2024 2nd Pre-Season Assessment Survey

Falkland calamari

(*Doryteuthis gahi*)

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Summary

1) A stock assessment survey for *Doryteuthis gahi* (Falkland calamari) was conducted in the Loligo Box from 11th to 22nd July 2024. A total of 47 scientific trawls were performed during the survey; 39 fixed-station trawls and 8 adaptive-station trawls. The scientific catch of the survey was 49.45 tonnes *D. gahi*.
2) An estimate of 13, 679.01 tonnes *D. gahi* (95% confidence interval: 7, 704 to 19, 814 tonnes) was calculated for the fishing zone by inverse distance weighting. Of the total, 2, 744.35 tonnes were estimated north of 52 ºS, and 10, 934.66 tonnes were estimated south of 52 ºS. The proportion north (20.1%) was the lowest for a 2nd pre-season survey estimate since 2017.
3) *D. gahi* had significantly greater average mantle lengths and maturities south of 52˚S compared with individuals north of 52ºS. Males north: mean mantle length 10.24 cm; mean maturity stage 2.97, south: mantle length 10.90 cm; maturity 3.22. Females north: mantle length 9.57 cm; maturity 2.08, south: mantle length 9.96 cm; maturity 2.15. Mantle length distributions suggested that it is unlikely that immigration occurred throughout the survey.
4) A total of 93 taxa were identified in the catches. *D. gahi* was the second largest species group at 32.7% of total catch by weight; the lowest percentage on record for 2nd pre-seasons. Common hake (49.89%), rock cod (11.16%), red cod (1.6%), frogmouth (0.7%), and toothfish (0.54%) were the only other taxa comprising ≥0.5% of total survey catch. Biological measurements and samples were taken from *D. gahi*, rock cod, toothfish, hoki, southern blue whiting, common hake, southern hake, and several non-commercial species.

Introduction

A stock assessment survey for *Doryteuthis gahi* (Falkland calamari – Patagonian longfin squid – colloquially *Loligo*) was carried out by the FIFD on-board the fishing vessel *Robin M Lee* from the 11th to 22nd July 2024; experimental license FK0036E24. This survey continues the series of surveys that have, since February 2006, been conducted immediately prior to season openings to estimate *D. gahi* stock available to commercial fishing at the start of the season, and to initiate the in-season management model based on depletion time series of the stock.

Objectives of the survey were to:

1) Estimate the biomass and spatial distribution of *D. gahi* on the fishing grounds at the onset of the 2nd fishing season, 2024.
2) Estimate the biomass and distribution of common rock cod (*Patagonotothen ramsayi*) and other commercial species in the 'Loligo Box', for continued monitoring of these stocks in parallel to the finfish research survey.
3) Estimate the bycatch of toothfish (*Dissostichus eleginoides*) in the *D. gahi* fishery.
4) Collect biological information on *D. gahi*, rock cod, toothfish and opportunistically sample other fish and invertebrates taken in the trawls.

The survey was designed to cover the 'Loligo Box' fishing zone (Arkhipkin et al. 2008, 2013) that extends along the shelf break across the southern and eastern part of the Falkland Islands Interim Conservation Zone, plus two grids directly to the north. The delineation of the Loligo Box (Figure 1) represents an area of approximately 31,517.9 km^2, subtracting the 3-nautical mile exclusion zone around Beauchêne Island.

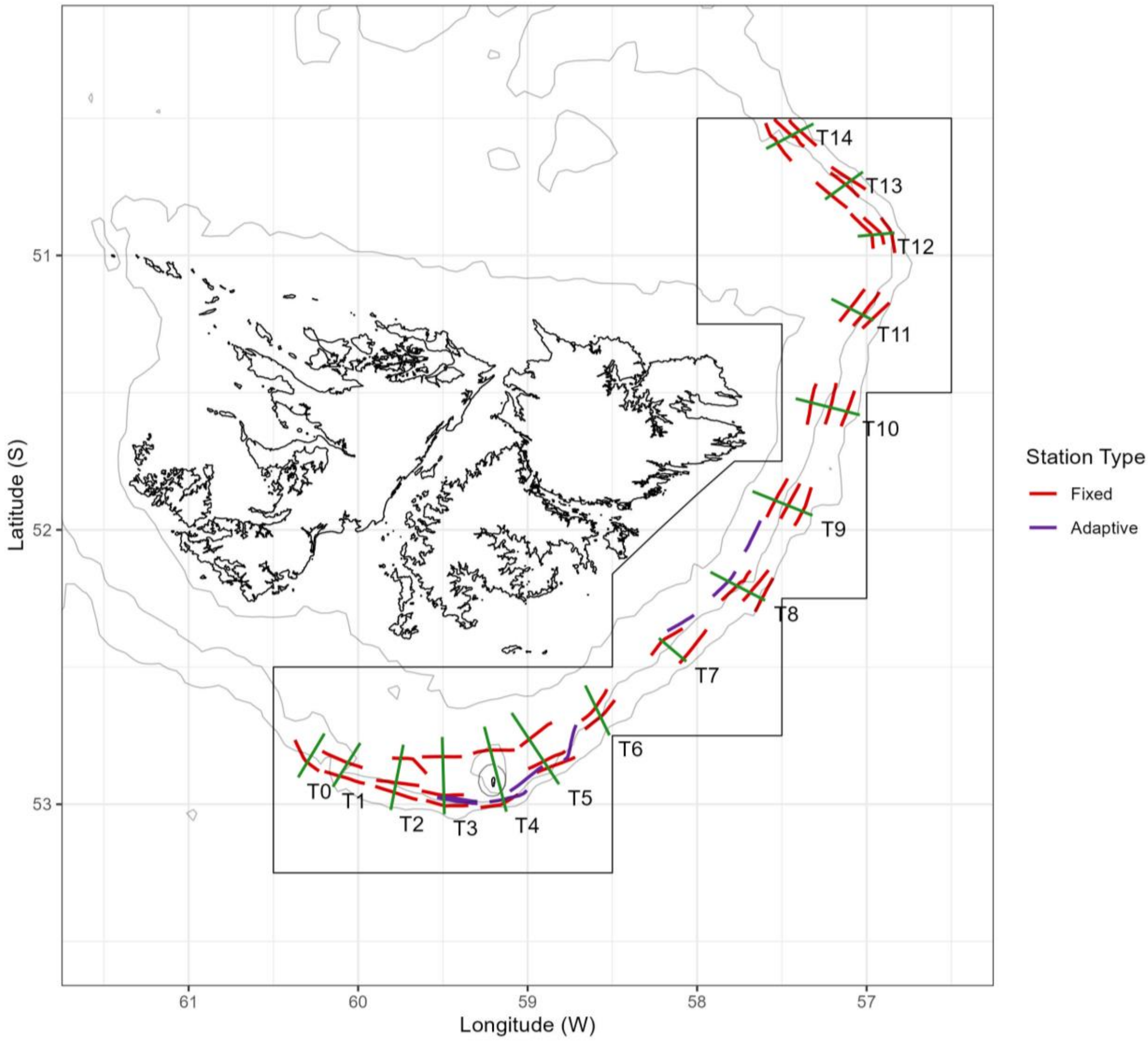

Figure 1. Survey transects (green lines), fixed-station trawls (red), adaptive-station trawls (purple), and extra north station trawls (blue) sampled during the 1st pre-season 2024 survey. Boundaries of the 'Loligo Box' and Beauchêne Island exclusion zone, are in black.

