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LINGCOD EGG MASS AND REEF FISH DENSITY SCUBA SURVEY IN THE STRAIT OF GEORGIA, FEBRUARY 17 - MARCH 3, 2004

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ABSTRACT

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Dives were conducted at seven sites in the Nanaimo region in the Strait of Georgia between February 17-March 3, 2004 in order to provide lingcod (*Ophiodon elongatus*) egg mass density estimates. The index site at Snake Island reef was included in this survey, and it has been previously surveyed in 1990, 1991, 1994, 2001, and 2002. We completed 14 dives at Snake Island reef, 6 dives at Entrance Island, 4 dives each at Douglas Island and Round Island, 3 dives each at Neck Point reef, Hudson Rocks and Five Finger Island. The highest egg mass densities were observed at Snake Island and Entrance Island. Despite the presence of some suitable nesting habitat, no egg masses (or very few) were observed at the other locations. However, lower lingcod densities were also observed at the remaining sites. In addition to counting lingcod egg masses, large fish (>20 cm) were also counted. Copper rockfish (*Sebastes caurinus*), lingcod, and kelp greenling (*Hexagrammos decagrammus*) were the most consistently encountered fish. SCUBA survey methods may prove to be a useful non-intrusive method of assessing relative reef fish abundance at shallow depths.

RÉSUMÉ

King, J. R. and Haggarty, D.R. 2004. Lingcod egg mass and reef fish density SCUBA survey in the Strait of Georgia, February 17 - March 3, 2004. Can. Data Rep. Fish. Aquat. Sci. 1147: iv + 13 p.

Nous avons effectué, entre le 17 février et le 3 mars 2004, des plongées à sept endroits dans le détroit de Georgia, aux environs de Nanaimo, en vue d'obtenir des estimations de la densité des masses d'œufs de morue-lingue (*Ophiodon elongatus*). Le site témoin du récif de l'île Snake, évalué précédemment en 1990, 1991, 1994, 2001 et 2002, a été inclus dans le relevé. Nous avons fait 14 plongées sur ce récif, 6 à l'île Entrance, 4 à chacune de l'île Douglas et de l'île Round et 3 sur chacun du récif de la pointe Neck, du rocher Hudson Rocks et de l'île Five Finger. Nous avons trouvé les plus fortes densités de masses d'œufs à l'île Snake et à l'île Entrance. Bien qu'il y avait des parcelles d'habitat de nidification adéquates aux autres endroits, nous n'y avons pas vu de masses d'œufs (ou très peu). La morue-lingue y était aussi moins dense. En plus de dénombrer les masses d'œufs de cette espèce, nous avons aussi dénombré les gros poissons (> 20 cm). Le sébaste cuivré (*Sebastes caurinus*), la morue-lingue et le sourcil de varech (*Hexagrammos decagrammus*) étaient les espèces que nous avons le plus régulièrement rencontrées. Les relevés par plongée autonome pourraient se révéler une méthode non intrusive utile pour évaluer l'abondance relative des poissons de récifs à de faibles profondeurs.

INTRODUCTION

Lingcod (*Ophiodon elongatus*) have traditionally been a very important species in British Columbia's commercial fishery. Due to conservation concerns, the lingcod commercial fishery in the Strait of Georgia was closed in 1990 (Richards and Hand, 1989), and the recreational fishery was closed in 2002 (King, 2001). Egg mass density surveys have been conducted at an index site, Snake Island reef, in 1990, 1991, 1994, 2001 and 2002 (Yamanaka and Richards, 1995; King and Beaith, 2001; King and Winchell, 2002). A stock assessment framework for Strait of Georgia lingcod recommended that standardized egg mass density surveys be used to provide insight into relative abundance trends (King *et al.*, 2002). Additional sites in the Nanaimo region (Statistical Area 17) were selected for egg mass density surveys to augment the information obtained from the index site at Snake Island reef. There is also conservation concern regarding rockfish (*Sebastes* spp.) in the Strait of Georgia (Yamanaka and Lacko, 2001) and non-intrusive visual estimates of rockfish abundance may be required for species which are at extremely low abundance or for areas with depleted populations. We made visual estimates of rockfish densities at the 2004 SCUBA survey sites in order to provide information that might be used to develop a suite of non-intrusive surveys or used as auxiliary information to fishery and research surveys for rockfish.

