

2024 2<sup>nd</sup> Pre-  
Season  
Assessment  
Survey 2

Falkland calamari  
(*Doryteuthis gahi*)

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## Summary

- 1) A follow-up stock assessment survey for *Doryteuthis gahi* (Falkland calamari) was conducted in the Loligo Box from 4<sup>th</sup> to 14<sup>th</sup> August 2024. A total of 44 scientific trawls were performed during the survey; 39 fixed-station trawls and 5 adaptive-station trawls. The scientific catch of the survey was 27.66 tonnes *D. gahi*.
- 2) An estimate of 6, 828.42 tonnes *D. gahi* (95% confidence interval: 4, 308 to 13, 585 tonnes) was calculated for the fishing zone by inverse distance weighting. Of the total, 2, 126.89 tonnes were estimated north of 52 °S, and 4, 701.53 tonnes were estimated south of 52 °S.
- 3) *D. gahi* had significantly greater average mantle lengths and maturities south of 52°S compared with individuals north of 52°S. Males north: mean mantle length 9.72 cm; mean maturity stage 2.47, south: mantle length 10.86 cm; maturity 3.50. Females north: mantle length 9.72 cm; maturity 2.47, south: mantle length 9.90 cm; maturity 2.50. Mantle length distributions suggested that it is unlikely that immigration occurred throughout the survey.
- 4) A total of 113 taxa were identified in the catches. *D. gahi* was the second largest species group at 21.7% of total catch by weight. Common hake (56.92%), rock cod (12.94%), toothfish (1.2%), frogmouth (1.1%), were the only other taxa comprising ≥1.0% 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 4<sup>th</sup> to 14<sup>th</sup> August 2024; experimental license FK053E24.

Objectives of the survey were to:

- 1) Estimate the biomass and spatial distribution of *D. gahi* on the fishing grounds to compare with the pre-season survey (Chemshirova et al. 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<sup>2</sup>, subtracting the 3-nautical mile exclusion zone around Beauchêne Island.

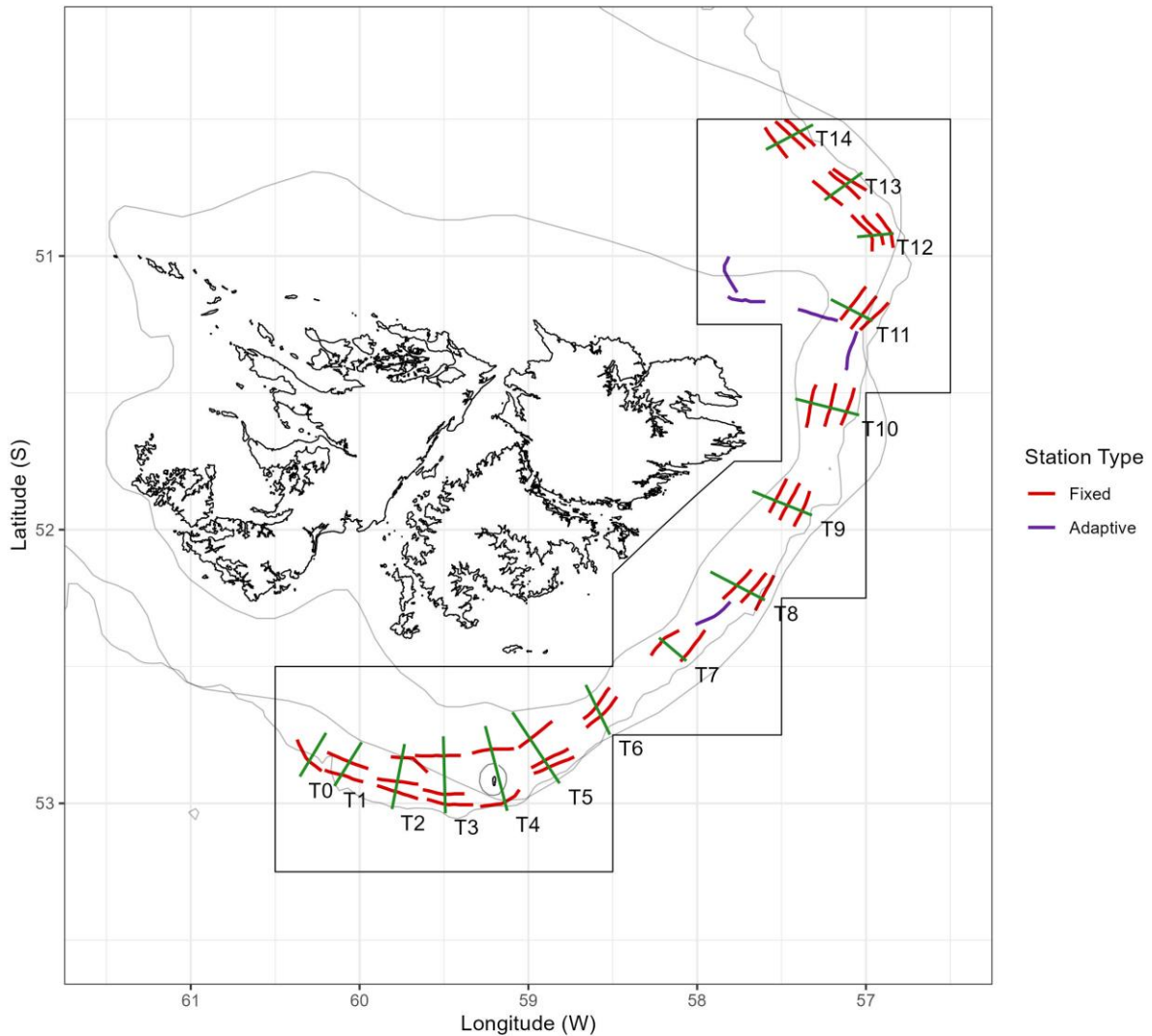


Figure 1. Survey transects (green lines), fixed-station trawls (red), adaptive-station trawls (purple), and extra north station trawls (blue) sampled during the 1<sup>st</sup> pre-season 2024 survey. Boundaries of the ‘Loligo Box’ and Beauchêne Island exclusion zone, are in black.

