Survey of Northern Abalone, *Haliotis kamtschatkana*, Population in the Strait of Georgia, British Columbia, October 2009

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SURVEY OF NORTHERN ABALONE, *Haliotis kamtschatkana*, POPULATION IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA, OCTOBER 2009

by

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ABSTRACT

Egli, T. P. and Lessard, J. 2011. Survey of northern abalone, *Haliotis kamtschatkana*, population in the Strait of Georgia, British Columbia, October 2009. Can. Manuscr. Rep. Fish. Aquat. Sci. 2955: iii + 12 p.

Index site surveys have been conducted by the Department of Fisheries and Oceans Canada to monitor northern abalone, *Haliotis kamtschatkana*, populations in British Columbia since 1978. Due to low population levels and steadily decreasing densities, the coast of British Columbia has been completely closed to abalone harvesting since 1990. First listed as ‘threatened’ in 1999 by the Committee on the Status of Endangered Wildlife in Canada, the status of northern abalone was up-listed to ‘endangered’ in 2009, furthering the need for conservation planning. The northern Strait of Georgia has never been extensively surveyed for abalone and this study will be used as reference for future surveys in the area. A total of six northern abalone were found at four (13.3%) of the 30 sites surveyed. Overall density for the area was estimated to be 0.013 ± 0.007 abalone/m^2, which is below what is generally regarded as densities required for successful fertilization. The low numbers found in this survey may indicate poor abalone habitat and low levels of recruitment, along with poaching in accessible areas.

RÉSUMÉ

Egli, T. P. and Lessard, J. 2011. Survey of northern abalone, *Haliotis kamtschatkana*, population in the Strait of Georgia, British Columbia, October 2009. Can. Manuscr. Rep. Fish. Aquat. Sci. 2955: iii + 12 p.

La pêche de l’ormeau nordique, *Haliotis kamtschatkana*, en Colombie-Britannique (CB) a été fermée depuis 1990 afin de protéger l’espèce. L’ormeau nordique a été listé comme étant ‘menacé’ en 1999 par le Comité sur Situation des Espèces en Péril au Canada, et le statut a été élevé à ‘en voie de disparition’ en 2009. Des relevés à des sites indicateurs ont été effectués par Pêches et Océans Canada depuis 1978 pour surveiller l’état des populations d’ormeaux nordiques. Le détroit de Georgie n’a jamais été sujet à ces échantillonnages et par conséquent l’abondance et la distribution des ormeaux dans cette région sont peu connus. En septembre 2009, un échantillonnage a été effectué dans la partie nord du détroit de Georgie pour estimer l’abondance et la distribution des ormeaux nordiques. La densité des ormeaux est estimée à 0.013 ± 0.007 ormeau/m^2. Cette densité est considérée trop basse pour soutenir la population d’ormeau dans le détroit de Georgie et peut être dû au peu d’habitat approprié présent, à des taux faibles de recrutement ou au braconnage dans les régions accessibles.

INTRODUCTION

Northern abalone, *Haliotis kamtschatkana*, are patchily distributed along exposed or semi-exposed coastlines from northern Alaska to Baja California (McLean 1966; Geiger 1999, COSEWIC 2009). Historically, abalone were an important food source for First Nations of coastal British Columbia (BC) and more recently were the target of a commercial fishery. The biology and fishery of the northern abalone were reviewed by Sloan and Breen (1988) and Farlinger and Campbell (1992). Due to low population levels and rapidly declining densities, the Department of Fisheries and Oceans (DFO) banned the harvest of northern abalone in BC in December 1990. In 1999, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed the northern abalone as 'threatened' in Canada (COSEWIC 2000). Since then, little or no recovery of the wild abalone population has been observed and, in 2009, the status of northern abalone was up-listed to 'endangered' by COSEWIC (COSEWIC 2009). The continued illegal harvest of wild abalone as well as low recruitment levels are among the main threats to northern abalone recovery (DFO 2007; COSEWIC 2009). The northern abalone recovery strategy identifies the Georgia Basin as one of five biogeograhic zones where the long-term recovery goal is to "increase the number and densities of wild northern abalone to levels where the population becomes self-sustainable" (DFO 2007). Recovery objectives include increasing mean densities of mature (≥ 70 mm SL) abalone to ≥0.32/m^2 at index sites and increasing the number of surveyed quadrats with abalone to >40%.