F/V *Robin M Lee* is a Falkland Islands - registered stern trawler of 70 m length, 2036 gt, and 3000 main engine bhp. Like all vessels employed for pre-season surveys, *Robin M Lee* operates regularly in the Falkland Islands calamari fisheries, and used its commercial trawl gear for the survey catches. *Robin M Lee* was previously employed for the 1st pre-season survey in 2013 and a post-season survey in 2015 (Winter et al., 2013; Jones & Shcherbich, 2015). The following FIFD personnel participated in the 2nd pre-season 2024 survey:

Role	Name
Survey lead scientist	Irina Chemshirova
Fishery scientist	Peter Hoyer
Fishery scientist	Zhanna Shcherbich
Fishery scientist	Aina Amukwaya

Methods
Sampling procedures

The regular survey plan included 39 fixed-station trawls located on a series of 14 transects perpendicular to the shelf break around the Loligo Box (Figure 1), followed by 8 adaptive-station trawls selected to increase the precision of *D. gahi* biomass estimates in high-density or high-variability locations. The survey was shortened by three days, thus limiting the number of adaptive trawls. The *Robin M Lee* was required to participate in a search and rescue mission in Falkland Islands waters. This dual approach ensures that the scientific requirements of randomization and repeatability are met (via fixed stations) and the spatio-temporal variability of the *D. gahi* population is captured (via adaptive stations) (Gawarkiewicz and Malek Mercer 2018). All trawl tracks were designed for an expected duration of two hours each. All trawls were bottom (demersal) trawls. During the progress of each trawl, GPS latitude, GPS longitude, bottom depth, bottom temperature, net height, cable length, trawl door spread, and trawl speed were recorded on the ship's bridge in 15-minute intervals, and the quantity and quality of acoustic marks observed on the net-sounder were scored visually on a scale from 0 to 10. Following the procedure described in Roa-Ureta and Arkhipkin (2007), the acoustic marks were used to apportion the *D. gahi* catch of each trawl to the 15-minute intervals and thereby increase spatial resolution of the catches. For small catches acoustic apportioning cannot be assessed with accuracy, and any *D. gahi* amounts <100 kg were iteratively aggregated by adjacent intervals. For example, if the total *D. gahi* catch in a trawl was <100 kg it was assigned to one interval; the middle one.

Catch estimation

The catch of every trawl was processed by the factory crew and retained catch weight of *D. gahi*, by size category, was calculated from the number of standard-weight blocks of frozen squid recorded by the factory supervisor. Catch weights of commercially valued fish species were also recorded from the number of blocks of frozen product, but without size categorization. Processed product weights were scaled to whole weights using standard conversion factors (FIG 2016). Total catch composition per trawl, including commercially unvalued species, damaged fish, and undersized fish, was estimated using a combination of visual assessment and basket sample data. Baskets (30 – 35 kg capacity) were hand-sorted by FIFD survey personnel, and species weighed separately. The aggregate quantities of bycatch species in baskets were proportioned to the *D. gahi* catch of the whole trawl. Scarce bycatch species, and all toothfish, were collected and weighed entirely from each trawl. Non-commercial bycatch weights were then added to the factory production weights (as applicable) to give total catch weights of all fish and squid.

Biomass calculation

Biomass density estimates of *D. gahi* per trawl were calculated as catch weight divided by swept area. The calculation of biomass density thus assumes a catchability coefficient = 1, as commonly used in fishery surveys (Somerton et al. 1999)[a]. Swept area equals the product of trawl distance × trawl width, and 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[b]. Trawl width was derived from the distance between trawl doors (determined per interval) according to the equation (Seafish 2010):

trawl width = (door distance × footrope length) / (footrope length + bridle + sweep)

Measurements of *Robin M Lee*'s trawl, provided by the vessel master, were as follows: footrope = 170.1 m, sweep = 135 m, bridle = 40 m.

Biomass density estimates were extrapolated to the fish stock area[c] using an inverse distance weighting algorithm (Ramos and Winter 2022). As previously, the fish stock area was

[a] Albeit more likely to underestimate than overestimate true density (Harley and Myers 2001); thus conservative.
[b] At the end of any trawl the net may continue to 'fish' for some distance as it is being hauled. Swept-area bias caused by this factor cannot be quantified but is unlikely to be substantial.
[c] The (approximate) area occupied by the fishable stock of *D. gahi*. This is largely overlapping, but not exactly equal, to the Loligo Box, which is the area that is legally open to *D. gahi* trawling.

delineated to 20,062.8 km^2, partitioned for analysis into 800 area units of 5×5 km. Forty area units with average depth either <90 m or >400 m, where calamari trawlers do not work, were assumed for this analysis to comprise zero *D. gahi*. Biomass densities from all 800 area units were averaged and multiplied by the total fish stock area for total biomass, as well as separately north and south of 52 ºS; the standard sub-area demarcation (Winter and Arkhipkin 2015).

Uncertainty of the biomass density extrapolation was estimated by hierarchical bootstrapping. For 30,000 iterations a number of survey trawls equivalent to the total number were randomly selected with replacement, and within each selected survey trawl its 15-minute intervals were randomly selected with replacement. The trawl's catch was re-proportioned according to the selected intervals' acoustic scores, thus varying the spatial distribution of the catch over that trawl track. When applicable, the aggregation of *D. gahi* amounts <100 kg (see Sampling procedures) was summed to an interval of the trawl also chosen randomly; not necessarily the middle interval. At each of the 30,000 iterations, the inverse distance weighting algorithm was re-calculated over the 5 × 5 km area units.

Biological analyses

Random samples of *D. gahi* (target n = 150, as far as available) were collected from the factory at all trawl stations. Biological analysis at sea included measurements of the dorsal mantle length rounded down to the nearest half-centimetre, sex, and maturity stage scored by inspection of the gonads. Statistical significance of sex ratio departures from 50/50, in total and by station, was evaluated with randomized re-sampling. Statistical significance of differences in mantle length and maturity stage distributions were evaluated with Kruskal-Wallis tests, non-parametric one-way analysis of variance (Kruskal and Wallis 1952).

Additional specimens of *D. gahi* were collected opportunistically according to area stratification (north, central, south) and depth (shallow, medium, deep), and frozen for statolith extraction and age analysis (Arkhipkin 2005), as well as calculation of the length-weight relationship $W = \alpha \cdot L^{\beta}$ (Froese 2006). A sample of 100 rock cod was taken at every trawl station, as far as available. All catches of toothfish were collected from all trawl stations to maximize the time series catch and biological information base for juvenile toothfish. Otoliths were taken from toothfish that corresponded to required size categories, and other fish species as available; usually the predominant fish bycatch in any trawl.