METHODS

Seven sites were selected for SCUBA surveys: Snake Island reef; Entrance Island; Round Island, Hudson Rocks; Five Finger Island; Neck Point reef; and Douglas Island (Figure 1). Snake Island reef is an index site for lingcod egg mass surveys, and has been previously surveyed in 1990, 1991, 1994, 2001, and 2002 (Yamanaka and Richards, 1995; King and Beaith, 2001; King and Winchell, 2002). The remaining sites were selected based on relative lingcod catch per unit effort (CPUE) data from a hook and line survey conducted in October, 2003 (Haggarty and King, 2004). Sites were selected that had low lingcod CPUE (Hudson Rocks; Five Finger Island; Round Island; Entrance Island), midrange CPUE (Douglas Island; Snake Island) and high CPUE (Neck Point reef). Relative rockfish CPUE for these sites were similar, with fewer rockfish caught at Hudson Rocks or Five Finger Island and many rockfish caught at Neck Point reef (Haggarty and King, 2004). Depending on the weather, 1-7 dives were completed each day. Sampling began February 17, 2004, ended March 3, 2004, and occurred between the hours of 9:00 and 15:00 PST.

For each dive, a surface deployed anchor buoy was released according to both a GPS position and a diveable depth (<60 ft.). Attempts were made to ensure even spatial coverage within a site, and to avoid overlap of

surveyed areas (dives). Two divers descended from the marker buoy to the cannonball and then attached a 10 m line to the cannonball which is the fixed base of the marker buoy. The team of two divers would then swim a circle, with a radius of 10 m formed by the sweeping line, around the fixed point searching for lingcod egg masses and counting reef fish. Lingcod, rockfish (*Sebastes* spp.), greenlings (*Hexagrammos* spp.), and cabezon (*Scorpaenichthys marmoratus*), and surfperches (Embiotocidae) were large (>20 cm) fish that we expected to see on near shore reefs. Crevices, and under large flora, were searched with a light for these species, and total counts within the circular quadrat were recorded. Smaller fish, such as sculpins (Cottidae) and gobies (Gobiidae) were not counted due to logistical constraints.

Upon the discovery of a lingcod egg mass the following information was recorded: the depth (ft) at which the egg mass was located; location of the egg mass (uncovered, beneath overhanging rocks, within a horizontal or vertical crevice); presence of a guarding male and its total length (cm); volume of the egg mass and the stage of egg development. Egg development stages were described by colour and were classified as creamy (new), white (intermediate), grey-white (old), eyed eggs (almost hatched), and hatched. Underwater dive lights were used to aid in the accurate assessment of the eggs' developmental stages. Egg mass volume (cubic cm) was estimated by measuring the length, width and height (cm) of the egg mass, adjusting for irregularities in shape. The total length of the guarding male was estimated using measuring tape pulled alongside the resting male. A conscious effort was made to lift large flora in search of hidden egg masses.

At the end of each dive, the depth of the cannonball (ft), visibility (m), and the number of lingcod not guarding a nest in the quadrat were recorded. Depths were measured in feet with the divers' depth gauges and were later converted to depth in meters. However, they were not converted to below chart datum since the depth at observation best reflects the spawning habitat used by lingcod during the winter. The slope of the quadrat was estimated (flat, gradual or steep). The habitat was described using four categories: rocky, barren, cobble, boulders. The top three categories were ranked by order of proportion to best describe the habitat, with the dominant habitat feature being ranked higher than secondary and tertiary features. The type of flora that existed in each quadrat was noted as *Agarum* spp. or encrusting. In quadrats containing *Agarum* spp., the divers made an estimate of percent cover over the quadrat.

