Lingcod (*Ophiodon elongatus*) eggs to adult mass conversion factor for harvest allocation in the Strait of Georgia

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LINGCOD (*Ophiodon elongatus*) EGGS TO ADULT MASS CONVERSION FACTOR FOR HARVEST ALLOCATION IN THE STRAIT OF GEORGIA

by

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Lingcod eggs are a culturally important food source to some First Nations of coastal British Columbia. In this report, we developed a conversion factor to translate Lingcod egg harvest quantity to adult Lingcod management equivalents under a fishing allocation. A dive survey was conducted in the Strait of Georgia at Snake Island reef on January 24, 2022, to collect samples from three Lingcod egg masses. From these three samples, the mean weight per egg was 17.1 ± 0.2 mg (mean ± SE), the mean diameter per egg was 3.49 ± 0.03 mm, and the mean number of eggs per 100 ml was 2612 ± 268 eggs. Published data from previous Lingcod egg mass density surveys in 2001-2005 and 2010-2012 were also used in the conversion analysis. Previous surveys determined a mean nest density across all locations and years of 0.40 ± 0.03 nests per 100 m^2 and a mean nest volume of 4432 ± 218 ml. We estimated the conversion factor between Lingcod eggs and adult equivalents as 2.82 ± 0.36 kg of adult Lingcod per kg of Lingcod eggs. This conversion factor could be applied in determining future harvest allocations.

Résumé

Walker, L.C. and Haggarty, D.R. 2024. Lingcod (*Ophiodon elongatus*) eggs to adult mass conversion factor for harvest allocation in the Strait of Georgia. Can. Tech. Rep. Fish. Aquat. Sci. 3604: v + 15 p

Les œufs de morue-lingue sont une source de nourriture importante sur le plan culturel pour certaines Premières Nations de la côte de la Colombie-Britannique. Dans le présent rapport, nous avons élaboré un facteur de conversion pour transformer la masse d'œufs de morue-lingue récoltés en masse d'individus adultes équivalente, aux fins d'attribution des prises pour la pêche. Le 24 janvier 2022, on a effectué un relevé par plongée dans le détroit de Georgia, près du récif de l'île Snake, pour prélever des échantillons de trois masses d'œufs de morue-lingue. D'après ces trois échantillons, le poids moyen par œuf était de 17,1 ± 0,2 mg (moyenne ± erreur-type), le diamètre moyen par œuf était de 3,49 ± 0,03 mm et le nombre d'œufs moyen par 100 ml était de 2 612 ± 268 œufs. Des données publiées provenant de relevés sur la densité des masses d'œufs de morue-lingue réalisés de 2001 à 2005 et de 2010 à 2012 ont également été utilisées dans l'analyse de conversion. Les relevés antérieurs ont permis de déterminer une densité de nids moyenne de 0,40 ± 0,03 nid par 100 m^2 et un volume de nids moyen de 4 432 ± 218 ml dans tous les emplacements échantillonnés pendant les années de relevé. Nous avons estimé que le facteur de conversion entre la masse d'œufs de morue-lingue et la masse d'adultes équivalente était 2,82 ± 0.36 kg de morue-lingue adulte par kg d'œufs de morue-lingue. On pourrait appliquer ce facteur de conversion dans le cadre de l'attribution future des prises de la pêche.

1 Introduction

Lingcod (*Ophiodon elongatus*) is a large marine groundfish species unique to the west coast of North America. They occur from California to Alaska but are most abundant off the shores of British Columbia. Lingcod inhabit reefs and rocky areas primarily at depths from 10 to 100 m. They make seasonal spawning migrations, but once mature the majority of Lingcod remain within 10 km of the area where they spawn (Cass et al., 1990). Adult males exhibit strong nest site fidelity and return to the same location to spawn each year (King and Withler, 2005). Males arrive on the spawning grounds late in the year. Spawning then occurs around January to February, when the females join them.

On average a sexually mature female has an approximate relative fecundity of 26 eggs per gram of body weight (Cass et al., 1990). Large females can release up to 500,000 eggs in large sticky masses, also referred to as nests (Beamish and Cass, 1983). These egg masses are deposited in rocky crevices or under rocks and are guarded by a male until hatching, in approximately 5 to 11 weeks (Cass et al., 1990). Unguarded or shallow nests are more likely to suffer predation (Cass et al., 1990; Low and Beamish, 1978). Nests without sufficient water current velocities may suffer egg mortality due to poor oxygenation (Cass et al., 1990). A genetic study of Lingcod nesting behaviour showed that each egg mass was produced by one female and each year a female only laid one egg mass (King and Withler, 2005).

Lingcod support both commercial and recreational fisheries but they remain a conservation concern due to depressed populations from overfishing (King, 2001; Richards and Hand, 1989). The commercial fishery in the Strait of Georgia was closed in 1990 and the recreational fishery was closed during 2002-2005 (Logan et al., 2005). Some recovery of the population has occurred but the last Strait of Georgia stock assessment estimated that the biomass remains at 10-25% of the historical levels (DFO, 2015). Due to their limited movements and high spawning site fidelity, Lingcod appear to have limited ability to recolonize areas that have been overfished, making population recovery particularly challenging (Beamish and Cass, 1983). In addition to the commercial and recreational fishery, Lingcod and Lingcod eggs are a traditional and culturally important food to some First Nations of coastal British Columbia.