Results
Catch rates and distribution

The survey started with fixed-station trawls in the north part of the Loligo box and proceeded southward throughout the Loligo Box in the usual pattern. A schedule of 4 scientific trawls per day was maintained every day, with the exception of 22nd of July when only three trawls were carried out (Table A1), resulting in 47 scientific trawls total recorded during the survey: 39 fixed station trawls catching 35.93 tonnes *D. gahi*, 8 adaptive-station trawls catching 13.52 tonnes *D. gahi*. A total of 8 optional trawls (directed by the vessel master, after survey hours) yielded an additional 11.16 tonnes *D. gahi*, bringing the total catch for the survey to 60.98 tonnes. The scientific survey catch of 49.44 tonnes *D. gahi* is the lowest on record for a 2nd pre-season (Table 1).

Table 1. *D. gahi* 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	58	207	40090
2015	57	184	36424	53	137	25422
2016	57	65	21729	58	225	43580
2017	59	180	48785	63[A]	314	56807
2018	59[A]	115	32194	53	510	183593
2019	55	382	49618	51	298	50880
2020	59	268	27991	55	575	92194
2021	55	280	31770	59	534	77526
2022	60	421	47058	59	441	63348
2023	61[B]	549	44015	56	294	19859
2024	64	675	70334	47[C]	49	13679

[A] Includes four juvenile toothfish transect trawls.
[B] Includes four extra trawls north of the Loligo Box.
[C] Survey vessel participated in a search and rescue operation, reducing the number of survey trawls.

Average *D. gahi* catch density (Figure 2) among fixed-station trawls north of 52º S was 0.43 t km^{-2}; the lowest ever for 2nd pre-seasons. Average *D. gahi* catch density among fixed-station trawls south of 52º S was 0.91 t km^{-2}; the lowest on record since at least 2012. Average *D. gahi* catch density among adaptive-station trawls south of 52º S was 1.44 t km^{-2}; lowest on record for 2nd pre-seasons.

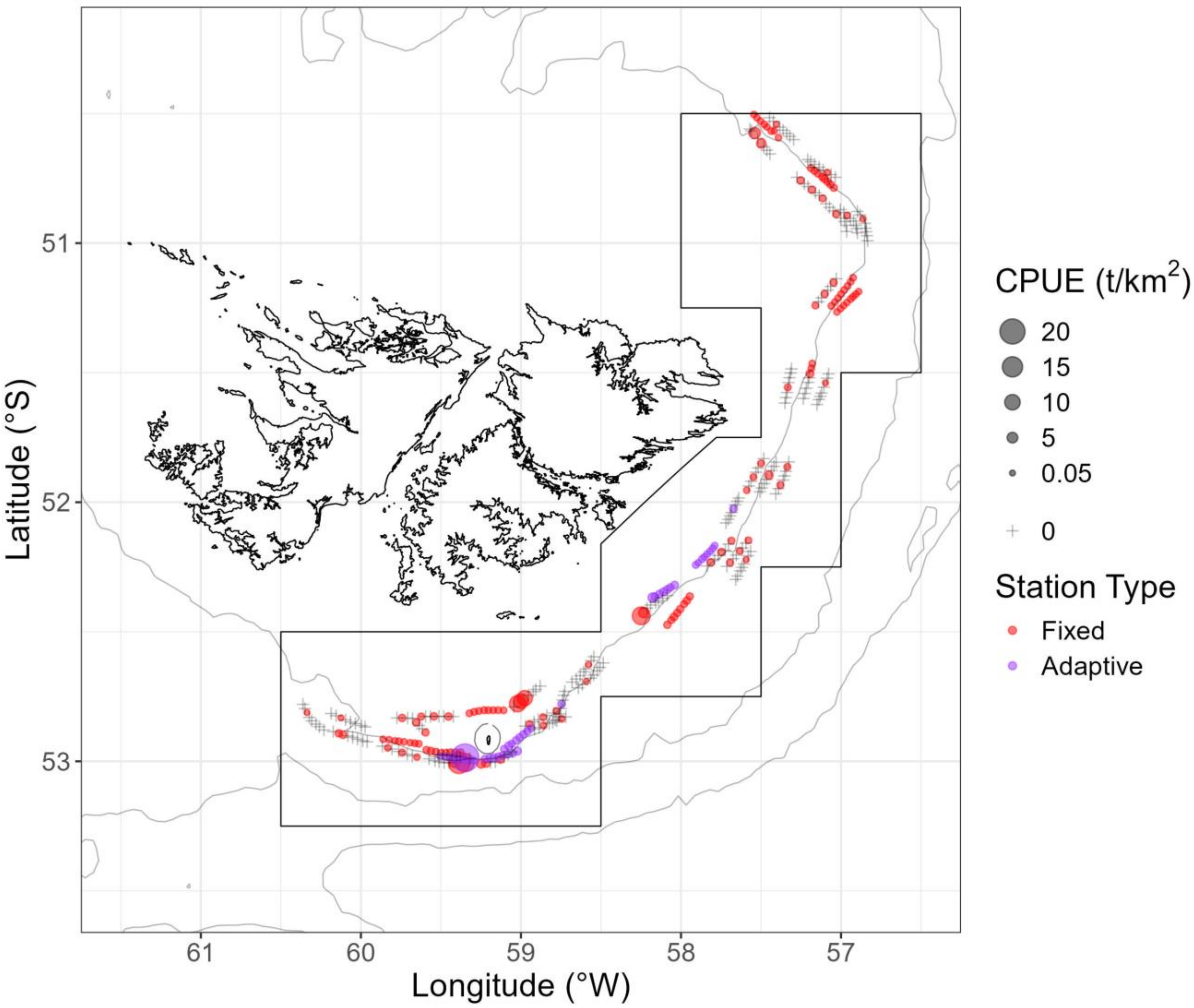

Figure 2. *D. gahi* CPUE (t/km^2) of fixed and adaptive stations per 15-minute trawl interval. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone (mostly hidden) are traced in black.

Biomass estimation

Total *D. gahi* biomass in the fish stock area was estimated at 13, 679.01[d] tonnes, with a 95% confidence interval of [7, 704.25 to 19, 814.19 tonnes]. The total biomass estimate was the lowest for a 2nd pre-season (Table 1). Partition of the estimated biomass was 2, 744.35 tonnes north [1, 911.13 to 4, 334.39 tonnes] vs. 10, 934.66 tonnes south 4, 866.34 to 16, 682.24 tonnes]. The biomass proportion north (20.1%) was the lowest for a 2nd pre-season since 2017. Within the north sub-area 50% of *D. gahi* density was aggregated in 50 of 368 5×5 km area units, and 95% of density was aggregated in 155 of the 368 5×5 km area units (Figure 3). Within the south sub-area 50% of *D. gahi* density was aggregated in 18 of 392 5×5 km area units, and 95% of density was aggregated in 143 of the 392 5×5 km area units (Figure 3).