*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 1<sup>st</sup> pre-season survey in 2013, 2024 and a post-season survey in 2015 (Winter et al., 2013; Chemshirova et al., 2024; Jones & Shcherbich, 2015). The following FIFD personnel participated in the 2<sup>nd</sup> pre-season 2024 survey:

Role	Name
Survey lead scientist	Peter Hoyer
Fishery scientist	Portia Harris
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 5 adaptive-station trawls selected to increase the precision of *D. gahi* biomass estimates in high-density or high-variability locations. The survey was scheduled for 11 days, ensuring even coverage of the Loligo Box through fixed stations, while reserving one day for adaptive trawling. 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)<sup>a</sup>. 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<sup>b</sup>. Trawl width was derived from the distance between trawl doors (determined per interval) according to the equation (Seafish 2010):

$$\text{trawl width} = (\text{door distance} \times \text{footrope length}) / (\text{footrope length} + \text{bridle} + \text{sweep})$$

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<sup>a</sup> Albeit more likely to underestimate than overestimate true density (Harley and Myers 2001); thus conservative.

<sup>b</sup> 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.

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<sup>c</sup> using an inverse distance weighting algorithm (Ramos and Winter 2022). As previously, the fish stock area was delineated to 20,062.8 km<sup>2</sup>, 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 °S; 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, resulting in 44 scientific trawls total recorded during the survey: 39 fixed station trawls catching 23.51 tonnes *D. gahi*, 5 adaptive-station trawls catching 4.15 tonnes *D. gahi*. A total of 11 optional trawls (directed by the vessel master, after survey hours) yielded an additional 4.68 tonnes *D. gahi*, bringing the total catch for the survey to 32.34 tonnes. The scientific survey catch of 27.66 tonnes *D. gahi* was lower than the initial pre-season survey that was carried out in July (Table 1).

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<sup>c</sup> 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.

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 <sup>A</sup>	314	56807
2018	59 <sup>A</sup>	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 <sup>B</sup>	549	44015	56	294	19859
2024	64	675	70334	47 <sup>C</sup>	49	13679
2024				44 <sup>D</sup>	27	6828

<sup>A</sup> Includes four juvenile toothfish transect trawls.

<sup>B</sup> Includes four extra trawls north of the Loligo Box.

<sup>C</sup> Survey vessel participated in a search and rescue operation, reducing the number of survey trawls.

<sup>D</sup> Survey was intended to primarily cover the fixed stations.

Average *D. gahi* catch density (Figure 2) among fixed-station trawls north of 52° S was 0.32 t km<sup>-2</sup>; which was lower than the initial survey carried out in July 2024. Average *D. gahi* catch density among fixed-station trawls south of 52° S was 0.45 t km<sup>-2</sup>; which was also lower than the initial survey. Average *D. gahi* catch density among adaptive-station trawls south of 52° S was 1.46 t km<sup>-2</sup>; this was marginally higher the density recorded in the initial survey (1.44 t km<sup>-2</sup>); however, this is based on only one trawl. The remaining adaptive trawls were carried out north of 52 ° S and the average catch density was 0.43 t km<sup>-2</sup>.