The Tla’amin First Nation has a modern treaty with Canada and British Columbia and has a defined harvest allocation of rockfish and Lingcod (*Tla’amin Final Agreement*, 2016). The Tla’amin First Nation harvest Lingcod eggs as a traditional food for elders within the Nation. Accordingly, the Tla'amin First Nation has requested that a portion of its treaty allocation of Lingcod be harvestable as Lingcod eggs. The current harvest allocation of Lingcod eggs by the Tla'amin Nation is 80 lbs (36 kg) of eggs annually. The annual harvest of Lingcod eggs may increase if additional First Nations also request to harvest Lingcod as eggs.

The harvesting of fish eggs removes reproductive products and a potential portion of the future adult fish population (Schweigert et al., 2018). The focus of this report is to identify a conversion factor that can be used to convert a harvest weight of Lingcod eggs to a management equivalent weight of adult Lingcod. This approach is the same concept that allows Pacific herring (*Clupea pallasii*) eggs to be harvested under a Pacific herring allocation and then converted to adult equivalents (Schweigert et al., 2018).

2 Methods

Fisheries and Oceans Canada (DFO) staff conducted a dive survey in the Strait of Georgia at Snake Island reef on January 24, 2022, to collect samples from three Lingcod egg masses. The nest samples were collected at the same location that King and Withler (2005) conducted their nest site fidelity study. The site was previously known to have plenty of suitable nesting habitat including large rocks and boulders with cracks or crevices and had previously produced relatively high nesting densities. Using the boat's GPS, DFO staff found the dive location from the previous work (49º 12.73' N; 123º 53.08' W) and dropped an anchor at the center of the site.

The divers opportunistically sampled the first three Lingcod egg masses they found from a depth of 9-12 m. They measured the length, width, and height of the egg mass before collecting any samples. The divers used a dive knife to collect samples comprising 40-50% of the egg masses and stored them in individual 3.79 L re-sealable bags. The samples were stored in seawater in a refrigerator until they could be processed in the lab. The coordinates for each nest sample collected are shown in Table 1.

The samples were analyzed in the laboratory on January 25, 2022. The samples were drained of seawater and blotted dry with paper towels. The volume and weight of each nest sample was then measured. To measure the volume of the samples, the mass was split into smaller pieces and inserted into a graduated cylinder (Figure 1). A 100 ml subsample of each mass was analyzed for weight and number of eggs. From each egg mass, another subsample of approximately 50 eggs was taken and weighed individually using a high-precision balance (± 0.1 mg). From each subsample, photographs of approximately 10 eggs were taken under 20x magnification on a dissecting scope (Figure 2). For the eggs that were photographed, the diameter was measured using ImageJ (Rasband, 2018). Due to the gelatinous matrix connecting the egg mass, individual eggs were difficult to separate from each other.

We calculated egg mass density per 100 m^2 and volume statistics using Lingcod egg mass density data from SCUBA surveys performed during the 2001-2005 and 2010-2012 periods (Haggarty et al., 2005; King and Haggarty, 2004; King and Beaith, 2001; King and Winchell, 2002; McPhie and King, 2012, 2011; Surry and King, 2007). During these years, an annual survey took place during spawning season at Snake Island in the Strait of Georgia near Nanaimo, BC. In some years, surveys also occurred at Entrance Island, Round Island, Hudson Rocks, Five Finger Island, Neck Point Reef, Douglas Island, or Law point, also near Nanaimo, BC. In 2005, surveys occurred at Discovery Passage, Maud Island, April Point, and Copper Cliffs, at the northern end of the Strait of Georgia near Campbell River, BC. The approximate coordinates for each survey location are shown in Table 2. Refer to King and Haggarty (2004, p. 12), Haggarty et al. (2005, p. 13), and McPhie and King (2011, p. 26) for maps of all the survey locations.

We calculated summary statistics for individual eggs, egg mass samples, and egg masses. We estimated the mean weight and diameter of an individual egg across all samples and by egg mass (Figure 3; Table 3). We also quantified the mean number of eggs per 100 ml, recognizing limitations due to small sample size (n = 3 nests; Table 1). Using data from previous studies, we estimated the mean number of nests per 100 m^2 (Figure 4) and the mean nest volume (Figure 5). We did not include the data from 2001 in our estimation of mean nest volume because different measurement methods were used. We estimated the mean weight of a sexually mature female Lingcod from DFO Groundfish survey data from the Strait of Georgia.

Using these summary statistics, we developed a relationship between the harvest weight of Lingcod eggs and management equivalent weight of whole adult Lingcod that could be used to determine harvesting allocation similar to that used for Pacific herring roe (Schweigert et al. 2018). The equation to calculate the weight of adult Lingcod required to produce one nest is shown below (Equation 1). We note that the Lingcod egg to adult mass conversion factor here uses the mean weight of a fertilized and water-absorbed egg, which will overestimate the weight of eggs per female and, consequently, underestimate the conversion factor. However, eggs that are harvested will also be fertilized and water-absorbed. Equation 2 shows how to use the conversion factor to calculate the management equivalent weight of whole adult Lingcod from the harvest weight of Lingcod eggs.

$$Q = f/[v * p * i] \quad \text{(Equation 1)}$$

Where Q is the conversion factor in grams adult Lingcod per grams of eggs, f is the mean weight of an adult female Lingcod (g), v is the mean volume of a nest (L), p is the mean number of eggs per L, and i is the mean weight per egg (g) (Table 4). Once the conversion factor is estimated using grams, it can be interpreted as grams adults per grams eggs or kilograms adults per kilograms eggs.

$$\beta = \mathrm{E} * Q \quad \text{(Equation 2)}$$

Where β is the harvest equivalent weight of adult Lingcod (kg), E is the weight of harvested Lingcod eggs (kg), and Q is the conversion factor (kg adult Lingcod per kg of eggs).