[d] The estimate and confidence intervals are different to the initial estimate presented, as two data entry errors were subsequently found, namely an incorrect position and door distance.

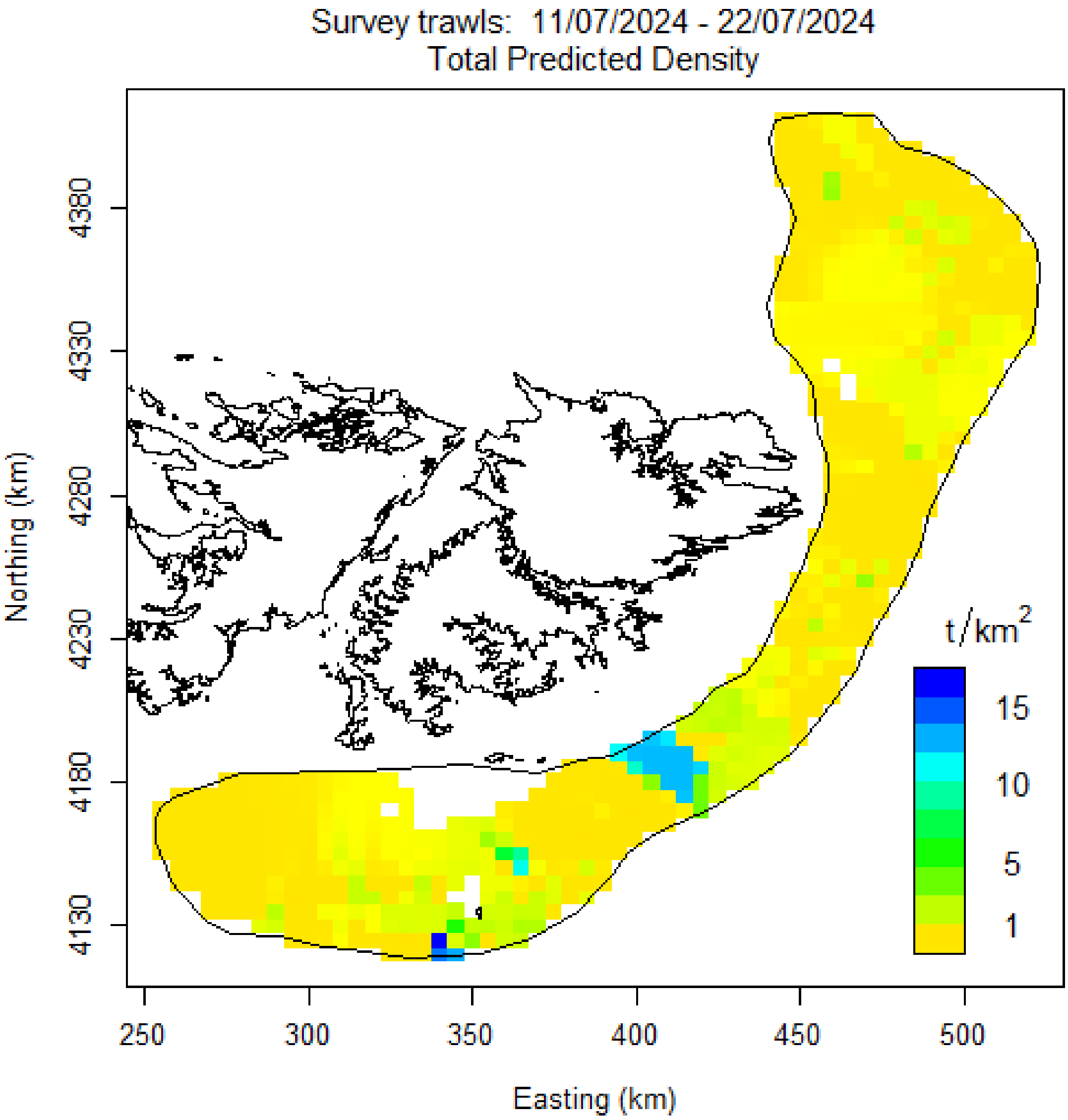

Figure 3. *D. gahi* predicted density estimates per 5 km^2 area units. Blank area units within the perimeter are either <90 or >400 m average depth. Coordinates were converted to WGS 84 projection in UTM sector 21F using the R library rgdal (proj.maptools.org).

Biological data

A total of 93 taxa were identified in the survey catches (Appendix Table A2). *D. gahi* was the second most abundant catch with 32.7% of the total (Table A2); the lowest percentage of 2nd pre-season catches since 2017 (64%). Common hake was the most predominant catch species with 49.9% of the total; the highest catch percentage in a 2nd pre-season survey since 2023 and the highest average catch per trawl (1,607 kg/trawl) for a second pre-season survey, with 2020 (1, 195 kg/trawl) having the second highest average catch per trawl of common hake. It is of note, that 96.4% of the hake was caught at stations deeper than 190 m (Figure 4A). The highest catches were near Beauchêne Island, and the northern-most part pf the Loligo Box, grid squares XVAK and XLAP, respectively (Figure 4B). Third-highest catch species was rock cod with 11.2%, the sixth-highest percentage in a 2nd pre-season survey since 2016 (13%). No other species group accounted for ≥0.5% of total catch but red cod, which made up 1.6% of the total survey catch. This can be attributed to one station, which had a catch of 1.6 tonnes, also near Beauchêne Island.

Toothfish, a highly restricted bycatch(as vessels are required to move grid square if toothfish bycatch exceeds 1.5%) had the second highest average catch rate for a 2nd pre-season at 17.45 kg per trawl, since 2015 (23.86 kg/trawl). Overall, 45.8% of the total toothfish survey catch was taken in four stations (St 984; 994; 995; 1002), all of these stations were south of 52°S. The largest single catch of toothfish (St 995; 200 kg; 24.4%) was in grid square XVAK, at the same station where the largest catches of both red cod and hake were also recorded. Additionally, upon investigation of the length-frequency of sampled individuals the range sampled was between 18 and 80 cm in total length.

During the survey 8439 *D. gahi* were measured for length and maturity (4693 males, 3746 females, from 46 trawl stations). The total sex ratio was significantly majority male ($p<0.0001$). A total of 9 individual trawls had a significant preponderance of females, whereas 19 had a significant preponderance for males. Finally, 18 individual trawls had no sex preponderance.

D. gahi mantle length and maturity distributions north and south of 52° S are presented in Figure 5. For males north: mean mantle length 10.24 cm; mean maturity stage 2.97 (on a scale of 1 to 6, Lipinski 1979), males south: mean mantle length 10.90 cm; mean maturity stage 3.22. Females north: mean mantle length 9.57 cm; mean maturity stage 2.08, females south: 9.96 cm; stage 2.15. Mean mantle lengths of males and females were smaller than the mean for both areas compared with the 2nd pre-season last year. Mantle lengths were significantly different between north and south, for females (Kruskal-Wallis test, $p<0.001$) and males (KW test, $p<0.001$). Significant difference was found in the maturity of females and males between north and south (KW test, $p<0.001$, for both).

