FALKLAND
ISLANDS
FISHERIES
DEPARTMENT

Loligo Stock Assessment Survey, 1st Season 2014

Vessel	Venturer (ZDLP1), Falkland Islands
Dates	09/02/2014 - 23/02/2014
Survey Team	Andreas Winter Lars Jürgens,

Summary

1) A stock assessment survey for *Loligo* squid was conducted in the 'Loligo Box' from 9th to 23rd February 2014. Sixty scientific trawls were taken during the survey, catching 123.5 tonnes of *Loligo*.
2) A geostatistical estimate of 34,673 tonnes *Loligo* (95% confidence interval: 22,182 to 47,762 t) was calculated for the fishing zone. This represents the highest 1st-season survey estimate since 2010. Of the total, 13,096 t were estimated north of 52 ºS, and 21,577 t were estimated south of 52 ºS.
3) Male and female *Loligo* had modal mantle lengths of 12 cm, both north and south of 52 ºS, but fewer *Loligo* in the south were smaller than 10 cm. More than 75% of all *Loligo* were at maturity 2, with a higher proportion of males than females at maturity 4 or 5.
4) Fifty-nine taxa were identified in the catches, of which *Loligo* made up the largest species group at 30.8% by weight. Medusae made up the second-largest group at 21.7%, and appear to be on an increasing trend since at least 1st season 2012. Specimens of *Illex* squid and *Martialia* squid, southern blue whiting, yellow rock cod, driftfish, red fish, and flounder were collected in addition to *Loligo*.

Introduction

A stock assessment survey for *Loligo* (*Doryteuthis gahi* - Patagonian squid) was carried out by FIFD personnel onboard the fishing vessel *Venturer* from the 9th to 23rd February 2014. This survey continues the series of surveys that have, since February 2006, been conducted immediately prior to *Loligo* season openings to estimate the *Loligo* stock available to commercial fishing at the start of the season, and to initiate the in-season management model based on depletion of the stock.

The survey was designed to cover the 'Loligo Box' fishing zone (Arkhipkin et al., 2008) that extends across the southern and eastern part of the Falkland Islands Interim Conservation Zone (Figure 1). The current delineation of the Loligo Box represents an area of approximately 31,118 km^2.

Objectives of the survey were to:

1) Estimate the biomass and spatial distribution of *Loligo* on the fishing grounds at the onset of the 1st fishing season, 2014.
2) Provide data for comparative estimates of rock cod (*Patagonotothen ramsayi*) bycatch in *Loligo* trawls.
3) Collect biological information on *Loligo*, rock cod, and opportunistically other commercially important fish and squid taken in the trawls.

The F/V *Venturer* is a Stanley, Falkland Islands - registered stern trawler of 84.2 m length, 1881 t gross registered tonnage, and 2450 main engine bhp. Recent observer coverage of this vessel is described in Davidson (2011), Watson (2011), and James (2013). Like all vessels employed for these pre-season surveys, *Venturer* operates regularly in the commercial *Loligo* fishery and used its commercial trawl gear for the survey catches. *Venturer* was also used for the 1st pre-season survey in 2011 (Winter et al., 2011). The following personnel from FIFD participated in the current survey:

Andreas Winter	stock assessment scientist
Lars Jürgens	fisheries observer

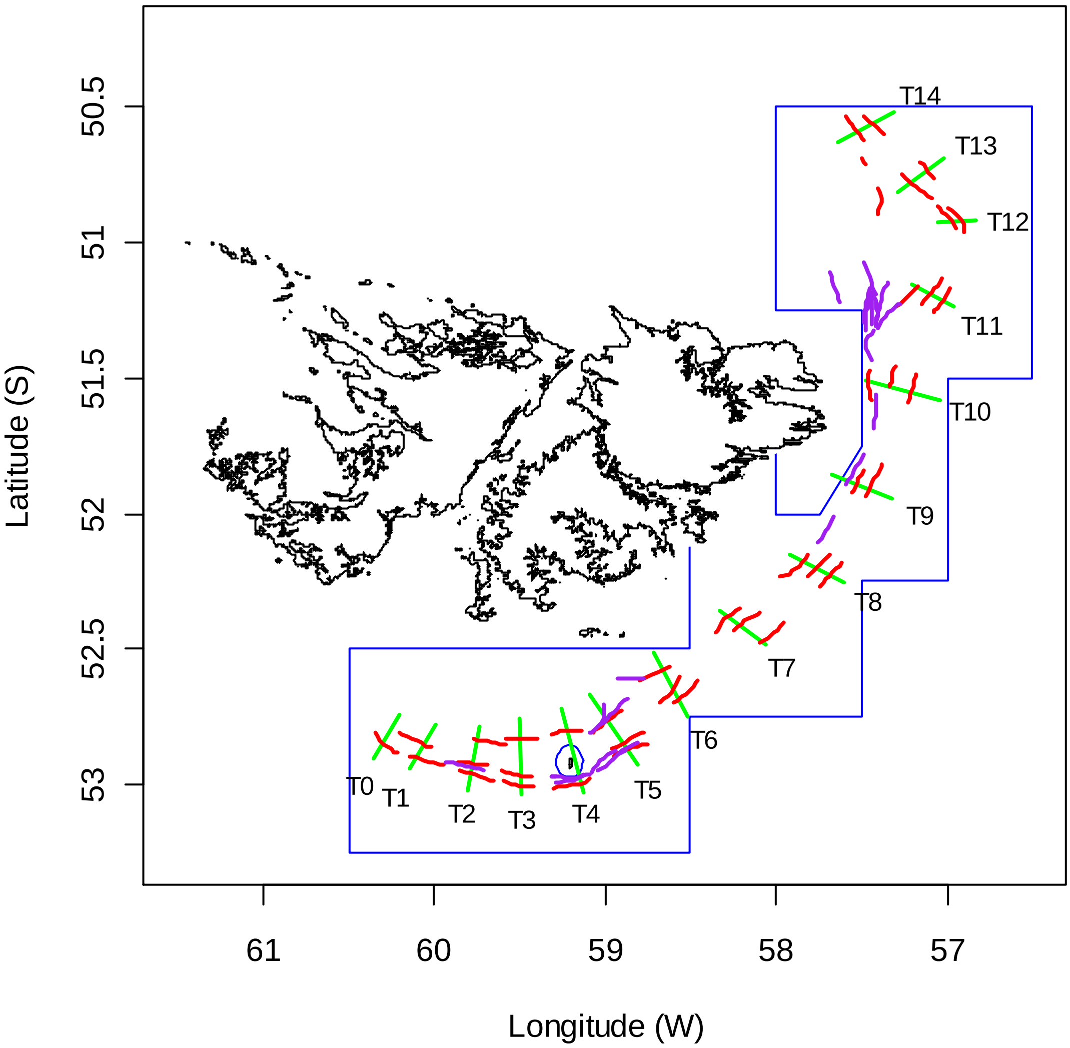


Figure 1. Transects (green lines), fixed-station trawls (red lines), and adaptive-station trawls (purple lines) sampled during the pre-season 1 2014 survey. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone are shown in blue.