Equation 1 converts the reproductive output of one female Lingcod to the biomass of that female Lingcod. To interpret this relationship as a harvest conversion factor we make the assumptions that all sexually mature female Lingcod create one egg mass each year on average, an adult female Lingcod and corresponding egg mass are comparable from an ecological and management perspective (i.e., some quantity of one can be exchanged for some quantity of another), and harvest of adult Lingcod catches predominantly female specimens.

All statistical analyses were performed using the R software program (R Core Team, 2023).

3 Results

Individual egg weights ranged from 11.1 mg to 24.2 mg across all nest samples, with an overall mean of 17.1 ± 0.2 mg per egg (mean ± SE). When averaged by egg mass, the mean weight per egg ranged from 16.2 ± 0.4 mg to 18.7 ± 0.4 mg for the three egg masses (Figure 3; Table 3). The mean diameter of an individual egg was 3.49 ± 0.03 mm. For the three sample masses the number of eggs per 100 ml sample ranged from 2079 to 2933, with a mean of 2612 ± 268 eggs per 100 ml (Table 1).

Mean nest density across all locations and years was 0.40 ± 0.03 nests per 100 m^2. When averaged by year, the lowest mean nest density recorded was 0.16 nests per 100 m^2 in 2007 and the highest mean nest density recorded was 0.59 nests per 100 m^2 in 2002 (Figure 4). Mean nest volume across all locations and years was 4432 ± 218 ml. By year, the lowest mean nest volume recorded was 2037 ml in 2007 and the highest mean nest volume recorded was 6391 ml in 2011 (Figure 5). The mean weight of a sexually mature female Lingcod was 5.58 ± 0.33 kg.

Using the mean values derived from Lingcod nest samples, SCUBA surveys, and Equation 1, we calculated a conversion factor between the harvest weight of Lingcod eggs and the management equivalent weight of whole adult Lingcod for harvest allocation as 2.82 ± 0.36 kg adult Lingcod per kg of eggs.

4 Discussion

We estimated the mean egg weight, number of eggs per 100 ml, nest volume, and weight of a mature female Lingcod to calculate a conversion factor between harvest weight of Lingcod eggs and management equivalent weight of whole adult Lingcod for harvest allocation. We also estimated mean egg diameter and nest density per 100 m^2. While most of the Lingcod egg mass surveys occurred near Nanaimo, BC, some data were collected near Campbell River, BC, so the estimated conversion factor may be applicable to other locations in the Strait of Georgia.

The Tla’amin Treaty and DFO Harvest Document permits the Tla'amin Nation to harvest 5000 lbs (2.27 tonnes) of rockfish or Lingcod (*Tla’amin Final Agreement*, 2016); 80 lbs (36 kg) of the Lingcod harvest can be in the form of Lingcod eggs. Currently, a conversion factor of one kilogram adult Lingcod per one kilogram eggs is being used to convert the weight of harvested Lingcod eggs to a management equivalent weight of adult Lingcod. Based on our analysis, a conversion factor of 2.82 ± 0.36 kg whole adult Lingcod per kg Lingcod eggs could be considered. Applying this conversion factor using Equation 2, an 80 lbs (36 kg) harvest allocation of Lingcod eggs would translate to 226 lbs (102 kg) of whole adult Lingcod from the Harvest Document amounts (*Tla’amin Final Agreement*, 2016).

In addition to the updated egg to adult conversion relationship, some other factors could be considered regarding the harvest of Lingcod eggs. Given the known Lingcod site fidelity and limited migration, harvesting too many nests from one area could result in reduced recruitment to that area. Once areas are over-fished, it has been shown that they are slow to repopulate (Cass et al., 1990). We recommend harvesting eggs or nests primarily in areas of higher nest density. We also suggest selecting nests without a guarding male present, as unguarded nests are highly likely to be predated. Finally, only harvesting a portion of an egg mass may allow some eggs from each nest to survive.

The harvesting of Lingcod eggs may have additional unintended consequences for the Lingcod population and ecosystem (Pikitch et al., 2004). Removing Lingcod eggs removes potential future reproductive adults from the population. However, stage-specific exploitation can have disproportionate effects on population dynamics, and harvesting multiple life stages can have additive effects (Shelton et al., 2014). The full impact of an egg harvest on the population may not be known until interactions with the adult harvest are considered. Removal of Lingcod nests also removes a food source (e.g., eggs and larvae) for other species, such as Kelp Greenling (*Hexagrammos decagrammos*) and Striped Seaperch (*Embiotoca lateralis*) (Low and Beamish, 1978).