A general additive model (GAM) was used to investigate the relationship between sampling day (representing time), mantle length, sex, latitude and longitude, and mean depth. The following was identified as the optimal model:

$$(Mantle\ Length_i) \sim \alpha\ + f(Latitude, Longitude_i) +$$
$$f(Sampling\ Day_i){:}\ Sex + f(Mean\ Depth_i){:}\ Sex + Sex_i + \varepsilon_i$$
$$\varepsilon_i \sim N(0, \sigma^2)$$

whereα is the intercept, $f(\,)$ denotes smooth term applied with penalized thin plate regression spline for Latitude and Longitude, and was varied by *Sex* for *Sampling Day* and *Mean Depth*.

The results from the GAM are presented in Table 2. Overall, mantle length significantly differed between sexes. The sampling day smoother showed an almost linear pattern for females, which showed a negligible increase over time, suggesting that there was little change of mantle length for females over the duration of the survey (Fig. 6A). The sampling day effect on the mantle length of males showed a more variable pattern; however, also showing a minor increase in mantle length over time (Fig. 6A). Overall, these findings may indicate that there were no migrations of females over the duration of the survey. If there were any migrations of males they may have been in numbers insufficient to provide a clear pattern.

The mean depth smoother, also showed a negligible increase of mantle length with increasing depth for females and males (Fig. 6B). This also indicates that it is unlikely that a migration pulse occurred during the survey. Additionally, as this species segregates by depth during the feeding period, the occurrence of larger females in deeper waters is to be expected along with male mantle length remaining consistent throughout the depth range as early in the season males tend to aggregate in shallower waters (Rodhouse et al., 2013).

Table 2. Estimated parameters of generalised additive model for mantle length presented above. edf, expected degrees of freedom; DE deviance explained

Response variable	Explanatory variable	edf	F-value	p-value	DE (%)
Mantle Length	Sex	-	858.2	<0.0001***	25.3
	Latitude, Longitude	26.53	41.31	<0.0001***	
	Sampling Day: Females	1.01	7.51	<0.01**	
	Sampling Day: Males	8.72	14.61	<0.0001***	
	Mean Depth: Females	1.00	19.12	<0.0001***	
	Mean Depth: Males	4.27	5.19	<0.05*	

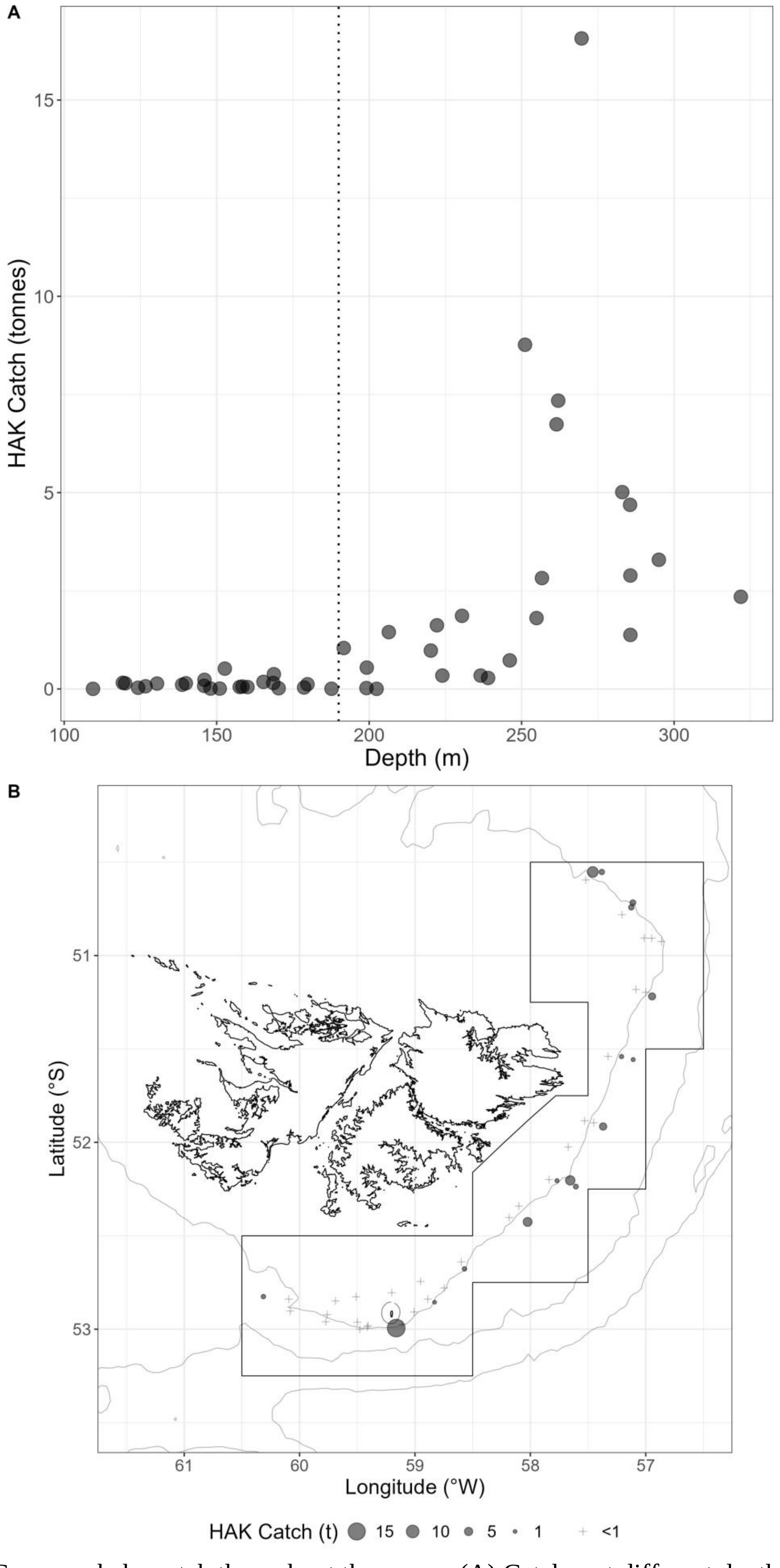

Figure 4. Common hake catch throughout the survey (A) Catches at different depth, dotted line indicates 190m depth and (B) Spatial distribution of common hake survey catch.