There are very few published occurrences of northern abalone in the Strait of Georgia. Most abalone surveys have been conducted in areas where they were harvested commercially and considered most abundant, that is on the central and northern coasts of BC as well as in the Haida Gwaii (formerly Queen Charlotte Islands) (Sloan and Breen 1988). Only 21,107kg of abalone were harvested in the Strait of Georgia between 1952 and 1990, which is <1% of the total recorded landings (Fedorenko and Sprout 1982; Sloan and Breen 1988; Harbo and Hobbs 1994). Thompson (1914 cited in COSEWIC 2009) could not find abalone in the Strait of Georgia in 1913, although Quayle (1962) mentioned their presence in the mid-20th century and studied a population at Hornby Island in 1968 (Quayle 1971).

Surveys in the southern Strait of Georgia (Adkins 1996) along with anecdotal information from recreational divers as well as poaching seizures suggest that there are some populations distributed within the area (Campbell 2000). Two surveys on the south coast of Vancouver Island are described by Adkins (1996) where density estimates in 1982 were 0.73 abalone/m^2 in Pacific Fishery Management Area (PFMA) 19, and in 1985 were 1.15 abalone/m^2 in PFMA 20. During surveys conducted in 1996/97 at Williams Head, a prison site on the south coast, divers found 211 abalone in 275 minutes of diving (0.77 abalone/min) (Wallace 1999). More recently, a small portion on the southern tip of Vancouver Island was surveyed in February 2005 and only 3 individual abalone were found at two (11%) of the 19 sites surveyed (Lessard et al. 2007). The mean density for all sites surveyed was 0.0098 abalone/m^2, considerably lower than the previous surveys in the same area. At 4 sites surveyed around Williams Head in 2005, only one abalone was measured (Lessard et al. 2007). The results from 2005 found abalone densities similar to those from surveys conducted in the San Juan

Islands by Washington Department of Fish & Wildlife (Rothaus et al. 2008). Despite the fisheries closure, clearly the abalone population on the south coast has continued to decline and may have reached critical levels.

While abalone distribution has been somewhat established in the southern portion of the Strait of Georgia, their distribution in the northern portion has been anecdotal and has not been systematically determined. Only two locations have been surveyed in the northern part of the Georgia Basin. Densities at Denman Island were estimated to be 0.048± 0.024 abalone/m^2 and 0.049±0.028 abalone/m^2 during surveys in 2000 and 2001 (Lessard et al. 2002; Lucas et al. 2002). Mitlenatch Island was designated a Provincial Park in 1961 and has been closed to most commercial fishing, with a voluntary closure of all marine life by recreational divers (Jamieson and Lessard 2000). Now a Rockfish Conservation Area (http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/rca-acs/rca-acs/south-sud/MitlenatchIChart3513-eng.htm), the island is a popular site for scuba diving and as such has been surveyed for abalone and other marine life twice in the past thirty years (unpublished data). Mitlenatch Island was found to have low and moderate densities of abalone when counted on timed swims. Although limited, this information provides a baseline to which the current survey can be compared.

This report describes an abalone survey conducted in the northern Strait of Georgia in October 2009. The objectives of the survey were two fold: to estimate abalone abundance in the Strait of Georgia as part of ongoing monitoring of index sites and to determine abalone distribution in the northern portion of the Georgia Basin. The results of this survey can be used in conjunction with other index site survey results in BC to better understand the distribution of abalone and to further the conservation efforts to effectively manage this species.

METHODS

SURVEY METHODS

The Canadian Coast Guard research vessel 'CCGS Vector' was used as the base for daily diving operations. One smaller vessel was used as diving platform and transported the scuba dive team to and from the survey sites for 5 days in October 2009. The boat was equipped with a GPS and nautical charts to find the location of each site.

Approximately 40 sites were randomly selected in the northern portion of Georgia Strait. These sites were chosen without bias using 'Random Points Along a Line', an ArcView (ESRI version 3.2) script (Eichenlaub 2000) that placed sites along the shoreline selected. The sites were dispersed to cover most of the coastline where abalone habitat can be expected and hopefully, find the extent of abalone distribution in the northern portion of the Georgia Basin. Not all sites were surveyed for abalone abundance (see sampling design below) because of time constraints or because abalone habitat was not present at the marked location. Sites selected for survey were grouped into two general areas: 'Texada' and 'Cortes', after the closest large Northern Gulf Island (Fig. 1). Five additional sites were selected based on previous information around Mitlenatch and Denman Islands. As these two locations were known to have abalone habitat and historical presence, timed swims were conducted in addition to the Breen survey (explained below) to determine the extent of the abalone distribution and relative abundance at each site.