RESULTS

EGG MASS DENSITY

Forty-three quadrat counts were completed over 8 days during February 17 to March 3, 2004 (Table 1). Since Snake Island reef has been used as an index site for egg mass density, a total of 19 dives were completed at this site. Unfortunately, the first five dives (quadrat number 1-5) were not conducted on the reef proper but across a deep channel closer to the island, and though the data are reported here they are not considered to be part of the Snake Island reef. The habitat at Hudson Rocks and Five Finger Island was marginally suitable lingcod nesting habitat. As a consequence only 3 dives were completed at each of these sites. Six dives were completed at the north side of Entrance Island. Neck Point reef had very limited area that was above a diveable depth (<60 ft) and only 3 dives could be completed at this site without overlap. Despite suitable lingcod nesting habitat at Douglas Island, only one lingcod egg mass was found and surveying of this area was terminated after 4 dives. No egg masses were found at Round Island, despite at least one quadrat with exceptional habitat, therefore surveying of this area was also terminated after 4 dives.

Snake Island reef and Entrance Island had the highest egg mass densities of the seven sites surveyed in 2004 (Table 2). These two locations also had the lowest proportion of quadrat counts with no egg masses. The other locations had relatively low, or zero, egg mass densities (Table 2). This was despite there being some suitable lingcod nesting habitat.

EGG MASS AND GUARDING MALE OBSERVATIONS

Thirty-four egg masses were observed in 2004 (Table 3). Egg masses were typically in the later, eyed stage of development, though all stages were observed. The mean estimated egg mass volume was 2.8 L. Males ranged in length from 49 to 78 cm. The modal and mean lengths of nest guarding males was 58 cm and 65 (n=18) which correspond to sizes at approximately age 3 and 4 respectively. There was no relationship between length of guarding male and estimated volume of the egg mass (Figure 2).

REEF FISH COUNTS

Copper rockfish (*Sebastes caurinus*), lingcod, and kelp greenling (*Hexagrammos decagrammus*) were the most consistently encountered fish (Table 4). There were three quadrat counts which had large schools of striped seaperch (*Embiotoca lateralis*). Whitespotted greenling (*Hexagrammos stelleri*), cabezon (*Scorpaenichthys marmoratus*), quillback rockfish (*S. maliger*), tiger rockfish (*S. nigrocinctus*) were also encountered. Overall, lower fish densities were observed at Hudson Rocks, Five Finger Island and Round Island sites.

DISCUSSION

The egg mass density observations at Snake Island reef continue the time series for this index site. The egg mass densities, lingcod densities and overall habitat characteristics indicate that Hudson Rocks, Five Finger Island and Round Island may not be suitable sites to revisit for egg mass surveys. Underwater visual estimates of reef fish densities were relatively easy to collect and we feel are likely accurate, given that cryptic fish hiding in crevices can be detected. This survey method may prove to be an informative tool for assessing relative abundance or estimating biomass of reef fish in shallow waters. Additional reef fish density SCUBA surveys are planned for summer 2004 and winter 2004/05 and will provide additional data to assess the suitability of this method.

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Table 1. Data for dive quadrats including date sampled, site location (SN=Snake Island reef; HR=Hudson Rocks; FF=Five Finger Island; EN=Entrance Island; NP=Neck Point reef; DI=Douglas Island; RI=Round Island), the latitude and longitude (in degrees, minutes, seconds) of the buoy marker, quadrat depth (m) as measured by depth gauge at the buoy line, visibility (m) in the water column, the number of lingcod egg masses observed, the number of observed egg masses with guarding males, and the number of males observed in the quadrat that were not guarding a nest. The slope (flat, gradual and steep) of the quadrat was estimated for the majority of the quadrat. The approximate percent of *Agarum* spp. cover, and the top three habitat descriptions for each quadrat is included.