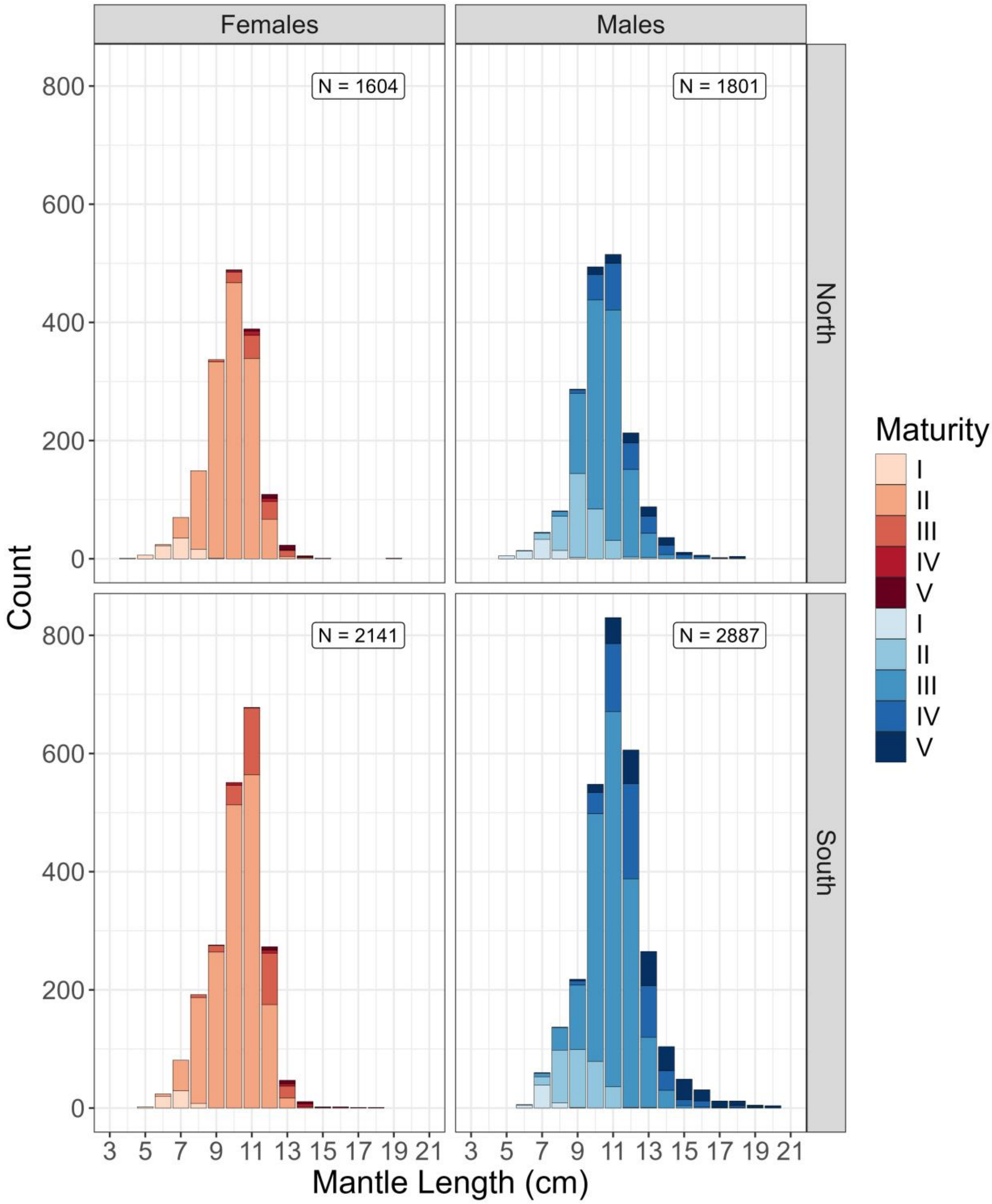

Figure 5. Length-frequency distributions by maturity stage of female (red) and male (blue) *D. gahi* from trawls north (top) and south (bottom) of latitude 52 ºS.

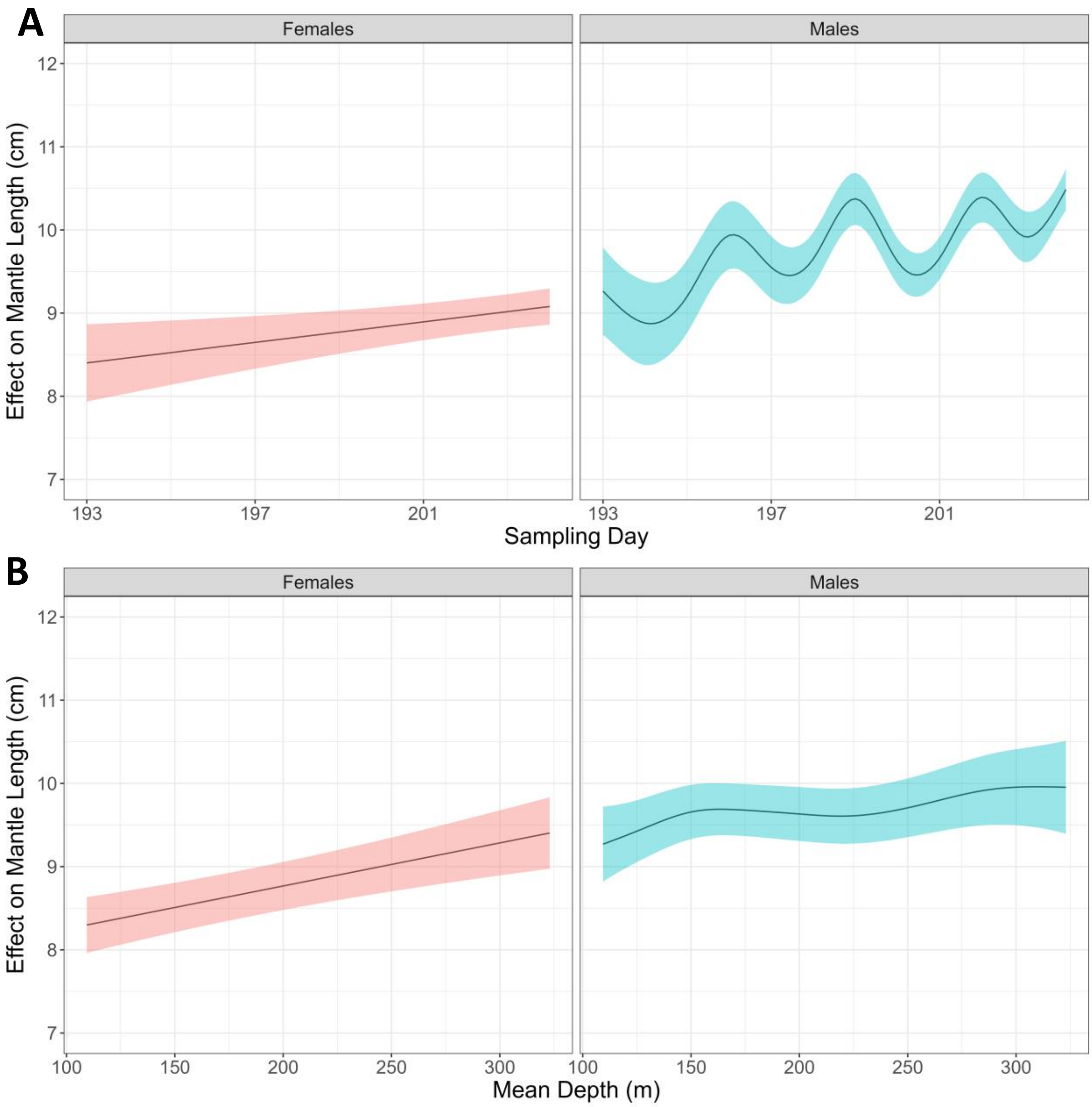

Figure 6. Generalised additive model of mantle length as a function of (A) Sampling Day and (B) Mean depth, smoothing curves were fitted per sex, with 95% confidence intervals shaded.