If the conversion factor for Lingcod egg to adult equivalents presented here is adopted for ongoing application, further studies are recommended to research and account for ecosystem and population dynamics consequences. Future work could investigate the consequences of harvesting different Lingcod life stages. The contribution of Lingcod eggs to future adult biomass depends on egg survival and development into mature Lingcod. Ontogenetic development takes time and this time lag between harvesting eggs and the corresponding removal of potential future adult biomass may have ecological consequences that are not considered here. These questions are beyond the scope of the present work.

Due to the small sample size and simplifying assumptions, the conversion factor calculated in our report should be viewed as a preliminary estimate. Given these limitations, we provide a transparent estimation of a conversion factor between Lingcod eggs to adult biomass based on available data that is more precautionary than current practice for managing Lingcod egg harvest allocation in the Strait of Georgia.

5 Acknowledgments

We would like to express our gratitude to Fiona Francis, Darienne Lancaster, and Sharon Jeffries for diving and Daniel Williams for boat tending. Thank you to S. Wischniowski from the PBS Sclerochronology lab for weighing and photographing individual eggs and Edith Kraus for helping to measure and count the egg masses in the lab. We also appreciate the thorough review of this document by Jake Schweigert, Bob Bocking, and Luke Rogers. Finally, thank you to the Tla’amin First Nation for being supportive of us carrying out this study.

6 Figures

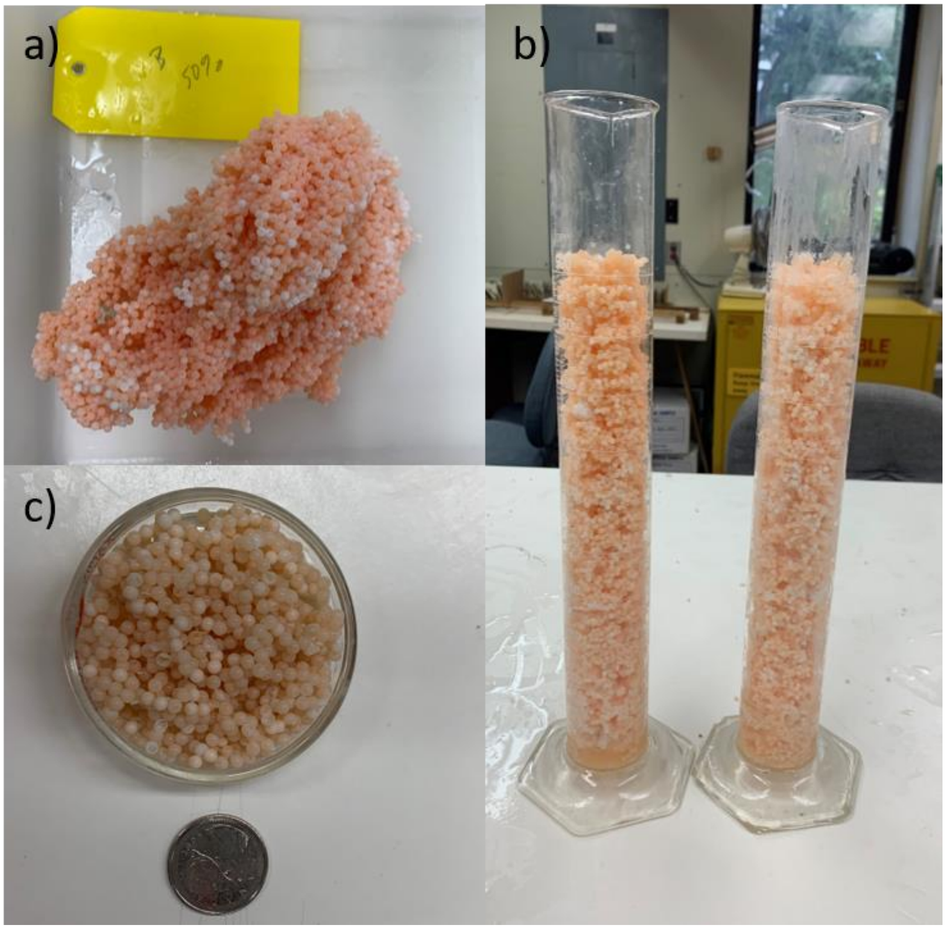

Figure 1. Photographs of (a) one sample of a Lingcod egg mass (approximately 40-50% of the total egg mass), (b) Lingcod eggs in graduated cylinders for volume measurement, and (c) Lingcod eggs in a petri dish, with a Canadian Quarter for scale.