Methods

Sampling procedures

The survey plan included 39 fixed-station trawls located on a series of 15 transects perpendicular to the shelf break around the Loligo Box (Figure 1), followed by up to 21 adaptive-station trawls selected to increase the precision of *Loligo* biomass estimates in high-density or high-variability locations. The same fixed-station survey plan as the previous 1st season (Winter et al., 2013a) was used, with some trawl stations placed further inshore than those sampled for 2nd seasons. Trawls were designed for an expected duration of 2 hours each, ranging in distance from 14.9 to

20.0 km (mean 16.8 km). All trawls were bottom trawls. During the progress of each trawl, GPS latitude, GPS longitude, bottom depth, bottom temperature, net height, trawl door spread, and trawling speed were recorded on the ship's bridge in 15-minute intervals, and a visual assessment was made of the quantity and quality of acoustic marks observed on the net-sounder. Following the procedure described in Roa-Ureta and Arkhipkin (2007), the acoustic marks were used to apportion the *Loligo* catch of each trawl to the 15-minute intervals and increase spatial resolution of the catches. For small catches acoustic apportioning cannot be assessed with accuracy, and any *Loligo* amounts <100 kg were iteratively aggregated by adjacent intervals (if the total *Loligo* catch in a trawl was <100 kg it was assigned to one interval; the middle one).

Catch estimation

Catch of every trawl was processed separately by the factory crew and retained catch weight of *Loligo*, by size category, was estimated from the number of standard-weight blocks of frozen *Loligo* recorded by the factory supervisor. Catch weights of commercially valued fish species, including rock cod, were recorded in the same way, although without size categorization. Discards of damaged, undersized, or commercially unvalued fish and squid were estimated by the FIFD observer either visually (for small quantities) or by noting the ratio of discards to commercially retained fish and squid in sub-portions of the catch (for larger quantities). Discards were added to the product weights (as applicable) to give total catch weights of all fish and squid.

Biomass calculations

Biomass density estimates of *Loligo* per trawl were calculated as catch weight divided by swept-area; which is the product of trawl distance × trawl width. Trawl distance was defined as the sum of distance measurements from the start GPS position to the end GPS position of each 15-minute interval. Trawl width was derived from the distance between trawl doors (determined per interval, from the net sensor) according to the equation:

trawl width = (door dist. × footrope length) / (footrope + sweep + bridle lengths)

(www.seafish.org/media/Publications/FS40_01_10_BridleAngleandWingEndSpread.pdf)

Measurements of *Venturer*'s trawl, provided by the vessel master, were: footrope = 104.1 m, sweep = 165 m and bridle = 30 m.

On one day of the survey (15th February) the door distance sensor was nonoperational. Door distances that day were instead estimated from a generalized additive model (GAM) as a function of predictive variables trawl depth, trawl speed, net height and warp cable out; calculated with all other survey days' data on which the door distance sensor was operational (n = 368). The GAM resulted in 72% deviance explained. This procedure was also used in the 1st season 2010 survey when the door distance sensors failed (Arkhipkin et al., 2010).

Biomass density estimates on the trawls were extrapolated to the fishing area using geostatistical methods described in Roa-Ureta and Niklitschek (2007). The methods are based on the approach of separately modelling positive (non-zero) catch densities, and the probability of occurrence (presence/absence) of the positive catch densities (Pennington, 1983), then multiplying the two together. Positive catch densities were modelled for spatial correlation using a fitted variogram (Cressie,

1993) and Box-Cox transformation to normalize the data (MacLennan and MacKenzie, 1988). Presence/absence was modelled for spatial correlation using Monte Carlo Markov Chain simulation (Christensen, 2004; Roa-Ureta and Niklitschek, 2007). Biomass on the fishing grounds was calculated by multiplying average extrapolated density by the fishing area. The same fishing area as the previous 1st season (Winter et al., 2013a) was delineated (Figure 2); 16,911 km^2, partitioned for analysis as 675 area units of 5×5 km.

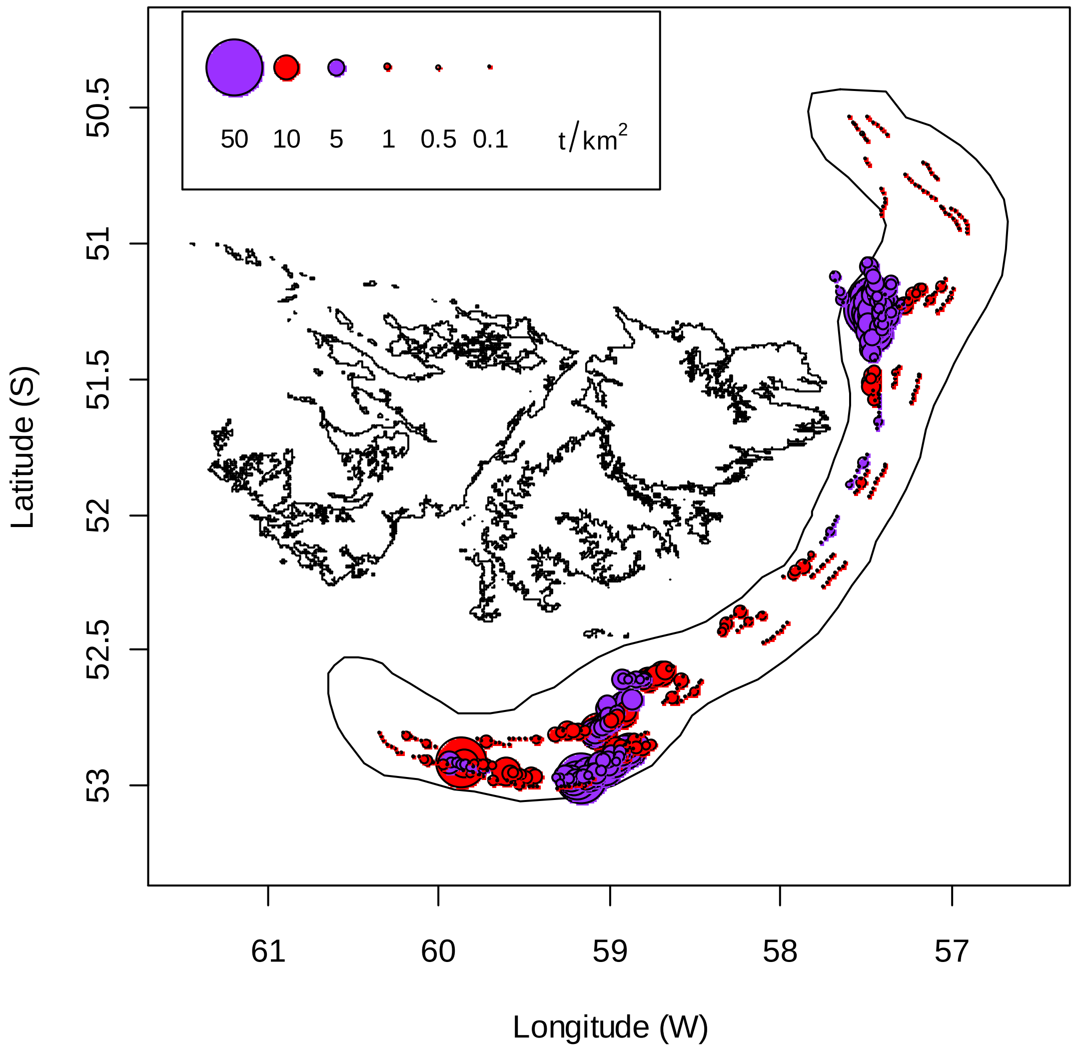


Figure 2. *Loligo* CPUE (t km^{-2}) of fixed-station trawls (red) and adaptive trawls (purple), per 15-minute trawl interval. The boundary of the fishing area is outlined.