Otoliths taken during the survey are summarized in Table A3.

Pinniped and seabird monitoring

The 2nd pre-season survey in 2024 was conducted with seal exclusion devices (SED) in all trawls, to align with compulsory SED use in the following commercial X-licence fishery. Shooting and hauling of survey trawls was monitored from the bridge by the lead scientist. Pinnipeds were occasionally sighted near the stern of the vessel at the shoot and/or haul of the survey, but none were caught in fishing gear. Seabirds were also sighted near the stern of the vessel over the duration of the survey but none were caught in fishing gear.

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Appendix

Table A1. Survey stations with total *Doryteuthis gahi* catch. Time: Stanley FI time. Latitude: °S; Longitude: °W. Transects labelled A were adaptive-station trawls.

			Start			End				
Transect - Station	Data Station	Date	Time	Lat	Lon	Time	Lat	Lon	Depth (m)	*D. gahi* (kg)
14-39	968	11/07/2024	06:20	50.51	57.46	08:20	50.60	57.30	275	20
14-38	969	11/07/2024	09:30	50.60	57.37	11:30	50.50	57.55	253	883
14-37	970	11/07/2024	12:30	50.52	57.60	14:30	50.66	57.44	168	1,533
13-34	971	11/07/2024	15:40	50.73	57.30	17:40	50.83	57.11	132	714
13-36	972	12/07/2024	06:30	50.76	57.01	08:30	50.68	57.21	312	84
13-35	973	12/07/2024	09:45	50.70	57.21	11:45	50.79	57.04	247	1,575
12-32	974	12/07/2024	12:45	50.86	57.02	14:45	50.96	56.90	130	105
12-31	975	12/07/2024	15:35	50.98	56.96	17:35	50.85	57.09	106	221
12-33	976	13/07/2024	06:25	50.86	56.92	08:25	50.99	56.83	252	42
11-30	977	13/07/2024	10:00	51.17	56.87	12:00	51.27	57.03	313	840
11-29	978	13/07/2024	12:55	51.26	57.08	14:55	51.13	56.92	141	1,134
11-28	979	13/07/2024	16:00	51.12	57.01	18:00	51.24	57.16	126	588
10-27	980	14/07/2024	06:20	51.49	57.07	08:20	51.62	57.15	289	42
10-26	981	14/07/2024	09:30	51.62	57.24	11:30	51.46	57.18	231	609
10-25	982	14/07/2024	12:25	51.47	57.30	14:25	51.62	57.35	139	189
9-22	983	14/07/2024	15:50	51.81	57.47	17:50	51.95	57.59	161	462
8-21	984	15/07/2024	06:25	52.17	57.55	08:25	52.30	57.66	313	45
8-20	985	15/07/2024	09:30	52.26	57.73	11:30	52.15	57.58	260	465
9-24	986	15/07/2024	12:55	51.98	57.43	14:55	51.84	57.33	282	378
9-23	987	15/07/2024	15:50	51.83	57.39	17:50	51.96	57.51	227	504
0-1	988	16/07/2024	06:15	52.77	60.37	08:15	52.88	60.23	267	10
1-3	989	16/07/2024	09:00	52.88	60.20	11:00	52.92	59.96	220	588
2-5	990	16/07/2024	11:45	52.91	59.89	13:45	52.93	59.64	183	1,006
3-8	991	16/07/2024	14:30	52.95	59.62	16:30	52.97	59.38	181	1,766
1-2	992	17/07/2024	06:15	52.81	60.21	08:15	52.87	59.97	221	42
2-6	993	17/07/2024	09:10	52.93	59.90	11:10	52.98	59.65	231	420
3-9	994	17/07/2024	11:55	52.99	59.60	13:55	53.00	59.35	242	6,115
4-11	995	17/07/2024	14:45	53.01	59.28	16:45	52.96	59.06	307	1,386
6-15	996	18/07/2024	06:15	52.58	58.53	08:15	52.69	58.68	194	42
5-12	997	18/07/2024	09:10	52.70	58.86	11:10	52.79	59.04	134	4,374
5-13	998	18/07/2024	12:00	52.87	59.00	14:00	52.81	58.78	143	546
5-14	999	18/07/2024	17:20	52.88	58.95	19:20	52.83	58.72	146	368
6-16	1000	19/07/2024	06:10	52.73	58.66	08:10	52.62	58.49	232	8
7-17	1001	19/07/2024	09:40	52.46	58.27	11:40	52.36	58.09	165	3,427
7-18	1002	19/07/2024	13:15	52.49	58.10	15:15	52.36	57.94	269	2,081
8-19	1003	19/07/2024	16:15	52.26	57.86	18:15	52.15	57.68	199	736
4-10	1004	20/07/2024	06:30	52.80	59.08	08:30	52.81	59.32	110	1,074
3-7	1005	20/07/2024	09:50	52.83	59.39	11:50	52.83	59.62	135	707
2-4	1006	20/07/2024	13:10	52.83	59.80	15:10	52.89	59.60	167	798
A1	1007	20/07/2024	16:05	52.97	59.53	18:05	53.00	59.30	198	1,806
A2	1008	21/07/2024	06:20	52.71	58.71	08:20	52.84	58.79	154	248
A3	1009	21/07/2024	09:15	52.86	58.91	11:15	52.95	59.10	146	2,213
A4	1010	21/07/2024	12:15	52.95	59.01	14:15	52.99	59.22	190	2,465
A5	1011	21/07/2024	15:00	52.99	59.30	17:00	52.97	59.52	179	3,746
A6	1012	22/07/2024	06:20	51.97	57.63	08:20	52.08	57.72	141	235
A7	1013	22/07/2024	09:25	52.15	57.77	11:25	52.24	57.91	148	936
A8	1014	22/07/2024	13:35	52.31	58.02	15:20	52.37	58.18	161	1,874

Table A2. Empirical estimates of survey total catches by species / taxon.