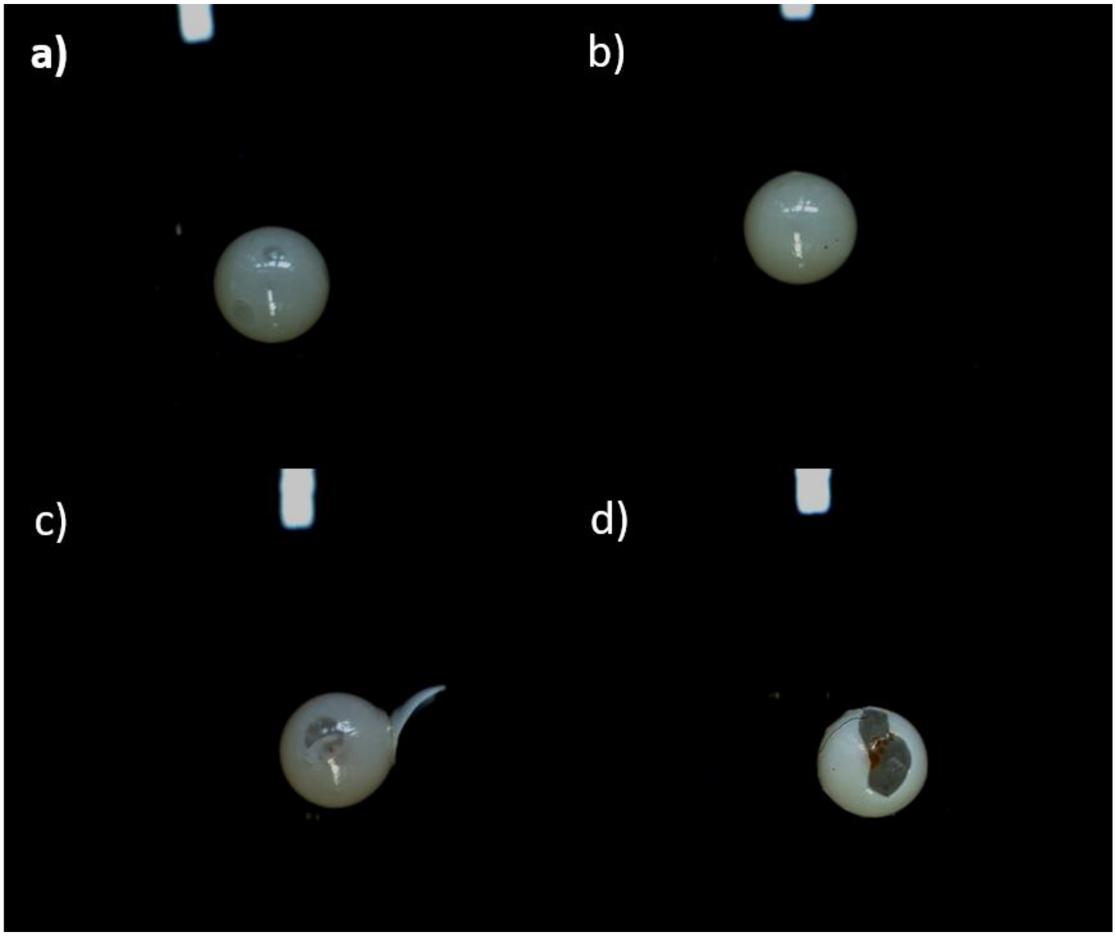

Figure 2. Photographs of Lingcod Eggs under 20x magnification. Photos a) and b) show eggs that are intact. Photo c) shows an egg with part of an adjacent egg and d) shows a broken egg. Due to the gelatinous matrix connecting the eggs they are difficult to separate.

