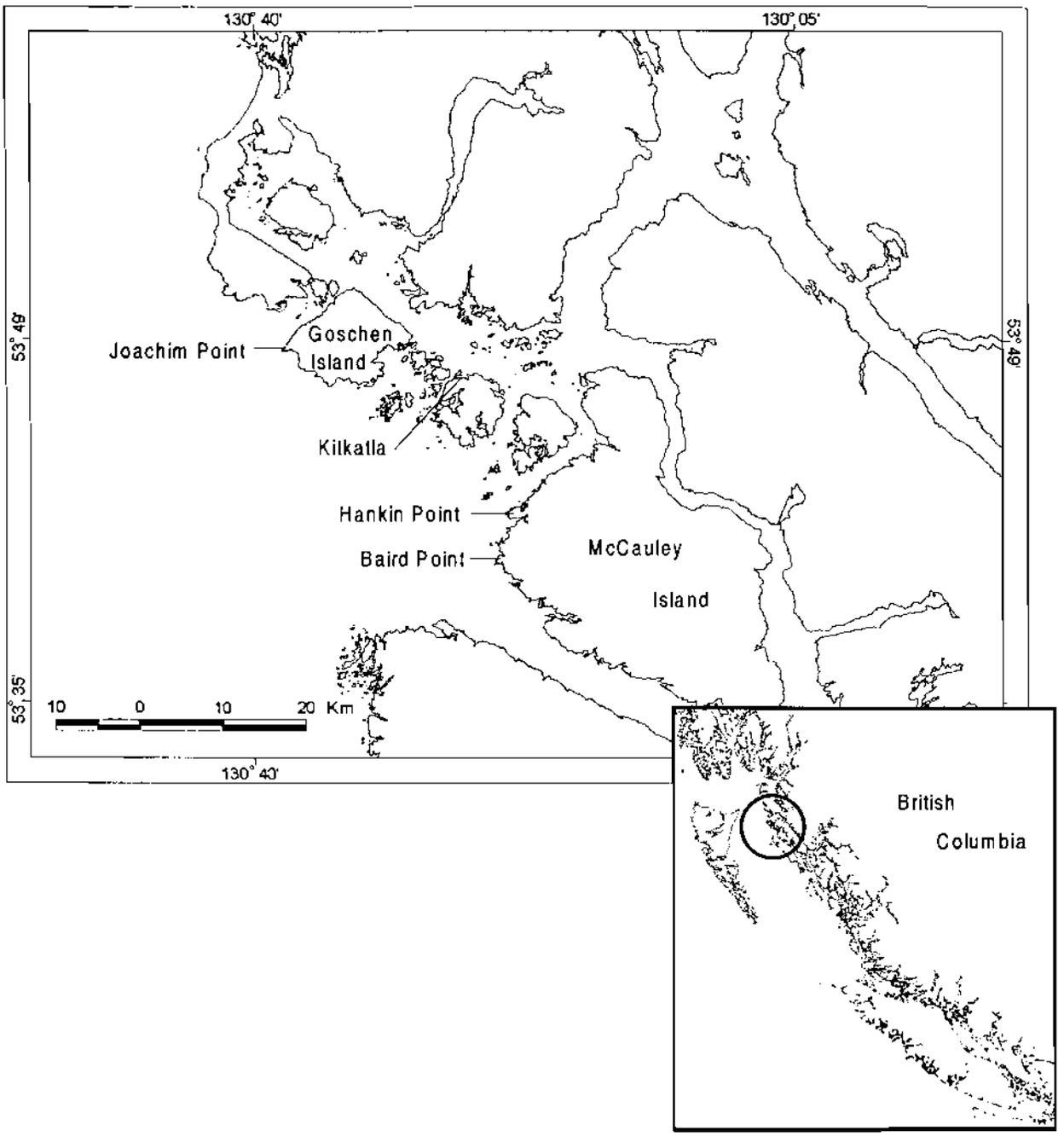

Figure 1. Abalone survey locations on McCauley Island, between Hankin Point and Baird Point, and on Goschen Island, near Joachim Point. The inset shows the Kitkatla area of British Columbia.

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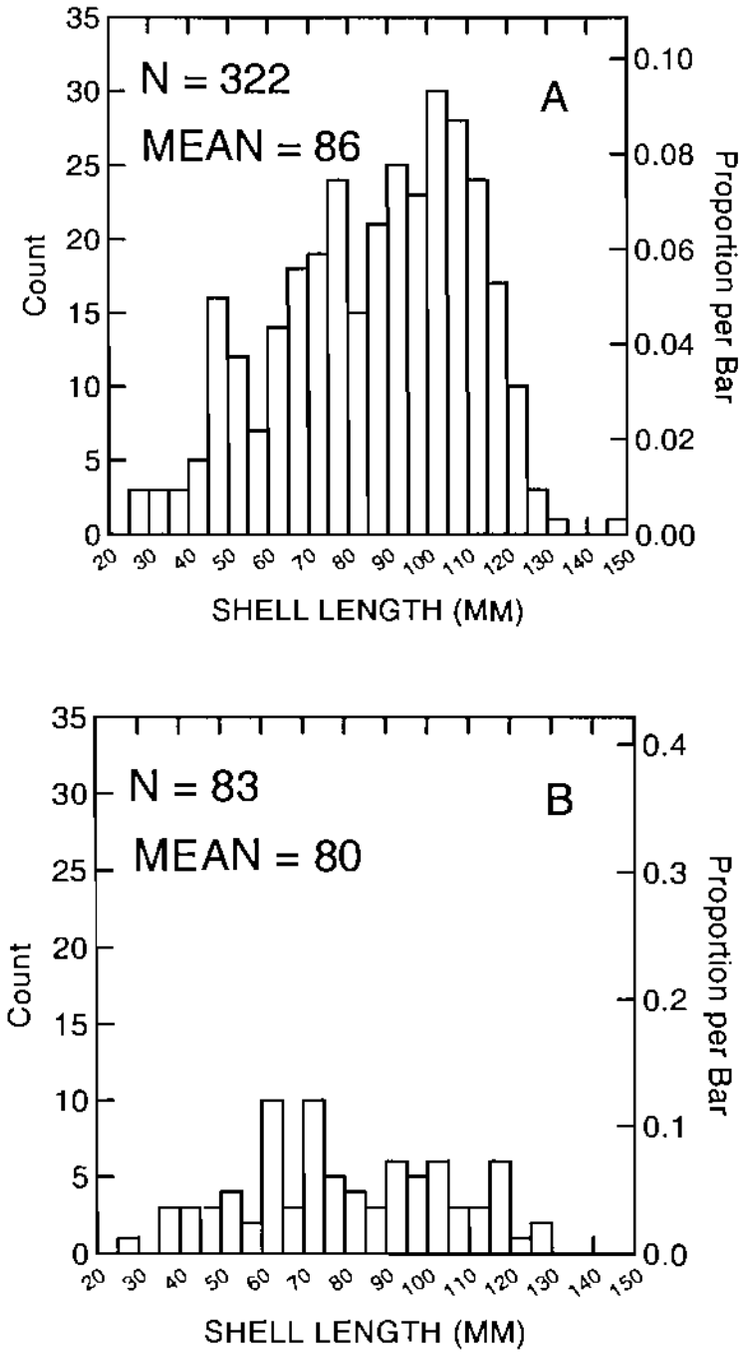

Figure 2. Size frequencies of emergent abalone found in quadrats during dive surveys in the Kitkatla area, March 14 – 21, 2000. Locations were (A) McCauley Island and (B) Goschen Island. Number of abalone (N) and mean shell length in mm are shown for each location.