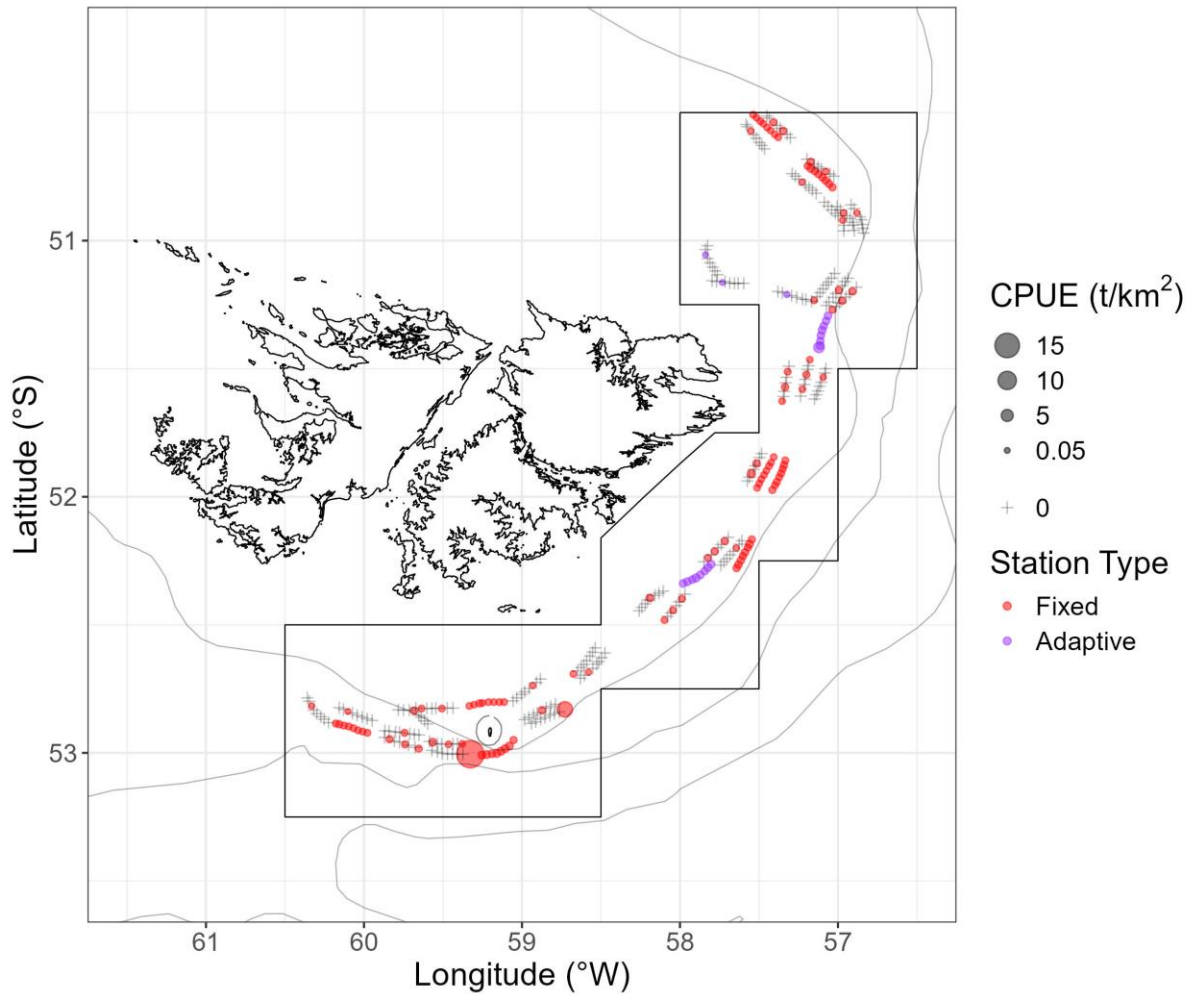


Figure 2. *D. gahi* CPUE ( $t/km^2$ ) of fixed and adaptive stations per 15-minute trawl interval. Boundaries of the ‘Loligo Box’ fishing zone and the Beauchêne Island exclusion zone are traced in black.

### ***Biomass estimation***

Total *D. gahi* biomass in the fish stock area was estimated at 6, 828.42<sup>d</sup> tonnes, with a 95% confidence interval of [4, 308.18 to 13, 585.56 tonnes]. The total biomass estimate was lower than that estimated in the initial survey for the 2<sup>nd</sup> pre-season (Table 1). Partition of the estimated biomass was 2, 126.89 tonnes north [1,488.08 to 3, 978.17 tonnes] vs. 4, 701.53 tonnes south [2, 028.98 to 11, 030.27 tonnes]. The biomass proportion north (31.1%) was higher than on the survey carried out in July 2024 (20.1%). Within the north sub-area 50% of *D. gahi* density was aggregated in 37 of 368 5×5 km area units, and 95% of density was aggregated in 115 of the 368 5×5 km area units (Figure 3). Within the south sub-area 50% of *D. gahi* density was aggregated in 12 of 392 5×5 km area units, and 95% of density was aggregated in 109 of the 392 5×5 km area units (Figure 3).

<sup>d</sup> The estimate and confidence intervals are different to the initial estimate presented, as an incorrect position for one of the intervals was corrected.