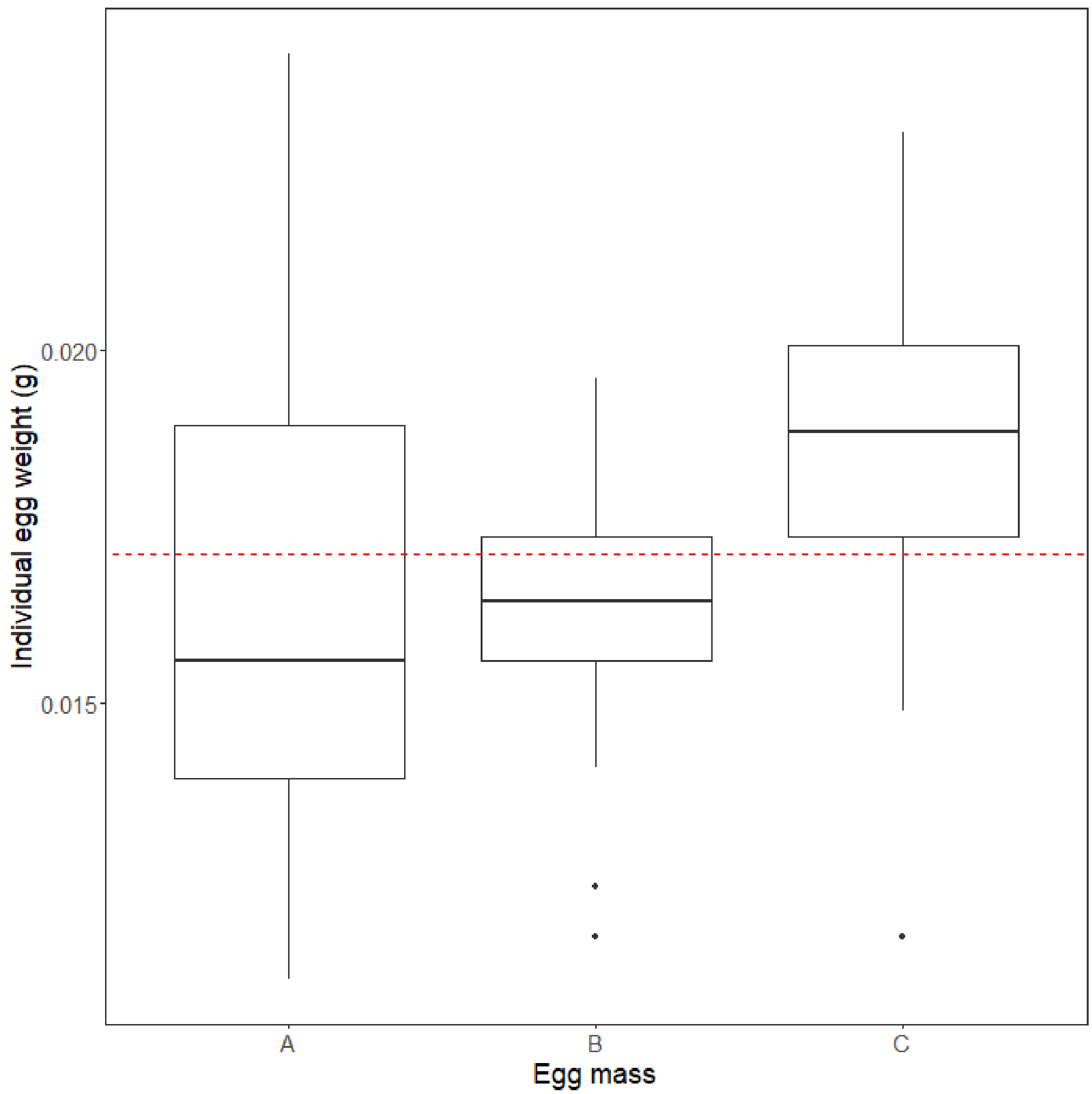

Figure 3. Boxplot summarizing the individual egg weights by egg mass. The median is indicated by the horizontal line in each box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by ●.The red dotted line is the overall mean weight per egg across all samples and egg masses.

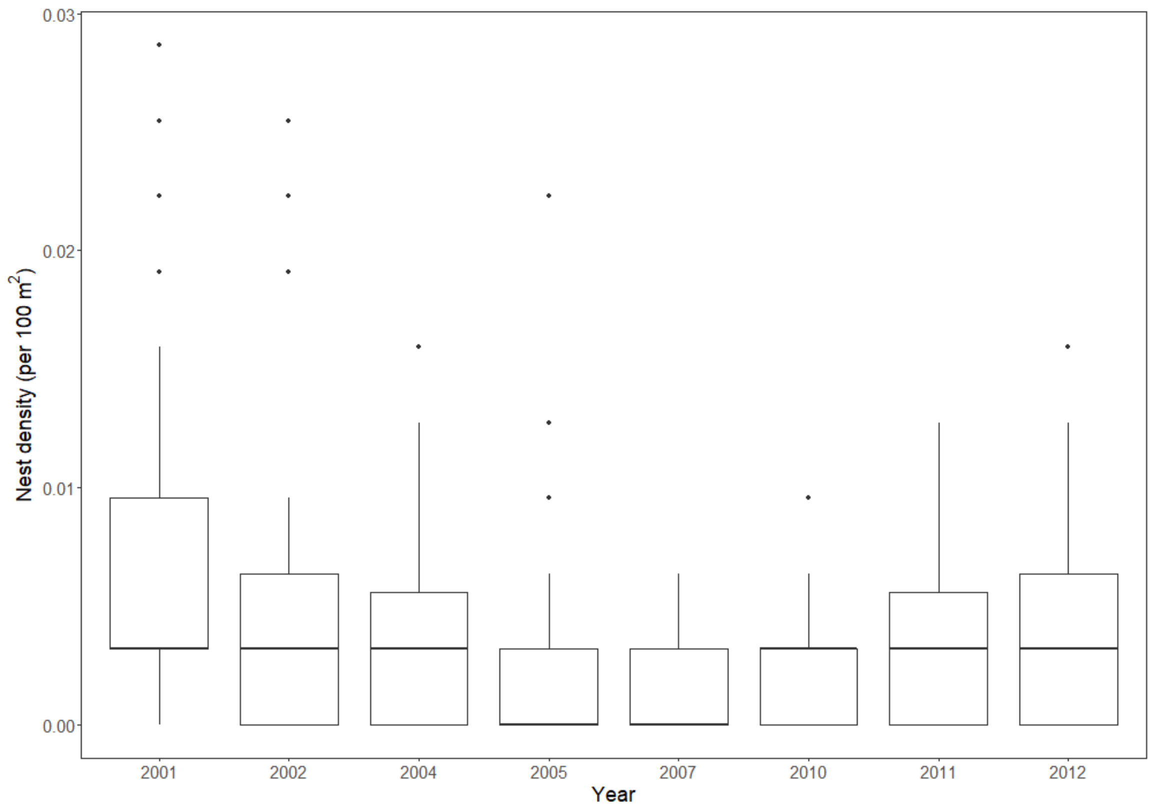

Figure 4. Boxplot summarizing Lingcod nest density by year across all sites. The median is indicated by the horizontal line in each box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by ●.