Date	Site Location	Quadrat Number	Latitude	Longitude	Quadrat depth (m)	Visibility (m)	Number of egg masses	Number of guarded egg masses	Number of non-guarding males observed	Slope	% Agarum	Habitat classifications		
												Primary	Secondary	Tertiary
17-Feb-04	SN	1	490745.9	1233220.6	8	12	1	1	0	Flat	50	Barren	Rocky	
17-Feb-04	SN	2	490745.4	1233119.2	13	12	2	2	1	Flat	60	Barren	Rocky	Boulder
17-Feb-04	SN	3	490751.4	1233114.9	12	12	3	3	2	Steep	15	Boulder	Barren	
17-Feb-04	SN	4	491241.9	1235304.7	6	12	5	4	1	Gradual	0	Barren	Crevice	Rocky
17-Feb-04	SN	5	491250.5	1235315.7	8	12	1	1	1	Steep	0	Barren	Rocky	
19-Feb-04	SN	6	491238.1	1235304.7	11	12	1	1	2	Steep	50	Barren	Rocky	
19-Feb-04	SN	7	491236.4	1235308.2	9	12	1	1	2	Flat	30	Barren	Boulders	Rocky
19-Feb-04	SN	8	491242.3	1235306.7	7	12	0	0	5	Flat	0	Barren		
19-Feb-04	SN	9	491241.3	1235307.1	7	12	5	5	0	Gradual	0	Barren	Boulders	
19-Feb-04	SN	10	491240.6	1235305.2	6	12	2	1	4	Gradual	0	Barren	Boulders	
20-Feb-04	SN	12	491235.5	1235305.7	11	10	1	1	0	Flat	20	Barren	Rocky	Crevice
20-Feb-04	SN	13	491239	1235306.8	9	10	4	4	2	Gradual	5	Barren	Rocky	Boulder
20-Feb-04	SN	14	491239.9	1235308.0	11	14	0	0	1	Steep	40	Barren	Rocky	Crevice
20-Feb-04	SN	15	491243.4	1235305.0	6	14	3	3	2	Gradual	10	Rocky	Boulders	Crevice
20-Feb-04	SN	16	491243.5	1235303.7	8	14	0	0	2	Flat	0	Barren	Crevice	
20-Feb-04	SN	17	491247.3	1235302.5	13	10	0	0	2	Steep	60	Rocky	Barren	Crevice
23-Feb-04	HR	18	491342.9	1235541.5	15	12	0	0	0	Gradual	0	Cobble	Rocky	
23-Feb-04	HR	19	491338	1235536.0	13	12	1	1	0	Flat	0	Cobble	Barren	Rocky
23-Feb-04	HR	20	491341.8	1235539.8	8	14	0	0	0	Steep	0	Crevice	Boulders	Rocky
23-Feb-04	FF	21	491346.4	1235503.0	13	14	0	0	0	Gradual	0	Cobble		
23-Feb-04	FF	22	491351.5	1235453.0	9	14	0	0	1	Gradual	0	Barren	Crevice	Cobble
23-Feb-04	FF	23	491323	1235539.0	8	10	0	0	0	Steep	40	Barren	Rocky	Cobble
27-Feb-04	EN	24	491236.2	1234831.9	12	10	1	1	0	Gradual	50	Barren	Rocky	Crevice
27-Feb-04	EN	25	491235.4	1234834.3	10	8	1	1	0	Flat	70	Rocky	Crevice	Barren

Table 1 continued.