Uncertainty of biomass on the fishing grounds was estimated by a hierarchical bootstrap re-sampling (Efron, 1981) of biomass densities in each of the 675 area units. Biomass densities per area unit were draws from the random normal distribution with mean equal to the empirical biomass density of each unit and standard deviation equal to the empirical biomass density multiplied by the average density coefficient of variation. The density coefficient of variation is the combination of positive catch density variation and presence/absence variation and was calculated jointly using the algorithm of Shono (2008). To this coefficient of variation was added a measure of error of acoustic apportionment (16.5%), which had been derived from the previous season's survey data (Winter et al., 2013b). The bootstrap for biomass uncertainty was iterated 10000×. This uncertainty is nevertheless still an understatement because it does not include evaluation of model error of the variogram itself.

Sea temperature and wind data

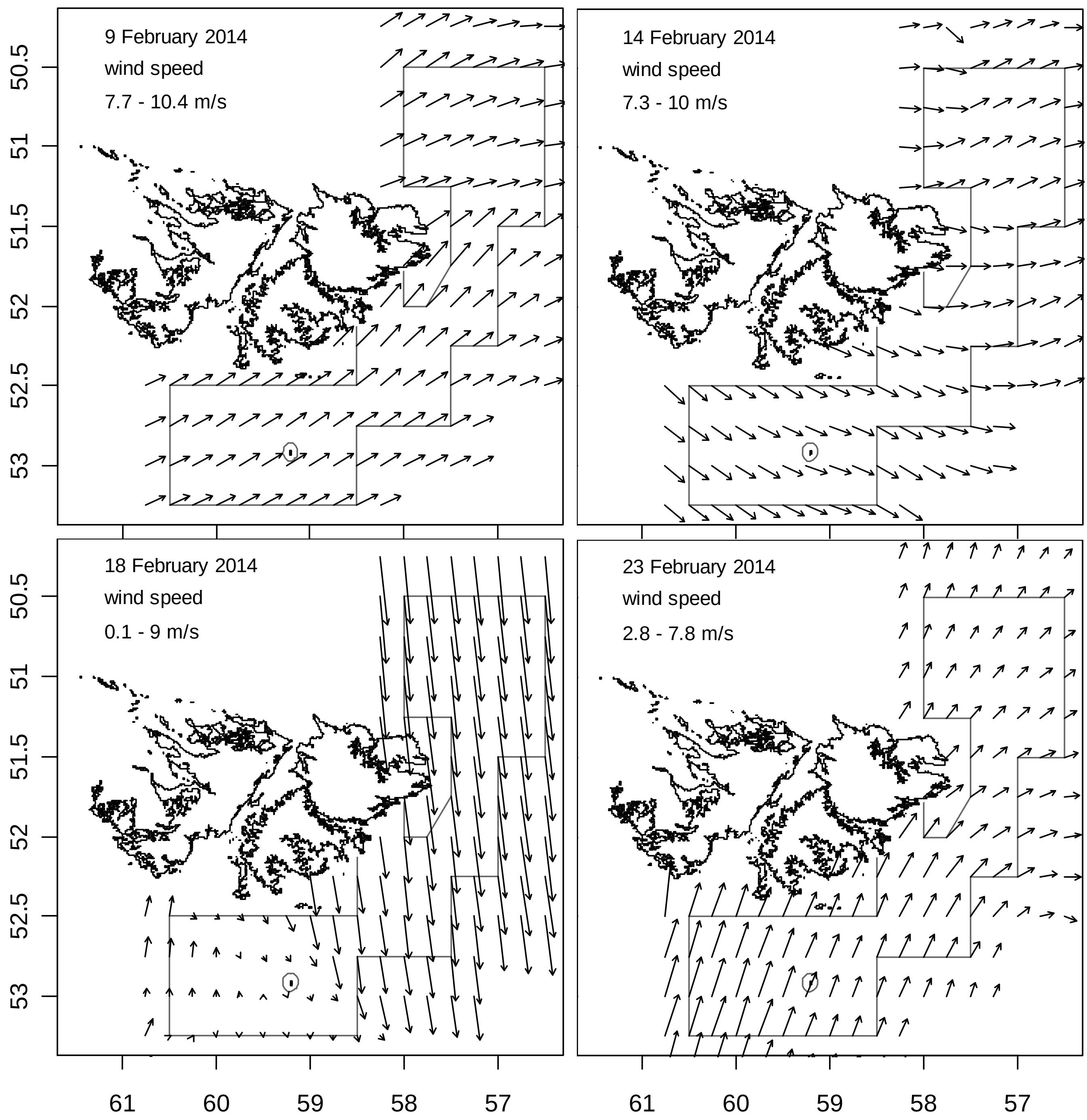


Figure 3. Sea wind vectors at 0.25° resolution, from satellite observations, on four days of the survey period.