Species Code	Species/Taxon	Total catch (kg)	Total catch (%)	Sample (kg)	Discard (kg)
HAK	*Merluccius hubbsi*	75565	49.9	2,755	10,574
LOL	*Doryteuthis gahi*	49450	32.7	261	313
PAR	*Patagonotothen ramsayi*	16902	11.2	258	16,902
BAC	*Salilota australis*	2475	1.6	41	2,475
CGO	*Cottoperca gobio*	987	0.7	0	987
TOO	*Dissostichus eleginoides*	820	0.5	535	820
ZYP	*Zygochlamys patagonica*	780	0.5	0	780
RBR	*Bathyraja brachyurops*	591	0.4	0	584
WHI	*Macruronus magellanicus*	574	0.4	7	574
LIS	*Lithodes santolla*	504	0.3	0	504
DGH	*Schroederichthys bivius*	414	0.3	0	414
GRC	*Macrourus carinatus*	221	0.1	24	221
MED	Medusa sp	190	0.1	0	190
RFL	*Dipturus lamillai*	181	0.1	0	160
BLU	*Micromesistius australis*	172	0.1	18	172
RDO	*Amblyraja doellojuradoi*	164	0.1	0	164
GRF	*Coelorinchus fasciatus*	161	0.1	0	161
ING	*Moroteuthopsis ingens*	145	0.1	0	145
GOC	*Gorgonocephalus chilensis*	141	0.1	0	141
RMC	*Bathyraja macloviana*	134	0.1	0	134
SPN	Porifera	127	0.1	0	127
PTE	*Patagonotothen tessellata*	122	0.1	0	122
STA	*Sterechinus agassizii*	73	<0.1	0	73
PAU	*Patagolycus melastomus*	67	<0.1	0	67
RAL	*Bathyraja albomaculata*	61	<0.1	0	61
KIN	*Genypterus blacodes*	51	<0.1	17	48
RBZ	*Bathyraja cousseauae*	43	<0.1	0	43
RGR	*Bathyraja griseocauda*	41	<0.1	0	41
ALG	Algae	34	<0.1	0	34
SQT	Ascidiacea	28	<0.1	0	28
PAT	*Merluccius australis*	27	<0.1	22	24
RED	*Sebastes oculatus*	24	<0.1	2	24
THO	Thouarella	20	<0.1	0	20
MUL	*Eleginops maclovinus*	19	<0.1	12	19
RSC	*Bathyraja scaphiops*	18	<0.1	0	18
NEM	*Psychrolutes marmoratus*	11	<0.1	0	11
ODM	*Odontocymbiola magellanica*	9	<0.1	0	9
RPX	*Psammobatis spp.*	9	<0.1	0	9
AST	Asteroidea	7	<0.1	0	7
CAZ	*Calyptraster sp.*	6	<0.1	0	6
DGS	*Squalus acanthias*	6	<0.1	0	6
FUM	*Fusitriton magellanicus*	6	<0.1	0	6
SAL	*Salpa sp.*	6	<0.1	0	6
ANM	Anemonia	5	<0.1	0	5
ILL	*Illex argentinus*	5	<0.1	0	5
RMG	*Bathyraja magellanica*	5	<0.1	0	5
OPV	*Ophiosabine vivipara*	4	<0.1	0	4
AUC	*Austrocidaris canaliculata*	3	<0.1	0	3
BRY	Bryozoa	3	<0.1	0	3
MAN	*Mancopsetta sp.*	3	<0.1	0	3
MLA	*Muusoctopus longibrachus akambei*	3	<0.1	0	3
MUE	*Muusoctopus eureka*	3	<0.1	0	3
OPL	*Ophiuroglypha lymani*	3	<0.1	0	3

Species Code	Species/Taxon	Total catch (kg)	Total catch (%)	Sample (kg)	Discard (kg)
SUN	*Labidiaster radiosus*	3	<0.1	0	3
CHE	*Champsocephalus esox*	2	<0.1	1	2
EUL	*Eurypodius latreillii*	2	<0.1	0	2
MIR	*Mirostenella sp.*	2	<0.1	0	2
POA	*Glabraster antarctica*	2	<0.1	0	2
WRM	Worm casings	2	<0.1	0	2
BAO	*Bathybiaster loripes*	1	<0.1	0	1
BUT	*Stromateus brasiliensis*	1	<0.1	1	1
COT	*Cottunculus granulosus*	1	<0.1	0	1
CTA	*Ctenodiscus australis*	1	<0.1	0	1
EGG	Egg mass	1	<0.1	0	1
EUO	*Eurypodius longirostris*	1	<0.1	0	1
HYD	Hydrozoa	1	<0.1	0	1
MAR	*Martialia hyadesi*	1	<0.1	0	1
NUD	Nudibranchia	1	<0.1	0	1
PRX	*Paragorgia sp.*	1	<0.1	0	1
ACS	*Acanthoserolis schythei*	<1	<0.1	0	0
ADA	*Adelomelon ancilla*	<1	<0.1	0	0
AGO	*Agonopsis chiloensis*	<1	<0.1	0	0
BAL	*Americominella longisetosus*	<1	<0.1	0	0
CAV	*Campylonotus vagans*	<1	<0.1	0	0
COG	*Patagonotothen guntheri*	<1	<0.1	0	0
CRY	*Crossaster sp.*	<1	<0.1	0	0
CYX	*Cycethra sp.*	<1	<0.1	0	0
FLX	*Flabellum spp.*	<1	<0.1	0	0
HEX	*Henricia sp.*	<1	<0.1	0	0
ILF	*Iluocoetes fimbriatus*	<1	<0.1	0	0
ISO	Isopoda	<1	<0.1	0	0
LAP	*Variolipallium patagonicum*	<1	<0.1	0	0
MAV	*Magellania venosa*	<1	<0.1	0	0
MUN	*Grimothea gregaria*	<1	<0.1	0	0
MYA	*Myxine australis*	<1	<0.1	0	0
OPS	*Ophiactis asperula*	<1	<0.1	0	0
PAE	*Patagonotothen elegans*	<1	<0.1	0	0
PES	*Peltarion spinulosum*	<1	<0.1	0	0
PLU	Primnoidae	<1	<0.1	0	0
POL	Polychaeta	<1	<0.1	0	0
PYX	Pycnogonida	<1	<0.1	0	0
SAR	*Sprattus fuegensis*	<1	<0.1	0	0
SEC	*Seriolella caerulea*	<1	<0.1	0	0

Table A3. Summary of otolith sample numbers by species by sex taken during the survey.

Species			No. of otolith pairs		
			M	F	J
HAK	Common Hake	*Merluccius hubbsi*	50	170	0
TOO	Patagonian Toothfish	*Dissostichus eleginoides*	97	108	0
PAR	Common Rock cod	*Patagonotothen ramsayi*	86	98	0
BAC	Red cod	*Salilota australis*	5	16	0
RED	Patagonian Redfish	*Sebastes oculatus*	11	5	0
BLU	Southern Blue Whiting	*Micromesistius australis*	7	9	0
GRC	Grenadier-Ridge Scaled Rattail	*Macrourus carinatus*	2	13	0
WHI	Whiptail Hake, Hoki	*Macruronus magellanicus*	6	7	0
KIN	Pink Cusk-eel	*Genypterus blacodes*	4	9	0
PAT	Patagonian Hake	*Merluccius australis*	1	11	0
CHE	Icefish	*Champsocephalus esox*	2	2	0
MUL	Falkland Mullet	*Eleginops maclovinus*	1	1	0
SEC	White warehou driftfish	*Seriolella caerulea*	1	0	0
BUT	Southwest Atlantic butterfish	*Stromateus brasiliensis*	0	1	0
PTE	Black southern rock cod	*Patagonotothen tessellata*	0	0	4