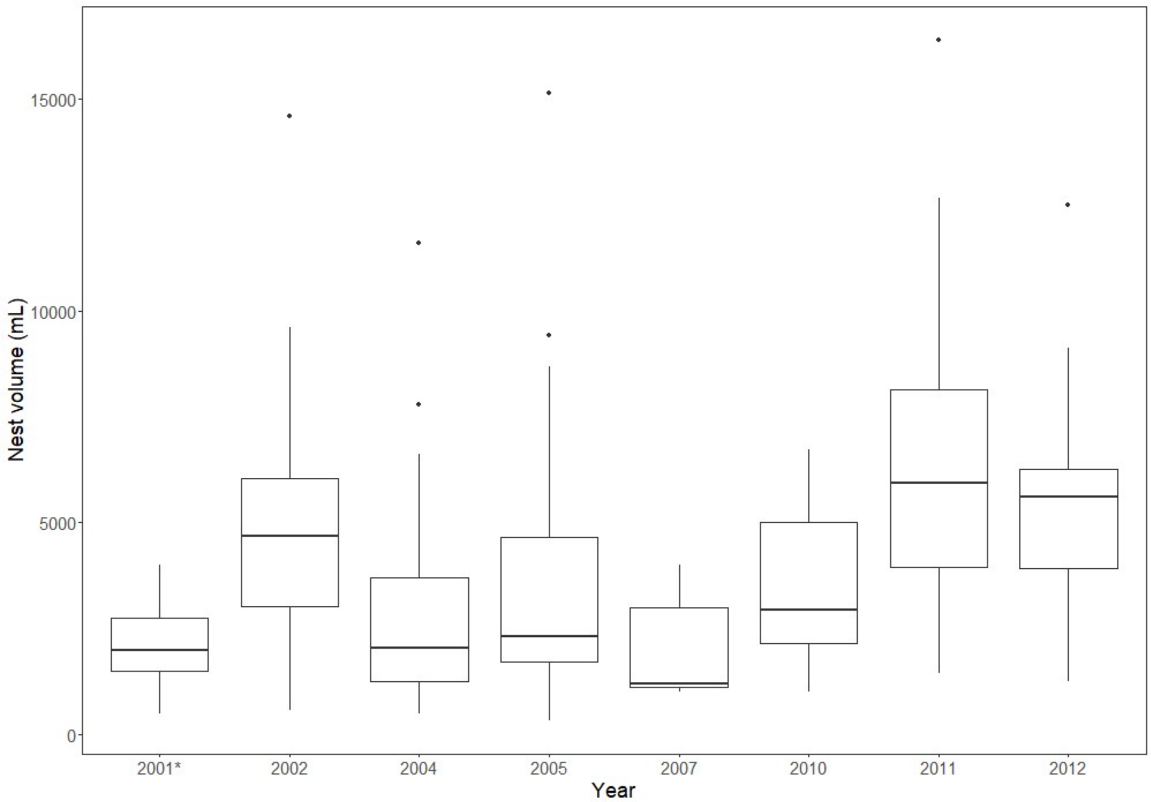

Figure 5. Boxplot summarizing Lingcod nest volume for all sites by year. The median is indicated by the horizontal line in each box, while box edges depict the 1st and 3rd quartiles. The typical range of the data are represented by the whiskers, while outliers are represented by ●. *The nest volume estimates from 2001 were round to the nearest 0.5L.

7 Tables

Table 1. Data for individual egg masses sampled on January 24, 2022. This table includes the percent of the egg mass that was collected, the length, width, and height of the whole egg mass, the weight and volume of the collected sample, the number of eggs and weight per 100 ml sample, and the coordinates of the egg masses. Latitude and longitude are in degrees decimal minutes.

Mass ID	% of egg mass	Egg mass			Sample		Eggs/ 100 ml	Weight/ 100 ml	Latitude	Longitude
		Length (mm)	Width (mm)	Height (mm)	Weight (g)	Volume (ml)				
A	50	245	115	105	701.4	1250	2933	-	49° 12.753	123° 53.058
B	50	150	125	-	282.0	-	2079	41.6	49° 12.751	123° 53.062
C	40	240	115	85	630.8	1350	2823	39.4	49° 12.751	123° 53.062

Table 2. Dive locations for the Lingcod egg mass density data from the SCUBA surveys performed during 2001-2012. An 'X' indicates a survey occurred at that approximate location that year, specific dive locations can be found in the corresponding report (Haggarty et al., 2005; King and Beaith, 2001; King and Haggarty, 2004; King and Winchell, 2002; McPhie and King, 2012, 2011; Surry and King, 2007). Latitude and longitude are in degrees decimal minutes. Refer to King and Haggarty (2004, p. 12), Haggarty et al. (2005, p. 13), and McPhie and King (2011, p. 26) for maps of all the survey locations.