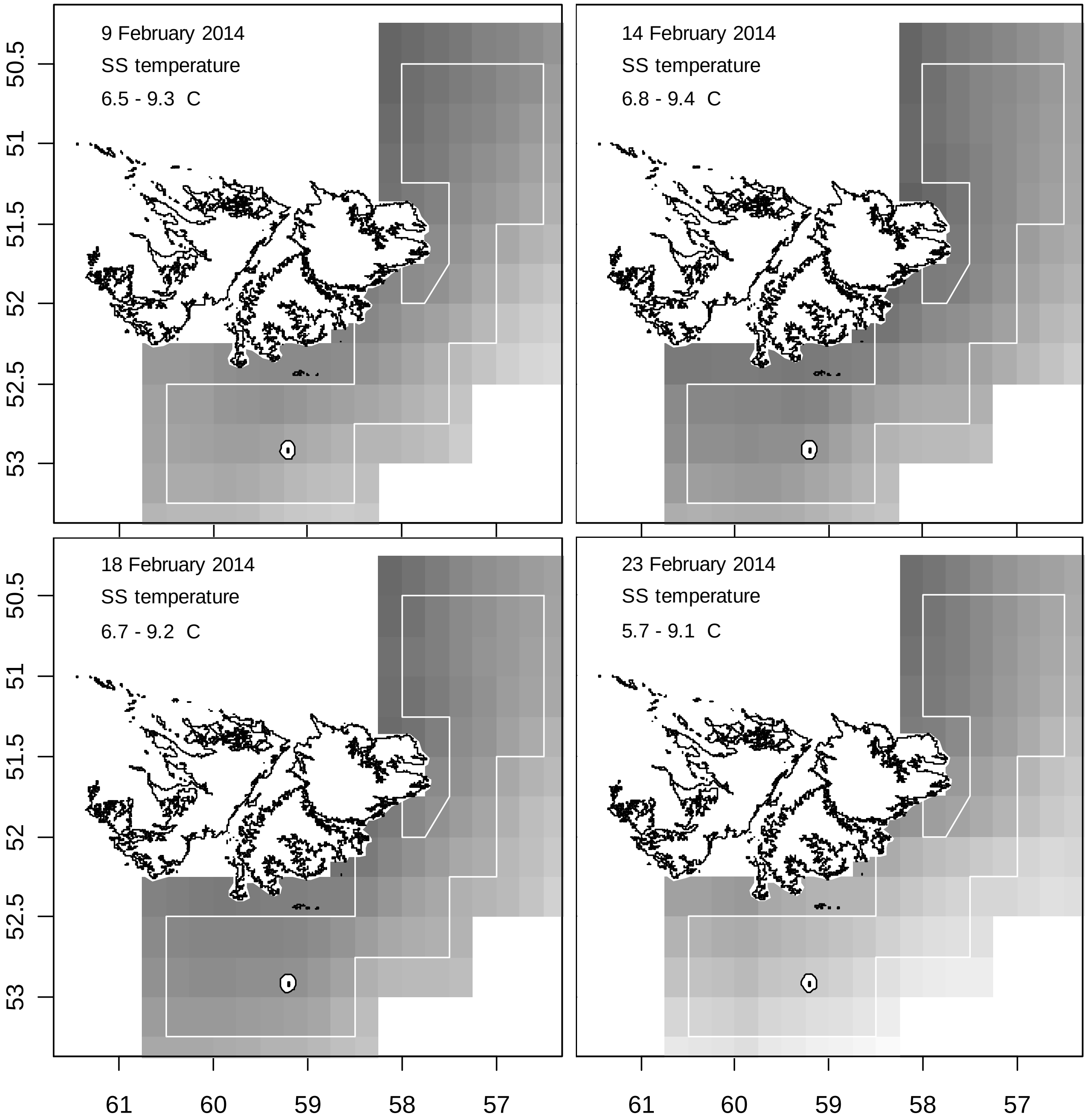


Figure 4. Sea surface temperature data at 0.25° resolution, from AVHRR observations, on four days of the survey period.

CTD measurements were not made on this survey. A sea surface temperature reading was taken by the FIFD observer for every trawl, and bottom temperatures were recorded from the vessel's net sounder or trawl door sensor gear array. Additionally, sea wind and sea surface temperatures on a daily time resolution and 0.25° grid were obtained from the NOAA National Climatic Data Center websites. Sea wind data are blended observations from multiple satellites with wind speed (m/s) resolved into north-south and east-west vectors (Zhang et al., 2006). Sea surface temperature data are observations from the Advanced Very High Resolution Radiometer (AVHRR) (Reynolds et al., 2007). Four days across the survey period are shown for illustration in Figures 3 and 4.

Biological analyses

Random samples of approximately 150 *Loligo* were collected from the factory at all trawl stations (as far as available). Biological analysis at sea included measurements of the dorsal mantle length (ML) rounded down to the nearest half-centimetre, sex, and maturity stage. The length-weight relationship $W = \alpha \cdot L^{\beta}$ (Froese, 2006) for *Loligo* was calculated by optimization from a subset of individuals that were weighed as well as measured. Length-weight relationship difference between males and females was evaluated using a log-likelihood ratio test (Mooij et al., 1999). Additional specimens of *Loligo* were collected according to area stratification (north, central, south) and depth (shallow, medium, deep), and frozen for statolith extraction and age analysis (Arkhipkin, 2005). *Illex argentinus* and *Martialia hyadesi* squid specimens were also kept for statolith analysis. Southern blue whiting (*Micromesistius australis*), icefish (*Champsocephalus esox*), yellow rock cod (*Patagonotothen guntheri*), driftfish (*Icichthys australis*), redfish (*Sebastes oculatus*), small flounder (*Thysanopsetta naresi*) and largemouth flounder (*Mancopsetta milfordi*) were taken for otolith analysis. Rock cod, slender tuna (*Allothunnus fallai*), red cod (*Salilota australis*), butterfish (*Stromateus brasiliensis*), kingclip (*Genypterus blacodes*), Patagonian hake (*Merluccius australis*) and skates (Rajidae) were length-frequency measured. Spiral valve samples from porbeagle (*Lamna nasus*) were collected for a parasitology study by the University of Otago and SAERI (Randhawa and Brickle, 2011).

Results

Catch rates and distribution

The survey started with fixed-station trawls in the north of the Loligo Box and proceeded south, reaching the furthest south-west of the survey area on the 9th day, then turning back to complete the final day's fixed-station trawls and the adaptive trawls on a generally north-east course. Weather was good throughout the survey and a schedule of 4 scientific trawls per day was maintained. Two trawls were re-located because the scheduled track ran across bad ground, and three trawls were shortened because the net was filling excessively with medusae (*Chrysaora*) or blue whiting (Appendix Table A1). In total 60 scientific trawls were recorded during the survey: 39 fixed station trawls catching 31.22 t *Loligo* and 21 adaptive trawls catching 92.32 t *Loligo*. Fourteen optional trawls (made after survey hrs) yielded an additional 39.88 t *Loligo*, bringing the total catch for the survey to 163.42 t. The scientific catch of 123.54 t is just below median for 1st seasons (Table 1).

Average *Loligo* catch density among fixed-station trawls was 0.36 t km^{-2} north of 52º S and 1.59 t km^{-2} south of 52º S. Average *Loligo* catch density among adaptive-station trawls was 6.29 t km^{-2} north of 52º S and 6.05 t km^{-2} south of 52º S. These average catch densities again suggest that sub-area and trawl station type may be confounded with the progression of the survey (cf. Winter et al., 2013a), whereby densities increase the later they are taken in the survey as a result of the *Loligo* continuing to out-migrate. However, some trawls did have significantly lower catch densities then earlier trawls taken nearby, indicating high levels of variability in the *Loligo* distributions. For example fixed station 2-5 on Feb. 16th caught 4096 kg *Loligo* (5.93 t km^{-2}), while two days later on a track slightly deeper and more southerly adaptive station A-40 caught only 1968 kg *Loligo* (2.15 t km^{-2}) (Appendix Table A1).

Table 1. *Loligo* pre-season survey scientific catches and biomass estimates (in metric tonnes). Before 2006, surveys were not conducted immediately prior to season opening.

Year	First season			Second season		
	No. trawls	Catch	Biomass	No. trawls	Catch	Biomass
2006	70	376	10213	52	240	22632
2007	65	100	2684	52	131	19198
2008	60	130	8709	52	123	14453
2009	59	187	21636	51	113	22830
2010	55	361	60500	57	123	51754
2011	59	50	16095	59	276	51562
2012	56	128	30706	59	178	28998
2013	60	52	5333	54	164	36283
2014	60	124	34673			

Biomass estimation

Overall 51% of 15-minute trawl intervals were assigned *Loligo* positive catch densities based on the acoustic marks. Geostatistical modelling of the positive catch densities and presence / absence had consistent spatial correlations only up to a distance of approx. 160 km (Figure 5). Similar to the previous 1st season (Winter et 2013a), both variograms showed two spatial correlation peaks about the same distance