Once at the coordinates for a given site, divers surveyed abalone habitat using the method described by Breen and Adkins (1979), commonly referred to as 'Breen' survey. Divers began surveying by placing a 1 m^2 quadrat at the top of the abalone habitat zone; the divers surveyed 16 quadrats within a 7 m by 16 m area. The 16 quadrats were arranged in four transects, each 4m apart; and each of the four quadrats within a transect, were 1m apart (i.e. every 2nd quadrat per transect). The percent cover and dominant algal species, substrate type and depth were recorded before all vegetation was cleared from the quadrats. Then, divers searched for exposed abalone among the substrate, and measured the shell length (SL in mm) of individuals found. Urchins and predators within the quadrat were also counted. If abalone were not encountered within the first 8 quadrats surveyed, the dive was aborted and the site count was scored as zero. No search was conducted for cryptic abalone in order to maximise the number of sites covered by the survey.

ANALYTICAL METHODS

All recorded depths were corrected for tide heights post survey. Each site was given a slope value based on the depth range encountered on the quadrats sampled.

Abalone and urchin densities were estimated as the number/m^2 for each site. Variation of mean density and mean size estimates are reported here as ± standard error of the mean (SEM). As very few abalone were encountered, densities for other size categories (e.g., immature < 70 mm SL) were not calculated. Similarly, no statistical analyses were performed due to the very low abalone densities.

RESULTS

A total of 30 sites were surveyed in the two areas shown in Figure 1. Two of the randomly selected sites were removed from the survey due to lack of any suitable abalone habitat, i.e. sand/gravel substrate.

A total of six abalone were measured, three from each of the two areas with a mean size of 81.7±31.5 mm for Cortes and 89.3± 7.8 mm for Texada (Table 1). Abalone were found at only two sites (21.4% of 14) in the Cortes area, and one site (6.25% of 16) in the Texada area. Overall, 13.4% of sites were found to have abalone.

Abalone density estimates for all sites were 0.013± 0.007 abalone/m^2 in the Cortes area and 0.012± 0.012 abalone/m^2 in the Texada area (Table 1). The overall density was estimated at 0.013± 0.007 abalone/m^2. Abalone densities at each site are listed in Table 2. Urchin density was estimated for each site and found to be 3.26± 2.64 urchins/m^2 in the Cortes area and 2.82± 1.72 urchins/m^2 in the Texada area (Table 2). These numbers reflect a majority of green sea urchins (*Strongylocentrotus droebachiensis*), and fewer red sea urchins (*S. franciscanus*).

An average of 19.9 minutes (range 2-50 minutes) was spent diving at each site and surveyed quadrats occurred at depths between -1 and 8 m chart datum (Table 2). The majority of sites were composed of bedrock/boulder or a mixture of hard and soft substrate (Table 3). The slope values varied widely between 2% and 84%. None of the sites had any canopy algal cover. The dominant algal species of the understorey layer were *Laminaria saccharina* and *Agarum fimbriatum*, and the most common variety of algae in the turf zone were unidentified red branched algae. There was a variable amount of encrusting algae found at each site.

DISCUSSION

This was the first extensive abalone survey conducted in the northern Strait of Georgia. The overall estimated population density in 2009 was 0.013± 0.007 abalone/m^2. The number of abalone measured was too low to derive meaningful conclusions from this survey, except to say that abalone were scarce and sparsely distributed in the northern Georgia Basin. The recovery objectives outlined by DFO are not being met in this biogeographic zone. Additionally, it is not known if the abalone population is self-sustaining.

The few previous studies conducted within the northern Strait of Georgia, including the present one, have found abalone abundance to be low. Sites surveyed at Denman Island yielded similarly low abalone densities in 2000/2001 (Lucas et al. 2002). Although not a single abalone was measured in this same area in 2009, divers did see some individuals during timed swims outside of the quadrats. Exact density estimates from Mitlenatch Island prior to this study are not available, however the dive surveys that were conducted found abalone present in low to moderate numbers in the 1970's and 1990's. For example, a timed swim of 30 minutes yielded 175 abalone between two divers in August 1993 (unpublished data). Although not directly comparable due to differences in survey design, the estimated density in the present study does not reflect the moderate numbers found in 1993. Only one individual was measured and three were seen by divers outside of the quadrats at the two sites on Mitlenatch in 2009. We recommend that, since there were known populations in these areas, Denman Island and Mitlenatch Island index sites be used to further monitor abalone abundance in the northern Strait of Georgia.