Date	Site Location	Quadrat Number	Latitude	Longitude	Quadrat depth (m)	Visibility (m)	Number of egg masses	Number of guarded egg masses	Number of non-guarding males observed	Slope	% Agarum	Habitat classifications		
												Primary	Secondary	Tertiary
27-Feb-04	EN	26	491234.6	1234841.2	11	10	2	2	0	Gradual	10	Rocky	Boulders	Barren
27-Feb-04	EN	27	493535.9	1234837.6	11	10	3	1	0	Gradual	10	Barren	Rocky	Boulder
27-Feb-04	EN	28	491237.6	1234850.0	14	10	2	2	3	Steep	25	Barren	Boulders	Rocky
27-Feb-04	EN	29	491232.9	1234854.0	13	10	0	0	1	Gradual	40	Barren	Rocky	
2-Mar-04	NP	30	491413.8	1235705.0	15	9	0	0	0	Steep	80	Rocky	Crevice	Boulder
2-Mar-04	NP	31	491413.6	1235705.2	15	9	1	1	0	Steep	80	Boulder	Crevice	Rocky
2-Mar-04	NP	32	491414.2	1235706.1	15	9	0	0	2	Gradual	50	Barren	Rocky	Boulder
2-Mar-04	DI	33	491841.3	1240913.0	7	8	1	1	2	Flat	0	Rocky	Boulders	
2-Mar-04	DI	34	491832.3	1240912.3	7	8	0	0	0	Steep	0	Boulder	Crevice	
2-Mar-04	DI	35	491836.2	1240910.2	13	8	0	0	0	Steep	35	Rocky	Crevice	
2-Mar-04	DI	36	491838.8	1240907.3	11	8	0	0	1	Steep	0	Cobble	Rocky	Boulder
3-Mar-04	RI	37	490654.9	1234746.8	10	5	0	0	0	Gradual	10	Barren	Crevice	
3-Mar-04	RI	38	490701.4	1234751.4	15	5	0	0	0	Gradual	10	Barren	Crevice	Boulder
3-Mar-04	RI	39	490703.7	1234749.0	12	5	0	0	0	Steep	40	Barren	Boulders	Rocky
3-Mar-04	RI	40	490705	1234742.2	9	5	0	0	0	Gradual	30	Rocky	Barren	Boulder
3-Mar-04	SN	41	491240.6	1235303.4	14	10	1	1	1	Gradual	90	Boulder	Crevice	Rocky
3-Mar-04	SN	42	491243.8	1235307.5	16	10	3	3	1	Steep	40	Crevice	Rocky	Boulder
3-Mar-04	SN	43	491242.9	1235307.9	15	10	1	1	2	Steep	0	Barren	Crevice	Boulder

Table 2. Summary of egg mass densities (egg masses/m²) estimated from the quadrat counts at the seven 2004 survey sites.

Site Location	Number of quadrat counts	Number of egg masses	Density Estimates		Proportion (%) of quadrat counts with no egg masses	Density Estimates (excluding quadrat counts with no egg masses)	
			Median	Mean		Median	Mean
Snake Island	14	22	0.003185	0.005005	29	0.004777	0.007006
Hudson Rocks	3	1	0	0.001062	75	0.003185	0.003185
Five Finger Island	3	0	0	0	100	--	--
Entrance Island	6	9	0.004777	0.004777	33	0.006369	0.005732
Neck Point	3	1	0	0.001062	66	0.003185	0.003185
Douglas Island	4	1	0	0.000796	75	0.003185	0.003185
Round Island	4	0	0	0	100	--	--

Table 3. Data for each egg mass observed at 2004 site locations (SN=Snake Island reef; HR=Hudson Rocks; EN=Entrance Island; NP=Neck Point reef; DI=Douglas Island). The quadrat that each egg mass was observed in is noted. The depth (m) of the egg mass location, the egg mass dimensions (length, width and height to the nearest cm) and volume (cubic cm) along with the location of the egg mass, the colour of the eggs, the presence of a male guarding one egg mass (M1), guarding two or three egg masses in sequential order (M2 or M3) or an unguarded egg mass (M0), and the total length (cm) of the guarding male are included. If a male was present, but no length is indicated, then measurement was not possible. Boxes are drawn to denote multiple egg masses guarded by a male. If egg mass dimension are not indicated, then the egg mass was located too far underneath a rock or in a crevice to measure. The egg mass location codes include: out in the open=0; under rock=1; in horizontal crevice=2; in vertical crevice=3. Egg development is coded by the following: 1=creamy white (new); 2=white (intermediate); 3=grey white (old); 4=eyed eggs (nearly hatched); 5=hatched.