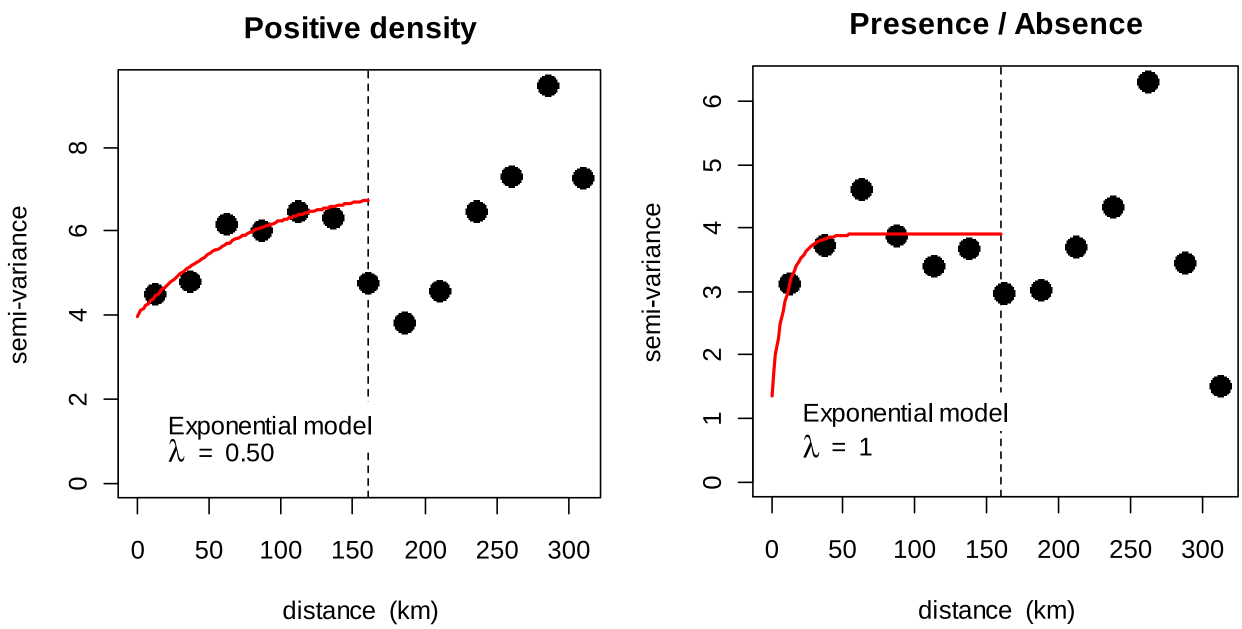


Figure 5. Empirical variogram (black points) and model variogram (red line) of *Loligo* positive catch density distributions (left) and presence / absence (right). Both model variograms were fit to a maximum distance of 160 km (dotted vertical lines).

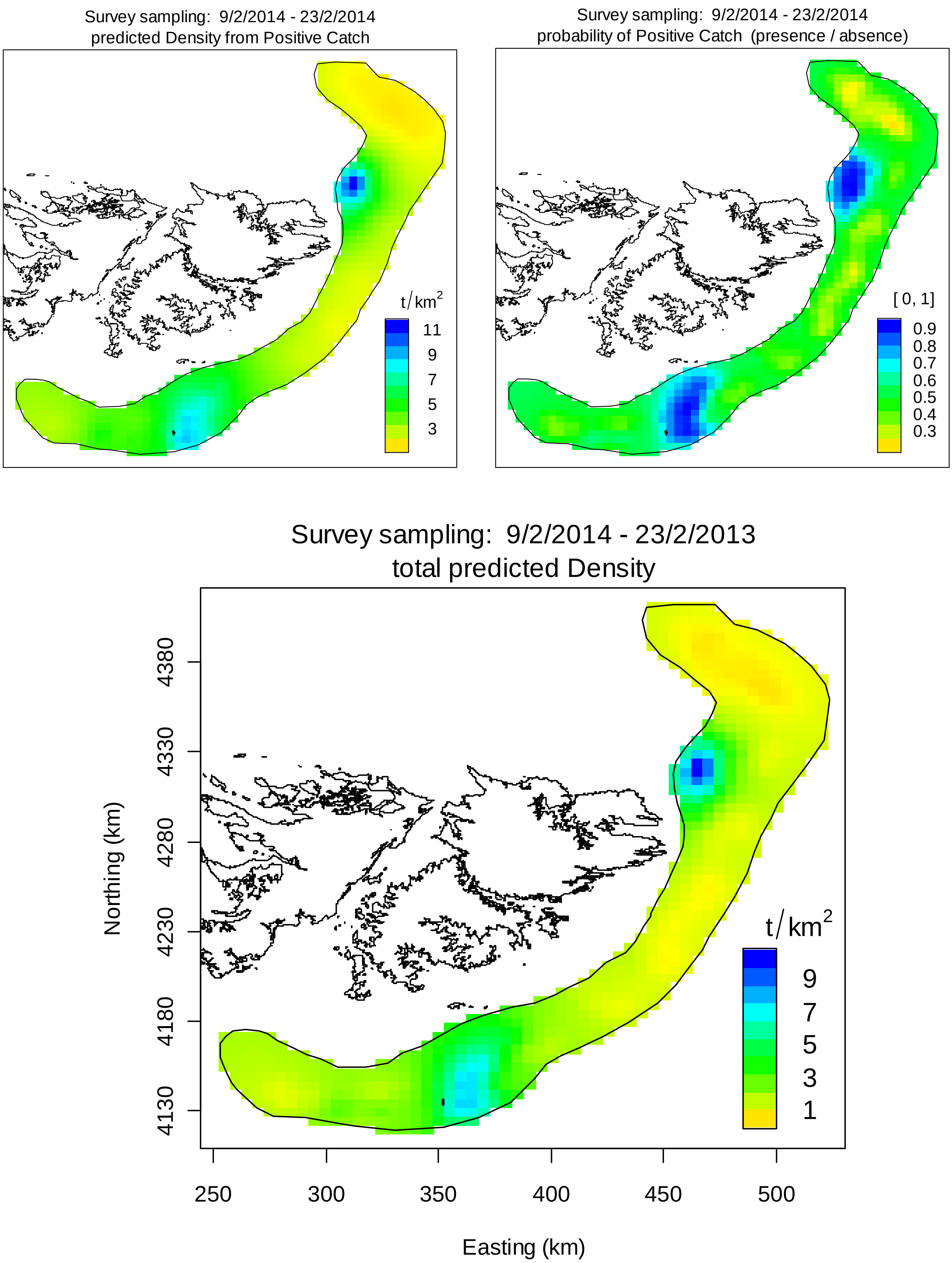


Figure 6. *Loligo* density estimates per 5 × 5 km area units. Top left (A): catch density distribution from variogram model of positive catches. Top right (B): probability of positive catch modelled from linear extrapolation of presence/absence. Main plot (C): predicted density = A × B. For calculating geostatistical estimates, coordinates were converted to WGS 84 projection in UTM sector 21F using Quantum GIS software (www.qgis.org).

apart as the two centres of high *Loligo* catch density (Figure 2). Geostatistical methods were originally designed for mineral deposits (Krige, 1951), and have been applied to fisheries primarily for regular patterns of unrepeated acoustic transects (Petitgas, 1993; Maravelias et al., 1996; Honkalehto et al., 2002). The format of the FIFD *Loligo* surveys, combining fixed and adaptive trawl stations, overlays temporal variability on the spatial variability as trawls may irregularly return to prior areas. It is therefore expected that the model variograms fit relatively imprecisely (Figure 5). As such, the best variogram fit for positive catch densities was obtained with an exponential model function and $\lambda = 0.50$ Box-Cox transformation of catch densities (Figure 5, left). The presence/absence variogram was also fit to an exponential model function, with $\lambda = 1$ Box-Cox transformation (no transformation); as required for binomial error distribution (Figure 5, right).