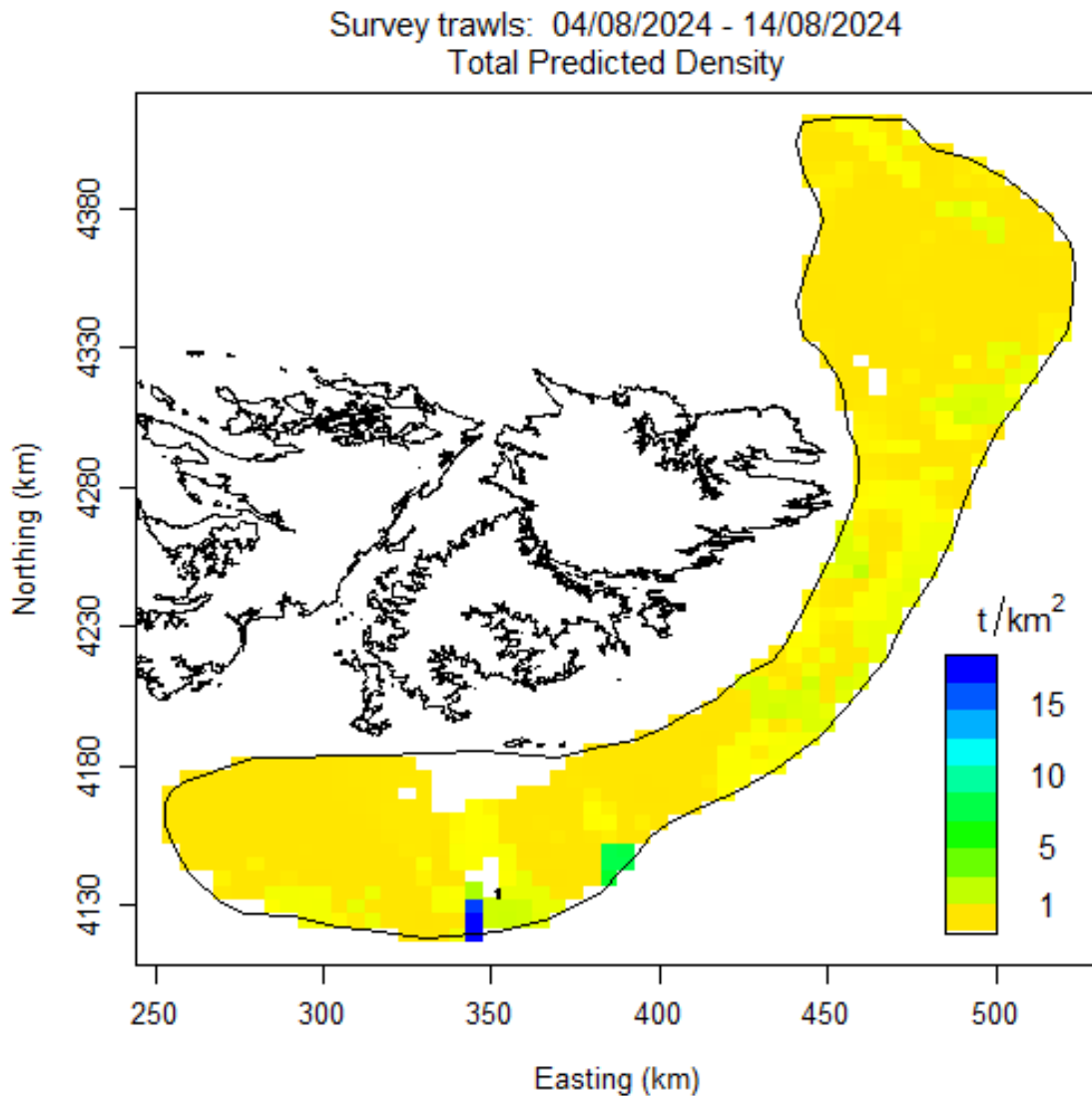


Figure 3. *D. gahi* predicted density estimates per 5 km<sup>2</sup> area units. Blank area units within the perimeter are either <90 or >400 m average depth. Coordinates were converted to WGS 84 projection in UTM sector 21F using the R library rgdal (proj.maptools.org).

### ***Biological data***

A total of 113 taxa were identified in the survey catches (Appendix Table A2). *D. gahi* was the second most abundant catch with 21.7% of the total (Table A2); lower than the initial survey carried out in July (32.7%). Common hake was the most predominant catch species with 56.9% of the total; higher than the initial July survey (49.9%), and the average catch per trawl (1,648 kg/trawl) was also higher than the one recorded in the July survey (1,607 kg/trawl). It is of note, that 98.0% of the hake was caught at stations deeper than 190 m (Figure 4A). The highest *D. gahi* catches were in the northern-most part of the Loligo Box (Figure 4B). Third-highest catch species was rock cod with 12.94%, the catch percentage was also higher than the July 2024 survey (11.2%). No other species group accounted for  $\geq 0.5\%$  of total catch except for toothfish and frogmouth, which made up 1.24% and 1.1% of the total survey catch respectively.

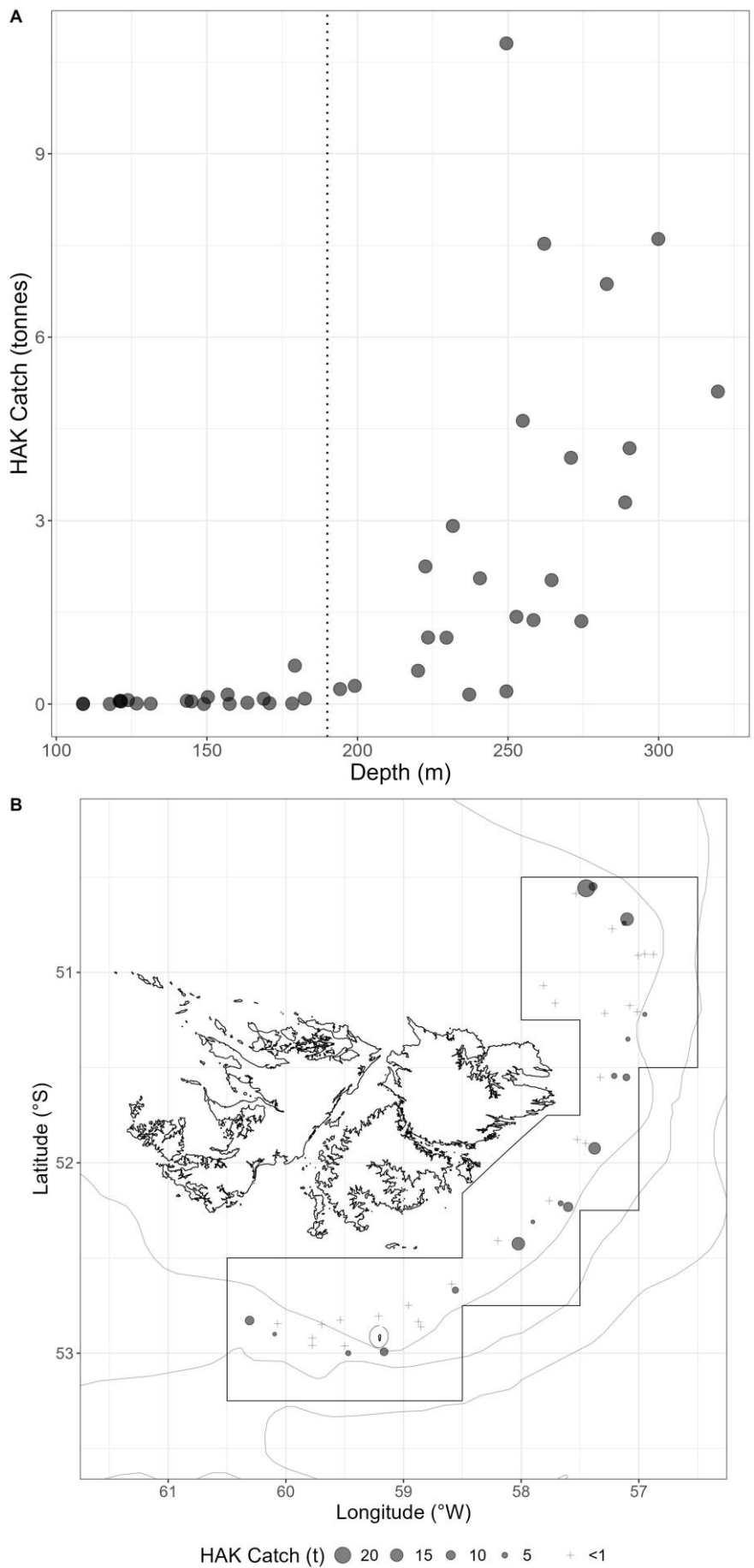


Figure 4. Common hake catch throughout the survey (A) Catches at different depth, dotted line indicates 190m depth and (B) Spatial distribution of common hake survey catch.