Site Location	Quadrat number	Egg mass depth (m)	Egg mass location	Egg colour	Length (cm)	Width (cm)	Height (cm)	Volume (cm^3)	Male present	Length of male (cm)
SN	6	12.2	1	4	--	--	--	--	M1	70
SN	7	9.75	3	4	8	14	11	1232	M1	66
SN	9	6.71	3	4	28	13	6	2184	M2	62
SN	9	6.71	1	4	10	10	6	600	M2	
SN	9	7.32	1	4	16	10	6	960	M3	68
SN	9	7.32	1	2/3	28	15	6	2520	M3	
SN	9	7.32	1	4	18	10	7	1260	M3	
SN	10	6.71	1	3/4	13	17	30	6630	M1	63
SN	10	6.71	0	2	10	6	8	480	M0	
SN	12	9.45	1	2/3	21	13	10	2730	M1	66
SN	13	8.53	1	3/4	27	10	15	4050	M1	58
SN	13	6.71	2	4/5	--	--	--	--	M2*	78
SN	13	6.71	2	3/4	--	--	--	--	M1	71
SN	13	8.53	2	3	--	--	--	--	M1	58
SN	15	6.4	1	3	35	8	13	3640	M1	65
SN	15	6.4	1	3	15	6	18	1620	M1	--
SN	15	6.4	2	3/4	11	10	27	2970	M1	71
HR	19	12.8	2	4	20	10	7	1400	M1	49
EN	24	12.5	3	2/3	15	5	15	1125	M1	--
EN	25	9.75	1	2	15	10	10	1500	M1[T]	72
EN	26	11.3	1	3/4	26	10	10	2600	M1	--
EN	26	12.5	1	3	20	10	10	2000	M1	64
EN	27	11.3	0	4	17	10	4	680	M0	
EN	27	11.3	1	4	--	--	--	--	M0	
EN	27	10.1	1	3/4	15	13	20	3900	M1	--
EN	28	13.7	1	3/4	25	8	10	2000	M2	69
EN	28	13.7	0	2/3	28	19	10	5320	M2	
NP	31	15.2	1	1/2	28	14	11	4312	M1	55
DI	33	10.1	2	3/4	--	--	--	--	M1	--
SN	41	12.2	1	3	15	43	18	11610	M1	58
SN	42	15.8	1	4/5	9	13	18	2106	M1	--
SN	42	15.2	3	4/5	30	13	20	7800	M2	--
SN	42	14.6	1	4/5	18	9	11	1782	M2	--
SN	43	12.5	3	4/5	20	6	6	720	M1	63

*Male was guarding two egg masses, but only one egg mass was within quadrat area.
[T]Male was tagged with Floy spaghetti tag from a 2003 tagging study (King and Haggarty, 2004).

Table 4. Fish counts for dive quadrats including date sampled, site location (DI=Douglas Island; EN=Entrance Island; FF=Five Finger Island; HR=Hudson Rocks; NP=Neck Point reef; RI=Round Island; SN=Snake Island reef). Information on latitude and longitude, depth of quadrat (m), visibility (m) and habitat are reported in Table 1.

Date	Site Location	Quadrat Number	Lingcod	Male kelp greenling	Female kelp greenling	Whitespotted greenling	Cabezon	Striped perch	Copper rockfish	Quillback rockfish	Tiger rockfish	Unidentified rockfish	Total Fish
02-Mar-04	DI	33	3	1	1			28	2				35
02-Mar-04	DI	34		1			1					1	3
02-Mar-04	DI	35		2	1				3			5	11
02-Mar-04	DI	36	1	1					8				10
27-Feb-04	EN	24	1	2	1							1	5
27-Feb-04	EN	25	1	4				3	1				9
27-Feb-04	EN	26	2		1			2	3			1	9
27-Feb-04	EN	27	1	2	1	2			1				7
27-Feb-04	EN	28	4		2			8	3				17
27-Feb-04	EN	29	1						4				5
23-Feb-04	FF	21		1									1
23-Feb-04	FF	22	1	1								1	3
23-Feb-04	FF	23										1	1
23-Feb-04	HR	18							2				2
23-Feb-04	HR	19	1										1
23-Feb-04	HR	20		1									1
02-Mar-04	NP	30			1				11	6			18
02-Mar-04	NP	31	1	1	1				10	2			15
02-Mar-04	NP	32	2	2					9	7	1		21
03-Mar-04	RI	37		1								1	2
03-Mar-04	RI	38											
03-Mar-04	RI	39						1	5				6
03-Mar-04	RI	40							1				1
17-Feb-04	SN	1	1	1					1				2
17-Feb-04	SN	2	3	1						1			5
17-Feb-04	SN	3	4					32	4	1			41
17-Feb-04	SN	4	4	2					1				7

Table 4 continued.