Loligo biomass in the fishing area was estimated by the combined geostatistical model at 34,673 tonnes, with a 95% confidence interval of [22,182 to 47,762 t]. Of this estimated total, 13,096 t [5,191 to 21,491 t] were north of 52 ºS, and 21,577 t [12,045 to 31,618 t] were south of 52 ºS. The total estimate of 34,673 t was the highest 1st season estimate since 2010, and approximately equal to the 1st season 2012 estimate (adjusted for differences in fishing area; Winter et al., 2012a) which had a slightly higher catch total at 128 vs. 124 t (Table 1). Notably, the 1st season 2014 estimate was nearly 4× higher than the 1st season 2008 estimate which had an even higher catch total at 130 t (Table 1). But in the 1st season 2008 survey *Loligo* densities were strongly concentrated only in the south (Payá, 2008), and did not reveal the high-density locus north-east, around grids XPAP / XPAQ, that has been encountered in 1st season surveys since 2011 (Figure 6; Winter et al., 2011; 2012a; 2013a).

Biological data

Fifty-nine taxa were identified in the catches (Appendix Table A2), of which *Loligo* made up 30.8% by weight, higher than 1st season 2013 but lower than 1st season 2012 (Winter et al., 2012a, 2013a). Medusae (mainly *Chrysaora* sp., and some *Aurelia* sp.) made up 21.7% of the catch by weight – representing the 2nd-highest group (Table A2) – and reflecting an increasing trend since at least 1st season 2012 (Winter et al., 2012a; 2012b; 2013a; 2013b). 9392 *Loligo* were measured for length and maturity (3140 M, 6252 F), of which 631 were also weighed (226 M, 405 F).

The optimized model fit of the *Loligo* length-weight relationship for males and females combined resulted in parameters (± 1 sd) $\alpha = 0.17004 \pm 0.01127$ and $\beta = 2.25139 \pm 0.02661$ (Figure 7). Optimized separately, male and female data gave significantly although narrowly different length-weight relationships ($\chi^2 = 30.1$, $p < 0.001$), characterized by females having higher weight per mantle length throughout the range of sampled lengths (Figure 7).

Loligo size and maturity distributions north and south of 52° S are plotted in Figure 8. All four *Loligo* distributions (male and female, north and south) had modal mantle lengths of 12 cm, and the south distributions additionally had saddles at 10 cm, resulting in only 3.2% of males and 4.9% of females in the south being <10 cm, whereas 11.7% of males and 6.4% of females north were <10 cm. Over ¾ of all *Loligo* (78.4% males and 75.6% females) were maturity 2. A higher proportion of males than females consisted of older (maturity 4 or 5) individuals: 4.3% vs. 1.0%. Older females were predominantly encountered north (32 of 42 maturity 4s and 22 of 23 maturity 5s), but older males were more evenly distributed (54 of 125 maturity 4s and 8 of 11 maturity 5s).

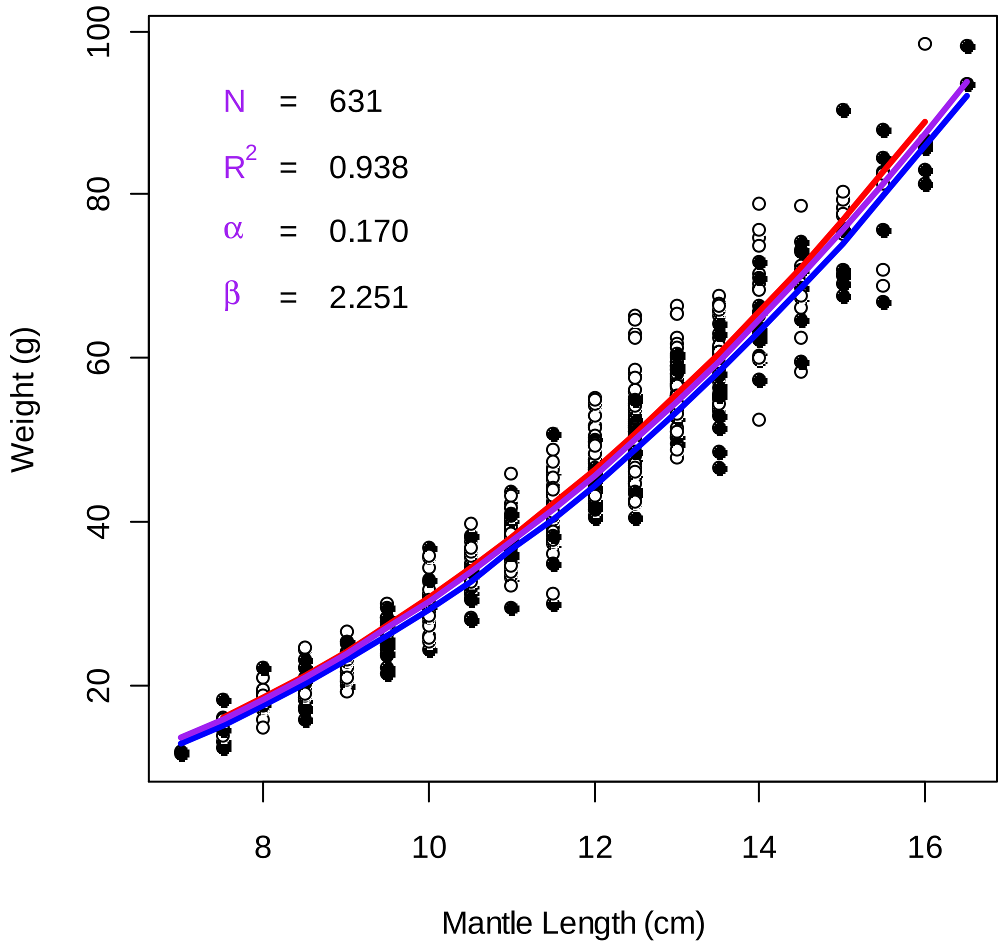
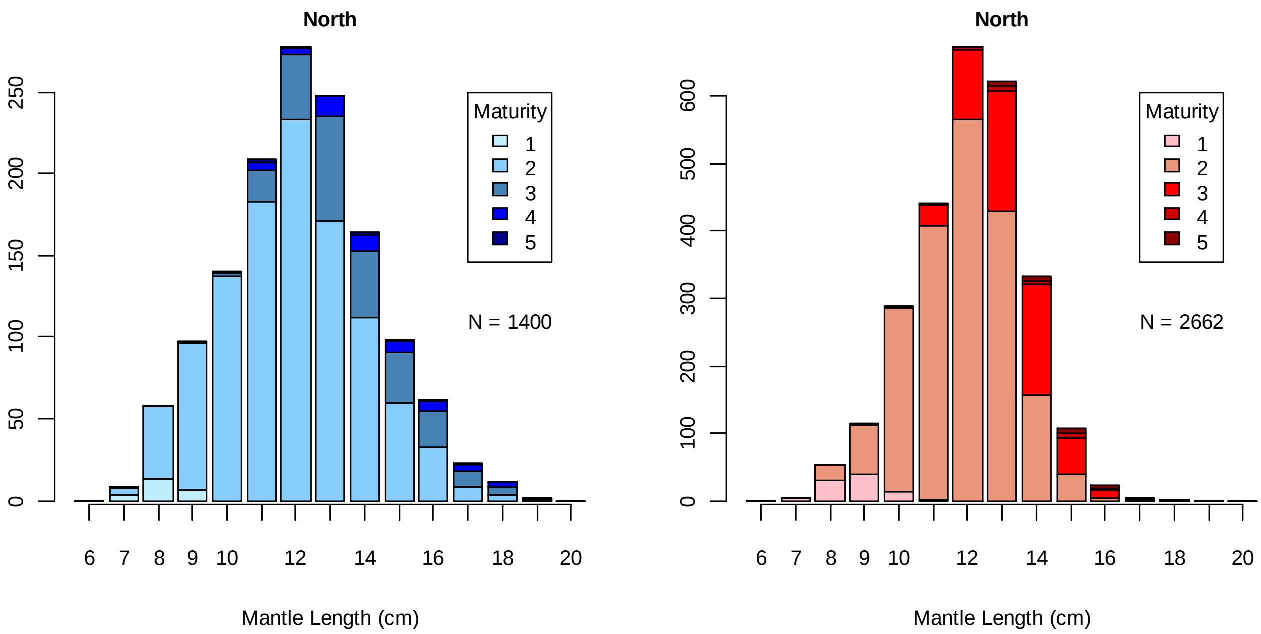
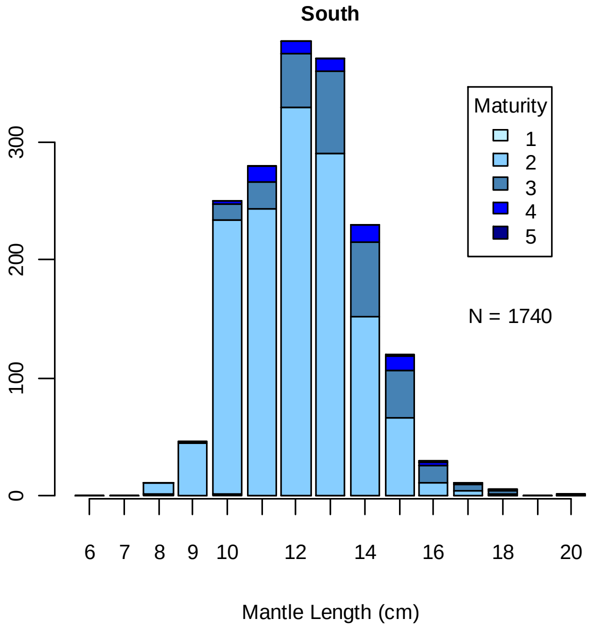