Toothfish, a highly restricted bycatch (as vessels are required to move grid square if toothfish bycatch exceeds 1.5%) had a higher average catch rate compared with the July 2024 survey (17.45 kg/trawl), at 35.83 kg per trawl. Overall, 40.35% of the total toothfish survey catch was taken in four stations (St 1020; 1034; 1046 and 1048), all of these stations were south of 52°S, except for St 1020, which was in the northernmost part of the Loligo Box (T13; 108.84 kg). The largest single catch of toothfish (St 1046; 273 kg; 17.33%) was near Beauchêne Island. Total lengths of sampled toothfish ranged between 20 and 96 cm.

During the survey 7,334 *D. gahi* were measured for length and maturity (4,023 males, 3,311 females, from 44 trawl stations). The total sex ratio was significantly majority male ( $p < 0.0001$ ). A total of 6 individual trawls had a significant preponderance of females, whereas 17 had a significant preponderance for males. Finally, 21 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 9.72 cm; mean maturity stage 2.47 (on a scale of 1 to 6, Lipinski 1979), males south: mean mantle length 10.86 cm; mean maturity stage 3.5. Females north: mean mantle length 9.72 cm; mean maturity stage 2.47, females south: 9.90 cm; stage 2.5. Mean mantle lengths of males and females were similar for both areas compared with the survey carried out in July 2024. Females appeared to be significantly larger ( $p < 0.01$ ;  $\chi^2 = 9.58$ ) and more mature ( $p < 0.05$ ;  $\chi^2 = 5.94$ ) south of 52° S. However, it should be noted that the magnitude of the effect was relatively small. Males were also significantly larger ( $p < 0.0001$ ;  $\chi^2 = 73.26$ ) and more mature ( $p < 0.0001$ ;  $\chi^2 = 22.16$ ) in the southern part of the Loligo Box. In contrast to females, these findings for males represent a more substantial effect.

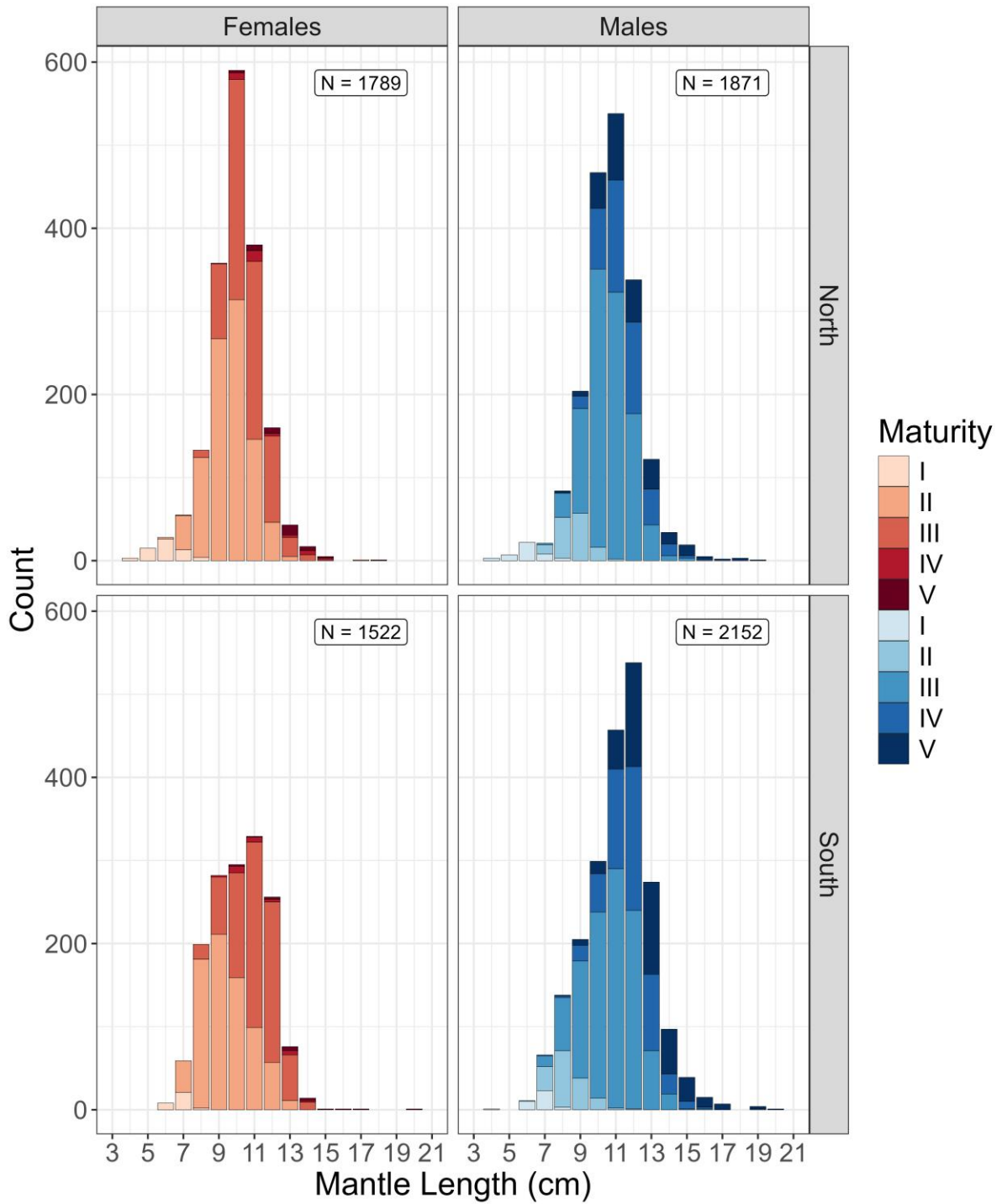


Figure 5. Length-frequency distributions by maturity stage of female (red) and male (blue) *D. gahi* from trawls north (top) and south (bottom) of latitude 52 °S.