Location	Latitude	Longitude	2001	2002	2004	2005	2007	2010	2011	2012
Snake Island Reef	49° 12.95	123° 53.45	X	X	X	X	X	X	X	X
Entrance Island	49° 12.55	123° 48.55			X	X		X		
Round Island	49° 07.01	123° 47.68			X					
Hudson Rocks	49° 13.50	123° 55.60			X					
Five Finger Island	49° 13.87	123° 54.97			X					
Neck Point Reef	49° 14.10	123° 57.25			X					
Douglas Island	49° 18.66	124° 09.17			X					
Discovery Passage	50° 11.60	125° 22.80				X				
Maude Island	50° 07.80	125° 20.50				X				
April Point	50° 03.89	125° 14.19				X				
Copper Cliffs	50° 05.88	125° 16.25				X				
Law Point	49° 09.60	123° 42.40							X	

Table 3. Data for the individual eggs sampled from the collected egg masses, including the egg mass the sample was taken from, the individual egg identifier, and the weight and diameter of the egg. The egg mass labels correspond to the egg masses in Table 1. Data for individual egg masses sampled on January 24, 2022. This table includes the percent of the egg mass that was collected, the length, width, and height of the whole egg mass, the weight and volume of the collected sample, the number of eggs and weight per 100 ml sample, and the coordinates of the egg masses. Latitude and longitude are in degrees decimal minutes.

Egg mass	Individual	Weight (g)	Diameter (mm)	Egg mass	Individual	Weight (g)	Diameter (mm)	Egg mass	Individual	Weight (g)	Diameter (mm)
A	1	0.0170		B	1	0.0169		C	1	0.0149	
A	2	0.0204		B	2	0.0174	3.377	C	2	0.0231	3.564
A	3	0.0177		B	3	0.0168		C	3	0.0185	
A	4	0.0242	3.43	B	4	0.0159	3.239	C	4	0.0207	
A	5	0.0135		B	5	0.0165		C	5	0.0164	3.411
A	6	0.0140		B	6	0.0145	3.511	C	6	0.0188	
A	7	0.0155	3.446	B	7	0.0183	3.527	C	7	0.0195	3.558
A	8	0.0165		B	8	0.0117		C	8	0.0169	
A	9	0.0171		B	9	0.0163		C	9	0.0210	
A	10	0.0220		B	10	0.0172		C	10	0.0159	
A	11	0.0220	3.607	B	11	0.0151		C	11	0.0204	
A	12	0.0143		B	12	0.0174		C	12	0.0170	
A	13	0.0205		B	13	0.0164		C	13	0.0151	
A	14	0.0156	3.594	B	14	0.0157		C	14	0.0203	3.661
A	15	0.0215		B	15	0.0154	3.578	C	15	0.0184	
A	16	0.0194		B	16	0.0187		C	16	0.0200	
A	17	0.0188		B	17	0.0162	3.557	C	17	0.0167	
A	18	0.0125	3.17	B	18	0.0159	3.286	C	18	0.0160	3.666
A	19	0.0209		B	19	0.0153		C	19	0.0195	
A	20	0.0199		B	20	0.0196		C	20	0.0166	
A	21	0.0163		B	21	0.0171		C	21	0.0178	3.609
A	22	0.0140		B	22	0.0173		C	22	0.0219	
A	23	0.0129	3.434	B	23	0.0176		C	23	0.0208	
A	24	0.0164		B	24	0.0157		C	24	0.0199	
A	25	0.0129		B	25	0.0141		C	25	0.0185	
A	26	0.0126		B	26	0.0170		C	26	0.0153	
A	27	0.0142		B	27	0.0165		C	27	0.0182	3.582
A	28	0.0198		B	28	0.0156		C	28	0.0206	
A	29	0.0160		B	29	0.0164		C	29	0.0195	
A	30	0.0120		B	30	0.0159		C	30	0.0196	
A	31	0.0138	3.255	B	31	0.0124	3.455	C	31	0.0189	

A	32	0.0136		B	32	0.0147		C	32	0.0184	
A	33	0.0164		B	33	0.0170		C	33	0.0204	3.558
A	34	0.0140		B	34	0.0151	3.354	C	34	0.0196	
A	35	0.0145		B	35	0.0188		C	35	0.0181	
A	36	0.0179		B	36	0.0158		C	36	0.0161	
A	37	0.0191	3.711	B	37	0.0150	3.369	C	37	0.0177	
A	38	0.0139		B	38	0.0146		C	38	0.0117	3.683
A	39	0.0117		B	39	0.0195		C	39	0.0206	
A	40	0.0151		B	40	0.0175		C	40	0.0219	
A	41	0.0162		B	41	0.0167		C	41	0.0194	
A	42	0.0148	3.718	B	42	0.0171	3.324	C	42	0.0192	
A	43	0.0144		B	43	0.0159		C	43	0.0228	
A	44	0.0122		B	44	0.0166		C	44	0.0225	
A	45	0.0126		B	45	0.0187		C	45	0.0174	3.444
A	46	0.0155		B	46	0.0186		C	46	0.0199	
A	47	0.0141		B	47	0.0153	3.542	C	47	0.0178	
A	48	0.0111		B	48	0.0175		C	48	0.0177	
A	49	0.0163		B	49	0.0189		C	49	0.0191	
A	50	0.0194		B	50	0.0156		C	50	0.0189	
A	51	0.0202						C	51	0.0174	
								C	52	0.0173	

Table 4. The symbol, name, units, and estimated value (± SE) of each variable in Equation 1.

Symbol	Name	Units	Estimated value (± SE)
Q	conversion factor	g adult Lingcod / g eggs in nest	2.82 ± 0.36
f	mean weight of a female Lingcod	g	5580 ± 330
v	mean volume of nest	L	4.432 ± 0.218
p	mean number of eggs per L	eggs / L	26120 ± 2680
i	mean weight per egg	g	0.0171 ± 0.0002

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