Figure 7. Length-weight relationship of *Loligo* sampled during the survey. Red: female, blue: male, purple: combined. Parameters refer to the combined relationship.





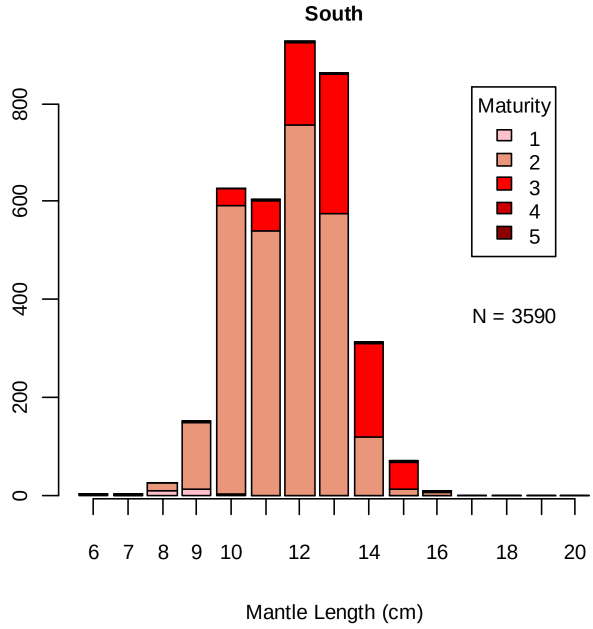


Figure 8. Length-frequency distributions by maturity stage of male (blue) and female (red) *Loligo* from trawls north (top) and south (bottom) of latitude 52 ºS.

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Appendix

Table A1. Survey stations with total *Loligo* catch. Time: local (Stanley, F.I.), latitude: °S, longitude: °W.

Transect Station	Obs Code	Date	Start Time	Start Lat	Start Lon	End Time	End Lat	End Lon	Depth (m)	*Loligo* (kg)
14 - 39	535	09/02/2014	07:00	50.52	57.51	08:45	50.60	57.37	253	2.25
14 - 38	536	09/02/2014	09:52	50.66	57.44	12:21	50.54	57.59	140	29
14 - 37	537	09/02/2014	13:36	50.68	57.51	14:18	50.72	57.47	136	[A, B] 0.00
13 - 34	538	09/02/2014	15:12	50.79	57.42	16:55	50.90	57.41	132	10.00
13 - 36	539	10/02/2014	06:59	50.78	57.05	08:30	50.71	57.16	272	[C] 5.55
13 - 35	540	10/02/2014	09:36	50.74	57.27	11:47	50.84	57.09	133	3.10
12 - 33	541	10/02/2014	12:31	50.86	57.02	14:27	50.96	56.90	124	4.51
12 - 32	542	10/02/2014	15:22	50.97	56.95	17:14	50.87	57.06	119	5.70
11 - 31	543	11/02/2014	07:05	51.16	56.97	08:58	51.26	57.08	144	60
11 - 30	544	11/02/2014	09:52	51.24	57.16	11:57	51.14	57.03	129	[A] 280
11 - 29	545	11/02/2014	12:54	51.16	57.14	14:57	51.24	57.29	115	1140
10 - 26	546	11/02/2014	16:44	51.46	57.46	18:55	51.58	57.44	130	1760
9 - 24	547	12/02/2014	07:11	51.83	57.48	08:46	51.92	57.55	168	[B] 160
9 - 25	548	12/02/2014	09:47	51.95	57.49	11:52	51.82	57.38	227	5.00
10 - 28	549	12/02/2014	13:29	51.61	57.24	15:20	51.49	57.19	229	1.83
10 - 27	550	12/02/2014	16:28	51.45	57.28	18:29	51.54	57.33	143	49
8 - 23	551	13/02/2014	07:08	52.17	57.60	09:07	52.27	57.74	266	3.50
8 - 22	552	13/02/2014	10:07	52.24	57.84	12:00	52.15	57.69	195	6.71
8 - 21	553	13/02/2014	12:58	52.14	57.80	14:58	52.23	57.97	138	700
7 - 18	554	13/02/2014	16:31	52.34	58.20	18:37	52.44	58.35	147	720
7 - 19	555	14/02/2014	07:08	52.45	58.26	09:03	52.36	58.10	185	280
7 - 20	556	14/02/2014	10:05	52.39	57.95	12:02	52.48	58.09	278	22.00
6 - 17	557	14/02/2014	15:08	52.71	58.63	17:06	52.61	58.46	241	160
6 - 16	558	14/02/2014	17:59	52.59	58.54	20:08	52.70	58.69	160	580
6 - 15	559	15/02/2014	07:03	52.55	58.60	09:03	52.61	58.80	136	4140
5 - 12	560	15/02/2014	10:07	52.71	58.89	12:14	52.80	59.07	120	6760
4 - 10	561	15/02/2014	12:54	52.80	59.11	15:00	52.81	59.31	108	1570
5 - 13	562	15/02/2014	16:24	52.87	58.99	18:30	52.81	58.78	146	1600
5 - 14	563	16/02/2014	07:03	52.84	58.73	09:11	52.89	58.95	206	2140
4 - 11	564	16/02/2014	10:09	52.97	59.07	12:23	53.01	59.31	264	60
3 - 8	565	16/02/2014	13:24	52.96	59.40	15:19	52.95	59.60	179	2920
2 - 5	566	16/02/2014	16:08	52.93	59.66	18:03	52.92	59.86	171	4096
1 - 2	567	17/02/2014	07:02	52.87	60.00	08:55	52.81	60.21	199	328
0 - 1	568	17/02/2014	09:59	52.79	60.36	11:54	52.88	60.22	254	7.50
1 - 3	569	17/02/2014	12:44	52.89	60.17	14:43	52.93	59.95	233	636
2 - 6	570	17/02/2014	15:27	52.94	59.88	17:26	52.98	59.66	238	369
2 - 4	571	18/02/2014	07:03	52.83	59.81	09:10	52.85	59.58	162	249
3 - 7	572	18/02/2014	10:07	52.83	59.61	12:04	52.83	59.40	150	156
3 - 9	573	18/02/2014	13:28	53.00	59.39	15:30	52.99	59.60	243	196
A - 40	574	18/02/2014	16:21	52.95	59.68	18:45	52.92	59.94	185	1968
A - 41	575	19/02/2014	07:05	52.99	59.32	09:15	52.96	59.09	171	9430
A - 42	576	19/02/2014	10:05	52.95	59.07	12:19	52.87	58.88	156	9740
A - 43	577	19/02/2014	13:05	52.87	58.92	15:07	52.95	59.09	152	5529
A - 44	578	19/02/2014	15:52	52.95	59.10	17:59	52.97	59.29	168	3349
A - 45	579	20/02/2014	07:08	52.60	58.74	09:01	52.61	58.93	124	1286
A - 46	580	20/02/2014	10:03	52.69	59.01	12:10	52.81	59.09	114	4607
A - 47	581	20/02/2014	13:00	52.79	59.05	15:12	52.68	58.87	123	5990
A - 48	582	20/02/2014	16:35	52.83	58.79	18:43	52.91	58.97	153	2927
A - 49	583	21/02/2014	07:03	52.12	57.77	09:05	52.01	57.66	139	129
A - 50	584	21/02/2014	10:03	51.91	57.60	12:06	51.79	57.49	141	349
A - 51	585	21/02/2014	13:01	51.71	57.44	15:10	51.56	57.41	136	141
A - 52	586	21/02/2014	16:18	51.46	57.44	18:29	51.33	57.43	115	4612
A - 53	587	22/02/2014	07:02	51.33	57.42	09:06	51.23	57.28	110	1488
A - 54	588	22/02/2014	10:04	51.21	57.41	12:10	51.08	57.48	108	4106