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

$$(Mantle\ Length)_i \sim \alpha + f(Latitude, Longitude)_i + f(Sampling\ Day)_i: Sex + f(Mean\ Depth)_i: Sex + Sex_i + \varepsilon_i$$

$$\varepsilon_i \sim N(0, \sigma^2)$$

where  $\alpha$  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 revealed a similar overall pattern for both females and males (Fig. 6A), although males were generally larger. Given the trend of increasing mantle length over time for both sexes, it is unlikely that migration occurred during this survey. Additionally, when compared to the smoother of the GAM from the July survey, it is unlikely that any migration took place during the one-week interval between the two surveys.

The mean depth smoother also revealed a minimal increase in mantle length with greater depth for both females and males (Fig. 6B). This further suggests that a migration pulse is unlikely to have occurred during the survey. Moreover, since this species typically segregates by depth during the feeding phase, the presence of larger females in deeper waters is expected. In contrast, male mantle length remains consistent across depths, as males generally aggregate in shallower waters early in the season (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	-	732.3	<0.0001***	29.7
	Latitude, Longitude	26.77	35.85	<0.0001***	
	Sampling Day: Females	4.19	13.41	<0.0001***	
	Sampling Day: Males	4.05	7.73	<0.0001***	
	Mean Depth: Females	4.67	7.39	<0.0001***	
	Mean Depth: Males	4.43	3.24	<0.01**	

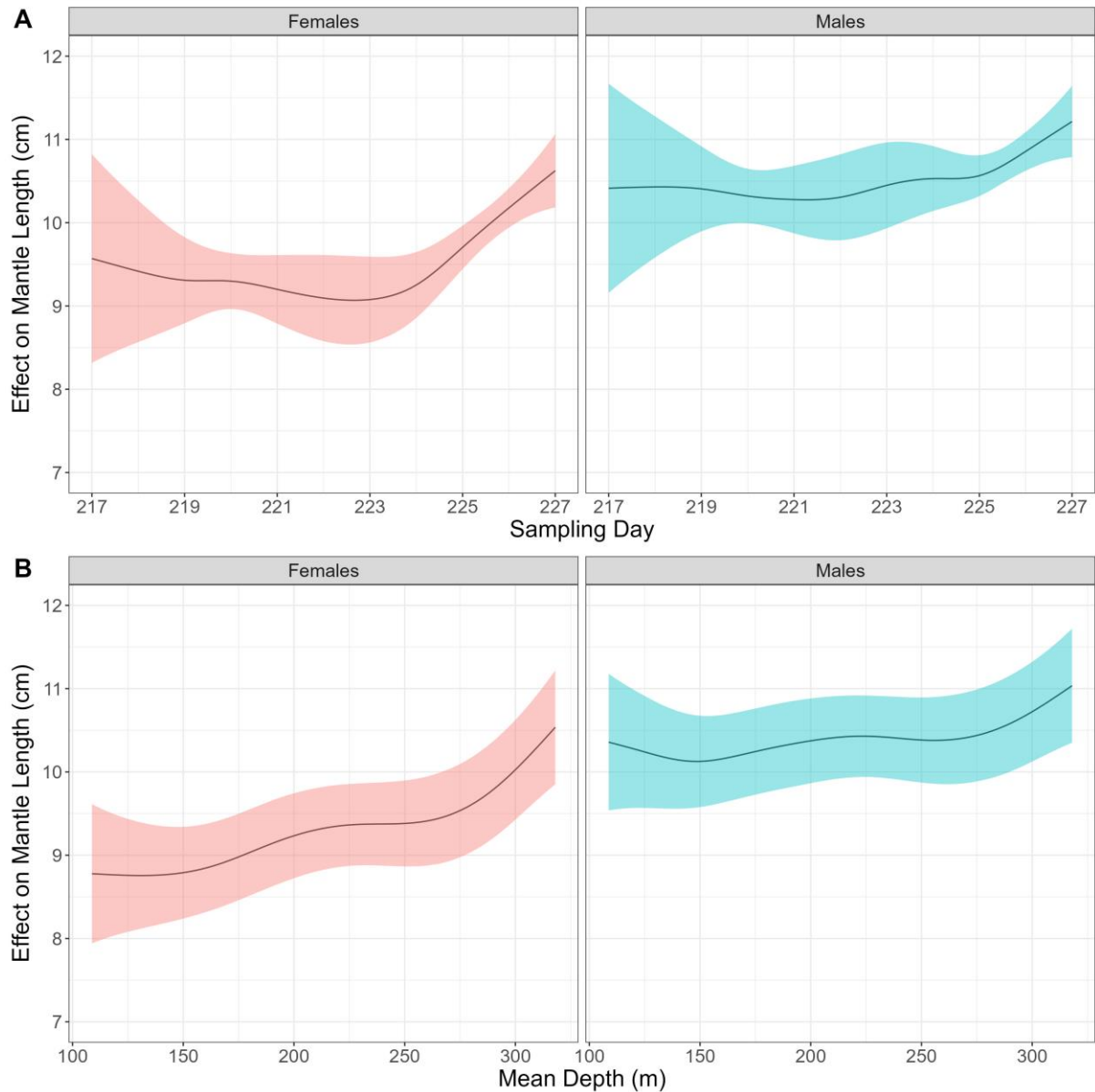


Figure 6. Generalised additive model of mantle length as a function of (A) Sampling Day and (B) Mean depth, smoothing curves were fitted per sex, with 95% confidence intervals shaded.