In general, densities observed in the present study were below those previously recorded in the southern Strait of Georgia. Only the most recent study in the southern portion of Georgia Strait found densities lower than what is reported here (Lessard et al. 2007). That study, however, was aimed at finding abalone that had been released from a poaching seizure, and not at a broader density survey. The research methodology used in the surveys in 1982 and 1985 (Adkins 1996) relied primarily on timed swim data collection which may have resulted in higher density estimates when compared to results from surveys conducted using the Breen method. Rothaus et al. (2008) reported a precipitous decline in abalone at index sites in the San Juan Islands, located at the southern end of Georgia Strait. Very low numbers to no juvenile were detected in the San Juan Islands in 2006 and mean size was larger than 2005 and 2001, indicating recruitment failure in recent years. In the present study, two out of the six abalone measured were juvenile (<70 mm SL) indicating that at least some recruitment has occurred in recent years in the northern Strait of Georgia.

The distribution of abalone within the northern Strait of Georgia is patchy, which is consistent with previous findings (COSEWIC 2009). The availability of suitable habitat will generally limit abalone distribution and to assist in assessment, COSEWIC (2009) has defined abalone habitat in BC using key physical and biological factors. A primary substrate of bedrock and/or boulders along with good water exchange will provide suitable habitat for abalone if coupled with the presence of encrusting coralline algae, sea urchins, and kelp. Some of the sites randomly selected in this survey offer good *H. kamtschatkana* habitat based on the above factors. However, a complete lack of canopy algal species at all of the sites points to a possible explanation for abalone being found at only a few locations. In 2009, 50% of the abalone were found within one site. This reinforces the notion that larger aggregations may yet be found in the area. Expanding future surveys to include more suitable abalone habitat will help to map out the current distribution and increase our knowledge of abalone populations in BC. Due to low numbers of abalone, the results from this study cannot effectively be used to determine the distribution of animals within the Strait of Georgia.

It is possible that the northern abalone has never been as abundant in the Strait of Georgia as in other parts of the BC coast, but has instead survived at low densities in certain areas that provide good habitat. Variation within spawning aggregates and high levels of genetic heterozygosity suggest that this species can exist in small, widely dispersed populations, so long as a source population is nearby (Withler et al. 2003). The continued presence of abalone in this study area suggests a successful spawning aggregation somewhere within the region. Low densities in Johnstone Strait (Davies et al. 2006) point to a source further afield or within the Georgia Basin itself. Campbell (1997) suggests that northern abalone abundance varies greatly over periods of time due to changes in recruitment. However, present abalone densities within the northern Strait of Georgia are at levels where the likelihood of recruitment failure is high (Shepherd and Parrington 1995; Babcock and Keening 1999; Campbell 2000). The abalone recovery strategy recommends investigation into “the frequency and size of patches required to maintain sufficient recruitment for a healthy population” (DFO 2007).

For future surveys, we recommend that sites containing suitable abalone habitat surveyed in 2009 within the northern Strait of Georgia be resurveyed, with additional sites being chosen to increase the extent of the surveyed area. In particular, expanding the study area north of Cortes Island and onto the south coast of the Strait of Georgia will assist in determining the limits of abalone distribution.

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Table 1: Summary of abalone densities and mean size at sites sampled in the Strait of Georgia, October 2009. Standard errors are shown in brackets.

General Area	Number of Sites Sampled	Number of Quadrats Sampled	Total Abalone Count	Mean Size (mm)	Total Density (#/m^2)	% of Sites with Abalone
Cortes	14	144	3	81.7 (31.5)	0.013 (0.007)	21.4
Texada	16	136	3	89.3 (7.8)	0.012 (0.012)	6.25
All sites – both locations	30	280	6	85.5 (14.6)	0.013 (0.007)	13.3

Table 2. Dive survey summary and density for abalone and urchins by site, Strait of Georgia, 2009. Standard errors are shown in brackets.