A - 55	589	22/02/2014	13:08	51.16	57.44	15:20	51.31	57.44	99	8428
A - 56	590	22/02/2014	16:05	51.31	57.43	18:33	51.15	57.34	102	3466
A - 57	591	23/02/2014	06:58	51.09	57.70	08:57	51.22	57.63	116	605
A - 58	592	23/02/2014	10:05	51.19	57.46	12:11	51.32	57.47	94	13970
A - 59	593	23/02/2014	13:10	51.31	57.49	15:14	51.17	57.45	94	7770
A - 60	594	23/02/2014	16:07	51.18	57.44	18:37	51.31	57.41	101	2427

A: Trawl moved south of scheduled track because of rough ground.
B: Trawl stopped short because net was filling with jellyfish.
C: Trawl stopped short because net was filling with blue whiting.

Table A2. Survey total catches by species / taxon.

Species Code	Species / Taxon	Total catch (kg)	Total catch (%)	Sample (kg)	Discard (kg)
LOL	*Doryteuthis gahi*	123533	30.8	490	0
MED	Medusae sp.	86890	21.7	0	86890
PAR	*Patagonotothen ramsayi*	76755	19.2	400	66740
BLU	*Micromesistius australis*	69370	17.3	1	43750
WHI	*Macruronus magellanicus*	29160	7.3	0	18
BAC	*Salilota australis*	5101	1.3	28	202
GRF	*Coelorhynchus fasciatus*	2090	0.5	0	2090
PTE	*Patagonotothen tessellata*	1480	0.4	0	1480
CGO	*Cottoperca gobio*	950	0.2	0	950
RBR	*Bathyraja brachyurops*	793	0.2	45	310
ING	*Moroteuthis ingens*	444	0.1	0	444
TOO	*Dissostichus eleginoides*	404	0.1	51	0
RGR	*Bathyraja griseocauda*	334	0.1	12	11
DGS	*Squalus acanthias*	322	0.1	0	322
SQT	Ascidiacea	321	0.1	0	321
SPN	Porifera	271	0.1	0	271
RBZ	*Bathyraja cousseauae*	263	0.1	9	38
RAL	*Bathyraja albomaculata*	251	0.1	18	166
EEL	*Iluocoetes fimbriatus*	242	0.1	0	242
GRC	*Macrourus carinatus*	231	0.1	0	231
KIN	*Genypterus blacodes*	230	0.1	11	0
RFL	*Zearaja chilensis*	227	0.1	13	5
RMC	*Bathyraja macloviana*	183	<0.1	11	183
RPX	*Psammobatis* spp.	134	<0.1	4	134
PAT	*Merluccius australis*	73	<0.1	20	0
RSC	*Bathyraja scaphiops*	67	<0.1	14	51
RMG	*Bathyraja magellanica*	64	<0.1	11	64
SAR	*Sprattus fuegensis*	54	<0.1	0	54
GOC	*Gorgonocephalas chilensis*	53	<0.1	0	53
ANM	Anemone	42	<0.1	0	42
ILL	*Illex argentinus*	40	<0.1	13	27
CHE	*Champsocephalus esox*	38	<0.1	3	4
ALF	*Allothunnus fallai*	36	<0.1	36	0
DGH	*Schroederichthys bivius*	26	<0.1	0	26
ZYP	*Zygochlamys patagonica*	18	<0.1	0	18
RMU	*Bathyraja multispinis*	14	<0.1	7	0
RDO	*Amblyraja doellojuradoi*	9	<0.1	0	9
NEM	*Neophyrnichthys marmoratus*	8	<0.1	0	8
MLA	*Muusoctopus longibrachus akambei*	7	<0.1	0	7
STA	*Sterechinus agassizi*	6	<0.1	0	6
COG	*Patagonotothen guntheri*	6	<0.1	0	5

COG	*Patagonotothen guntheri*	6	<0.1	0	5
PYM	*Physiculus marginatus*	5	<0.1	0	5
COT	*Cottunculus granulosus*	5	<0.1	0	5
AST	Asteroidea	5	<0.1	0	5
ICA	*Icichthys australis*	4	<0.1	2	2
OCM	*Octopus megalocyathus*	3	<0.1	0	3
RED	*Sebastes oculatus*	2	<0.1	2	0
THO	Thouarellinae	1	<0.1	0	1
RPA	*Bathyraja papilionifera*	1	<0.1	1	1
MYX	Myxine spp.	1	<0.1	0	1
EUO	*Eurypodius longirostris*	1	<0.1	0	1
BUT	*Stromateus brasiliensis*	1	<0.1	1	1
THN	*Thysanopsetta naresi*	<0.1	<0.1	0	0
SRP	*Semirossia patagonica*	<0.1	<0.1	0	0
POA	*Porania antarctica*	<0.1	<0.1	0	0
ODM	*Odontocymbiola magellanica*	<0.1	<0.1	0	0
MIR	Mirostenella sp.	<0.1	<0.1	0	0
AUC	*Austrocidaris canaliculata*	<0.1	<0.1	0	0
ALC	Alcyoniina	<0.1	<0.1	0	0
		400,569		1,203	205,197