Otoliths taken during the survey are summarized in Table A3.

### ***Pinniped and seabird monitoring***

The 2nd pre-season survey (2) in August 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.

Transect - Station	Data Station	Date	Start			End			Depth (m)	<i>D. gahi</i> (kg)
			Time	Lat	Lon	Time	Lat	Lon		
14-39	1015	04/08/2024	06:25	50.50	57.48	08:25	50.60	57.30	282	357.00
14-38	1016	04/08/2024	09:20	50.61	57.36	11:20	50.51	57.54	251	861.00
14-37	1017	04/08/2024	12:20	50.53	57.60	14:20	50.64	57.47	170	84.00
13-34	1018	04/08/2024	15:25	50.73	57.32	17:25	50.81	57.14	134	42.00
13-36	1019	05/08/2024	06:20	50.76	57.00	08:20	50.68	57.20	318	273.00
13-35	1020	05/08/2024	09:20	50.69	57.22	11:20	50.79	57.03	249	1,703.00
12-32	1021	05/08/2024	12:10	50.85	57.02	14:10	50.96	56.90	128	84.00
12-31	1022	05/08/2024	15:00	50.98	56.96	17:00	50.85	57.09	106	84.00
12-33	1023	06/08/2024	06:15	50.84	56.94	08:15	50.97	56.84	254	21.00
11-30	1024	06/08/2024	09:50	51.17	56.87	11:50	51.27	57.03	210	631.00
11-29	1025	06/08/2024	12:40	51.27	57.09	14:40	51.15	56.94	139	168.00
11-28	1026	06/08/2024	15:30	51.11	57.00	17:30	51.23	57.15	126	105.00
10-27	1027	07/08/2024	06:15	51.48	57.07	08:15	51.62	57.15	293	84.00
10-26	1028	07/08/2024	09:15	51.62	57.24	11:15	51.47	57.18	231	483.00
10-25	1029	07/08/2024	12:10	51.47	57.30	14:10	51.63	57.35	141	483.00
9-22	1030	07/08/2024	15:35	51.81	57.47	17:35	51.94	57.57	159	630.00
0-1	1031	08/08/2024	06:10	52.77	60.37	08:10	52.88	60.23	265	63.00
1-3	1032	08/08/2024	09:00	52.88	60.21	11:00	52.92	59.98	223	1,144.00
2-6	1033	08/08/2024	11:50	52.94	59.90	13:50	52.98	59.65	232	546.00
3-9	1034	08/08/2024	14:40	52.98	59.60	16:40	53.01	59.33	242	4,603.00
6-16	1035	09/08/2024	06:10	52.72	58.66	08:10	52.61	58.48	232	42.00
6-15	1036	09/08/2024	09:05	52.58	58.52	11:05	52.69	58.67	194	105.00
5-13	1037	09/08/2024	12:10	52.80	58.76	14:10	52.87	58.98	148	210.00
5-14	1038	09/08/2024	14:50	52.89	58.97	16:50	52.83	58.73	148	1,703.00
5-12	1039	10/08/2024	06:05	52.70	58.86	08:05	52.80	59.06	134	21.00
4-10	1040	10/08/2024	08:45	52.80	59.08	10:45	52.82	59.33	110	840.00
3-7	1041	10/08/2024	11:30	52.83	59.40	13:30	52.83	59.67	137	284.00
2-4	1042	10/08/2024	14:30	52.83	59.81	16:30	52.89	59.60	165	231.00
1-2	1043	11/08/2024	06:10	52.81	60.19	08:10	52.87	59.95	216	21.00
2-5	1044	11/08/2024	08:55	52.91	59.90	10:55	52.93	59.65	183	168.00
3-8	1045	11/08/2024	11:40	52.95	59.62	13:40	52.97	59.38	181	483.00
4-11	1046	11/08/2024	14:30	53.01	59.28	16:30	52.95	59.05	296	2,179.00
8-20	1047	12/08/2024	06:10	52.16	57.59	08:10	52.27	57.74	278	42.00
8-21	1048	12/08/2024	09:05	52.30	57.66	11:05	52.17	57.55	333	1,558.00
9-24	1049	12/08/2024	12:25	51.99	57.43	14:25	51.86	57.33	282	1,238.00
9-23	1050	12/08/2024	15:15	51.83	57.39	17:15	51.97	57.51	227	924.00
8-19	1051	13/08/2024	06:10	52.15	57.68	08:10	52.25	57.85	210	420.00
7-18	1052	13/08/2024	09:15	52.37	57.95	11:15	52.48	58.10	253	420.00
7-17	1053	13/08/2024	12:20	52.46	58.27	14:20	52.37	58.11	157	168.00
A1	1054	13/08/2024	15:10	52.35	58.01	17:10	52.26	57.80	210	2,117.00
A2	1055	14/08/2024	06:05	51.00	57.81	08:05	51.13	57.76	124	10.00
A3	1056	14/08/2024	08:45	51.15	57.82	10:45	51.17	57.60	108	12.71
A4	1057	14/08/2024	11:45	51.20	57.40	13:45	51.24	57.17	101	63.00
A5	1058	14/08/2024	14:40	51.27	57.05	16:40	51.42	57.12	234	1,947.00