Site	Date	Bottom Time (min)	Depth (m) Min	Max	Number Of Quadrats	Abalone Size (mm)	Abalone Density (#/m^2)	Urchin Count	Urchin Density (#/m^2)
Cortes									
10	Oct 1	33	0	5	16	144	0.063	40	20.00
11	Oct 1	50	-1	5	16	58	0.063	599	37.44
21	Oct 2	13	0	5	8	0	0.000	1	0.13
25	Oct 2	13	1	3	8	0	0.000	3	0.38
29	Oct 3	16	0	5	8	0	0.000	0	0.00
31	Oct 3	15	1	7	8	0	0.000	2	0.25
32	Oct 1	22	2	3	8	0	0.000	10	1.25
34	Oct 3	17	1	2	8	0	0.000	1	0.13
57	Oct 2	21	1	4	8	0	0.000	0	0.00
61	Oct 2	21	0	4	8	0	0.000	0	0.00
66	Oct 3	9	0	5	8	0	0.000	1	0.13
71	Oct 3	10	-1	6	8	0	0.000	2	0.25
M1	Oct 2	40	3	8	16	43	0.063	10	0.63
M2	Oct 2	38	2	2	16	0	0.000	42	2.63
					Totals	**3**	**0.013 (0.007)**	**711**	**3.26 (2.64)**
Texada									
06	Oct 4	11	1	4	8	0	0.000	0	0.00
12	Oct 4	21	0	5	16	75, 91, 102	0.188	28	1.75
14	Oct 5	15	1	5	8	0	0.000	0	0.00
19	Oct 3	16	0	5	8	0	0.000	38	4.75
30	Oct 4	18	0	4	8	0	0.000	1	0.13
43	Oct 3	15	1	7	8	0	0.000	4	0.50
48	Oct 4	14	1	3	8	0	0.000	0	0.00
49	Oct 4	15	0	3	8	0	0.000	1	0.13
58	Oct 4	14	-1	4	8	0	0.000	3	0.38
60	Oct 4	15	0	5	8	0	0.000	224	28.00
65	Oct 4	14	1	5	8	0	0.000	0	0.00
67	Oct 3	24	2	3	8	0	0.000	25	3.13
74	Oct 5	13	2	3	8	0	0.000	0	0.00
D1	Oct 5	31	2	3	8	0	0.000	30	3.75
D2	Oct 5	25	2	6	8	0	0.000	21	2.63
D3	Oct 5	17	3	4	8	0	0.000	0	0.00
					Totals	**3**	**0.012 (0.012)**	**375**	**2.82 (1.72)**

Table 3. Site Descriptions of all 30 sites sampled in the Strait of Georgia, October 2009. The most common substrate types are listed (1 = most common, 2 = second most common, 3 = third most common) and grouped by substrate type [1 = bedrock (hard and/or smooth), 2 = hard, complex boulder, 3 = cobble, 4 = mixed hard/soft with hard terminate, 5 = mainly soft]. The algae species are listed by growth characteristics as percentage cover (%) for the most common (Sp 1) and second most common (Sp 2), where AC = articulated corralines, AF = *Agarum fimbriatum*, BH = brown filamentous, GI = *Gigartina sp.*, GH = green filamentous, GR = *Gracilaria pacifica*, LA = *Laminaria sp.*, LS = *Laminaria saccharina*, RB = red branched, RF = red foliose, UL = *Ulva sp.*

	Substrate			**Slope**	**Canopy**		**Understorey**			**Turf**			**Encrusting**
Site	**1**	**2**	**3**	**%**	**%**	**Sp 1**	**%**	**Sp 1**	**Sp 2**	**%**	**Sp 1**	**Sp 2**	**%**
Cortes													
10	1	4	5	32	0		80	LS	AF	5	RB	UL	70
11	1	2	4	32	0		5	LA		10	UL	RB	70
21	1	4		53	0		50	LS	AF	20	RB	GH	20
25	2	1	4	19	0		20	LS		60	RB	RF	10
29	2	4	3	65	0		80	LS	AF	20	RB	RF	40
31	1	2	4	72	0		80	AF	LS	10	RB	RF	70
32	4	2	1	15	0		10	LS		20	UL	RB	70
34	2	4		8	0		80	LS		40	RB	GI	70
57	2	1		42	0		90	LS	AF	0			10
61	2			53	0		80	LS	AF	10	RB	BH	20
66	4	1	2	61	0		5	AF		5	RB	RF	80
71	1	4		84	0		10	AF		10	RB	UL	70
M1	2	3	1	30	0		10	AF		5	BH	RB	80
M2	2	4	3	2	0		0			20	UL		80
Texada													
06	4	2		46	0		30	LS		20	RB		10
12	1			29	0		0			5	RB		10
14	2	4		50	0		60	LS	AF	30	RB	RF	60
19	1	4		57	0		60	AF	LS	20	RB	GR	70
30	2	4		46	0		80	LS	AF	20	RB	GR	60
43	1	4	2	76	0		10	AF		5	RF	RB	70
48	2	1	4	23	0		60	LS		10	AC	RB	60
49	4	2	3	30	0		40	LS		40	RB		10
58	1	4		61	0		20	AF	LS	50	RB	GR	40
60	1			53	0		0			0			90
65	1	5		80	0		50	LS	AF	30	RB	AC	40
67	2	4		11	0		20	AF	LS	20	GI	RB	60
74	1	4	2	23	0		50	LS	AF	40	RB	AC	20
D1	4	2		23	0		20	LS		30	RB	GI	80
D2	1	4	2	42	0		0			5	UL	RB	10
D3	4	3		11	0		10	AF		100	GI	UL	20