Date	Site Location	Quadrat Number	Lingcod	Male kelp greenling	Female kelp greenling	Whitespotted greenling	Cabezon	Striped perch	Copper rockfish	Quillback rockfish	Tiger rockfish	Unidentified rockfish	Total Fish
17-Feb-04	SN	5	2	1			1	54					58
19-Feb-04	SN	6	3		2				5				10
19-Feb-04	SN	7	3						6				9
19-Feb-04	SN	8	5	2	1				1				9
19-Feb-04	SN	9	2						3			1	6
19-Feb-04	SN	10	5	1					6				12
20-Feb-04	SN	12	1	1	1				2				5
20-Feb-04	SN	13	6	1	6								13
20-Feb-04	SN	14	1		2				5	1			9
20-Feb-04	SN	15	5	5	1				8				19
20-Feb-04	SN	16	2		3								5
20-Feb-04	SN	17	2		4				3				9
03-Mar-04	SN	41	2		1				12				15
03-Mar-04	SN	42	3	1					8	6			18
03-Mar-04	SN	43	3	1					5				9
		Total	75	37	30	2	2	128	133	24	1	12	444

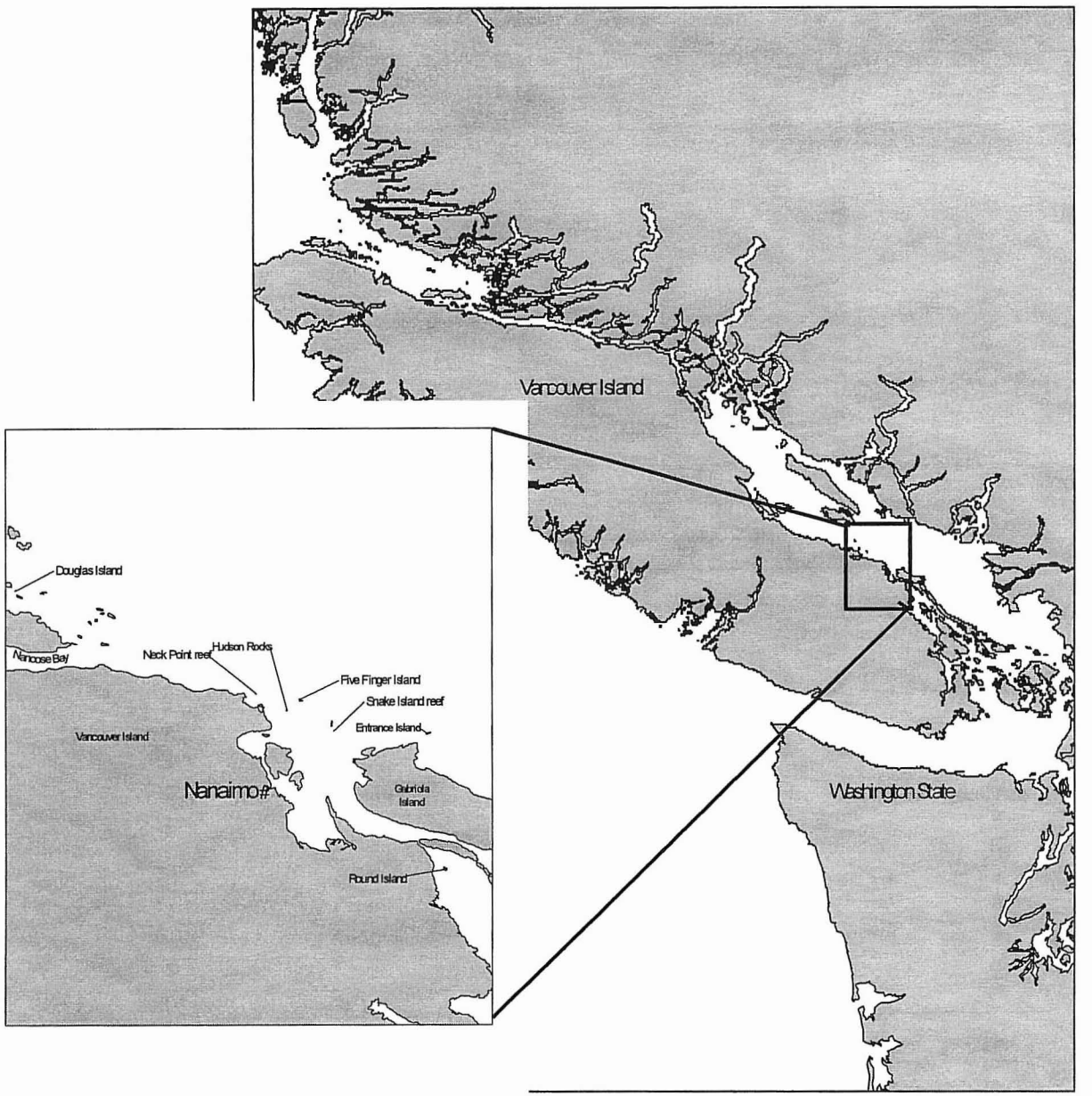

Figure 1. Location of study area near Nanaimo on southeastern Vancouver Island. Inset shows location of the seven study sites.

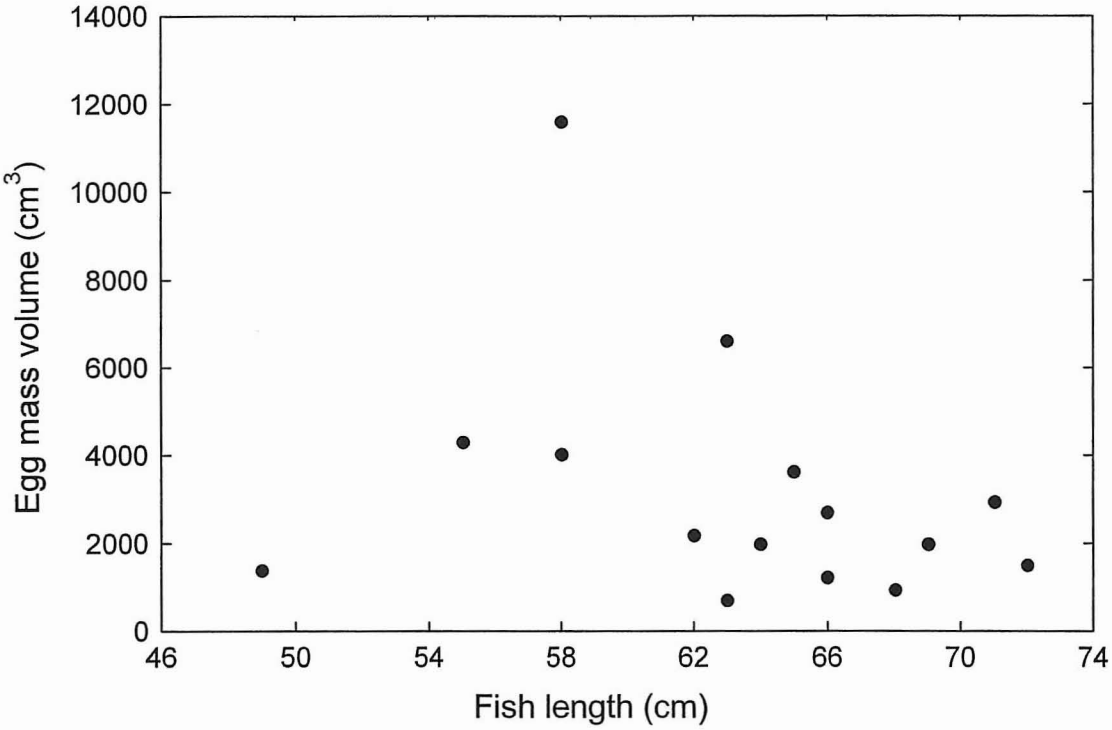

Figure 2. Scatterplot of estimated egg mass volume (cm^3) as a function of length of the guarding male lingcod (cm). Overall egg mass volume does not appear to be dependent on size of male.