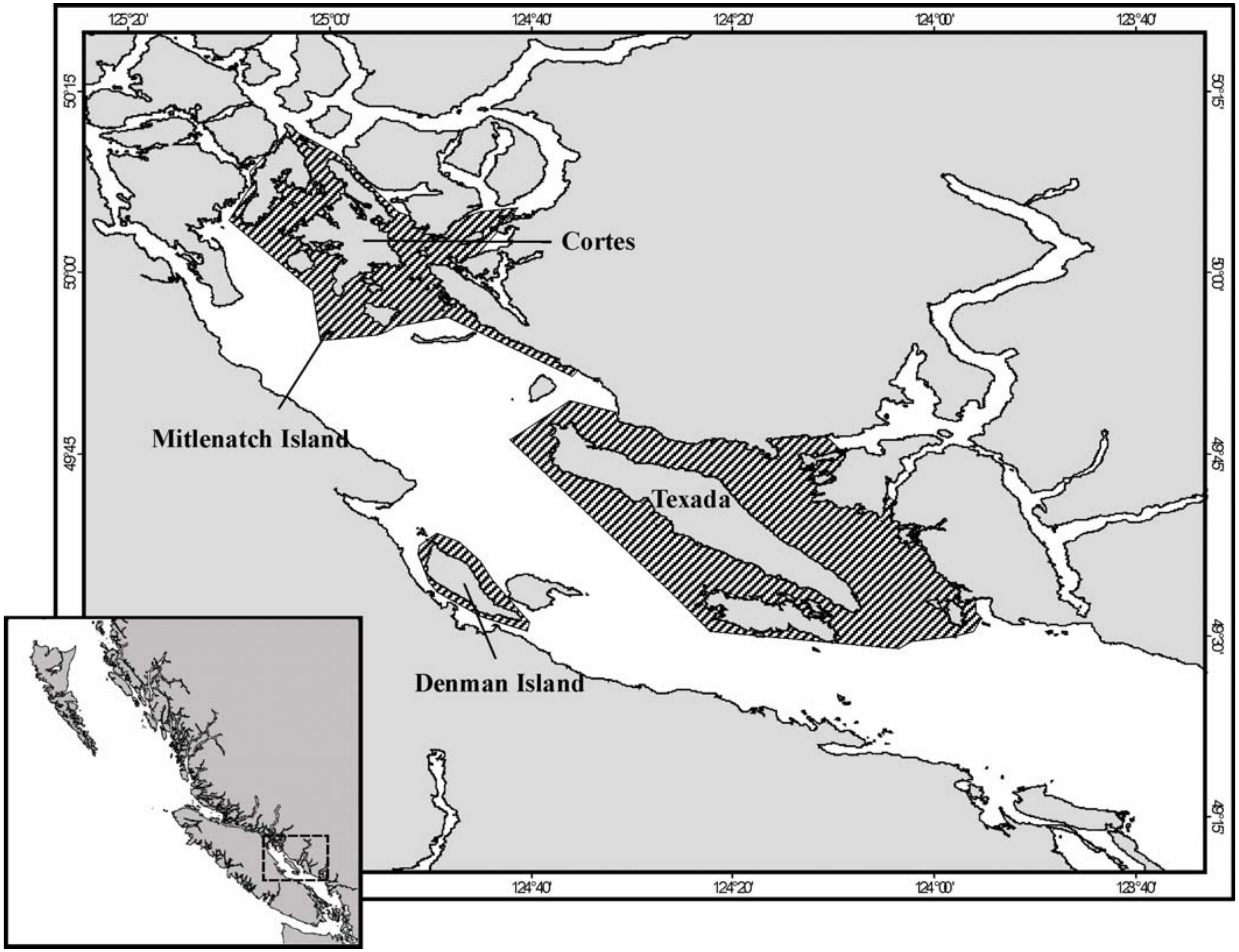

Figure 1. Map of northern Strait of Georgia, showing the two areas surveyed.