**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	<i>Merluccius hubbsi</i>	72529	56.9	2,904	2,977
LOL	<i>Doryteuthis gahi</i>	27655.71	21.7	226	274
PAR	<i>Patagonotothen ramsayi</i>	16491	12.9	224	14,302
TOO	<i>Dissostichus eleginoides</i>	1576	1.2	950	1,289
CGO	<i>Cottoperca gobio</i>	1338	1.1	0	1,338
BAC	<i>Salilota australis</i>	1193	0.9	154	1,171
LIS	<i>Lithodes santolla</i>	1078	0.8	0	1,078
RBR	<i>Bathyrāja brachyurops</i>	775	0.6	3	746
ZYP	<i>Zygochlamys patagonica</i>	518	0.4	0	518
SPN	Porifera	505	0.4	0	505
DGH	<i>Schroederichthys bivius</i>	434	0.3	0	434
GRC	<i>Macrourus carinatus</i>	388	0.3	76	388
GOC	<i>Gorgonocephalus chilensis</i>	260	0.2	0	260
RFL	<i>Dipturus lamillai</i>	256	0.2	2	256
STA	<i>Sterechinus agassizii</i>	233	0.2	0	233
PTE	<i>Patagonotothen tessellata</i>	172	0.1	0	172
RDO	<i>Amblyrāja doellojuradoi</i>	161	0.1	0	161
SQT	Ascidiacea	157	0.1	0	157
RMC	<i>Bathyrāja macloviana</i>	143	0.1	0	143
ALG	Algae	135	0.1	0	135
ING	<i>Moroteuthopsis ingens</i>	115	0.1	0	115
GRF	<i>Coelorinchus fasciatus</i>	95	0.1	0	95
RGR	<i>Bathyrāja griseocauda</i>	90	0.1	0	90
RAL	<i>Bathyrāja albomaculata</i>	86	0.1	0	86
WHI	<i>Macruronus magellanicus</i>	83	0.1	9	83
KIN	<i>Genypterus blacodes</i>	81	0.1	72	81
SAL	Salpa sp.	80	0.1	0	80
PAU	<i>Patagolytus melastomus</i>	75	0.1	1	75
RSC	<i>Bathyrāja scaphiops</i>	68	0.1	0	68
SHT	Mixed invertebrates	65	0.1	0	65
MED	Medusa sp	58	<0.1	0	58
BLU	<i>Micromesistius australis</i>	53	<0.1	9	53
RPX	Psammobatis spp.	42	<0.1	0	42
MUL	<i>Eleginops maclovinus</i>	32	<0.1	14	32
HYD	Hydrozoa	31	<0.1	0	31
RBZ	<i>Bathyrāja cousseauae</i>	30	<0.1	0	30
AST	Asteroidea	27	<0.1	0	27
ANM	Anemonia	25	<0.1	0	25
RAY	Rajiformes	23	<0.1	0	23
BRY	Bryozoa	21	<0.1	0	21
THO	Thouarella	18	<0.1	0	18
FUM	<i>Fusitriton magellanicus</i>	15	<0.1	0	15
RMG	<i>Bathyrāja magellanica</i>	15	<0.1	0	15
MIR	Mirostenella sp.	14	<0.1	0	14
OPV	<i>Ophiosabine vivipara</i>	12	<0.1	0	12
POA	<i>Glabraster antarctica</i>	12	<0.1	0	12
PAT	<i>Merluccius australis</i>	11	<0.1	8	11
SUN	<i>Labidiaster radiosus</i>	11	<0.1	0	11
COL	<i>Cosmasterias lurida</i>	10	<0.1	0	10
OCM	<i>Enteroctopus megalocyathus</i>	10	<0.1	5	10
CAZ	Calyptaster sp.	9	<0.1	0	9
CTA	<i>Ctenodiscus australis</i>	9	<0.1	0	9
EGG	Egg mass	9	<0.1	0	9

Species Code	Species/Taxon	Total catch (kg)	Total catch (%)	Sample (kg)	Discard (kg)
ILF	<i>Ilucoetes fimbriatus</i>	8	<0.1	1	8
OPL	<i>Ophiuroglypha lymani</i>	8	<0.1	0	8
EUL	<i>Eurypodius latreillii</i>	7	<0.1	0	7
AUC	<i>Austrocidaris canaliculata</i>	6	<0.1	0	6
WRM	Worm casings	6	<0.1	0	6
ODM	<i>Odontocymbiola magellanica</i>	5	<0.1	0	5
ILL	<i>Illex argentinus</i>	4	<0.1	0	4
NEM	<i>Psychrolutes marmoratus</i>	4	<0.1	4	4
MAM	<i>Neoachirosetta milfordi</i>	3	<0.1	3	3
HEX	Henricia sp.	2	<0.1	0	2
MAV	<i>Magellania venosa</i>	2	<0.1	0	2
MMA	<i>Mancopsetta maculata</i>	2	<0.1	2	2
PRX	Paragorgia sp.	2	<0.1	0	2
RED	<i>Sebastes oculatus</i>	2	<0.1	2	2
ASA	<i>Astrotoma agassizii</i>	1	<0.1	0	1
CEX	Ceramaster sp.	1	<0.1	0	1
CHE	<i>Champscephalus esox</i>	1	<0.1	1	1
CIR	Cirripedia	1	<0.1	0	1
COT	<i>Cottunculus granulatus</i>	1	<0.1	1	1
CRY	Crossaster sp.	1	<0.1	0	1
CYX	Cycethra sp.	1	<0.1	0	1
EUO	<i>Eurypodius longirostris</i>	1	<0.1	0	1
LOS	<i>Lophaster stellans</i>	1	<0.1	0	1
MLA	<i>Muusoctopus longibrachus akambeii</i>	1	<0.1	1	1
MYX	Myxine spp.	1	<0.1	0	1
NOW	<i>Paranotothenia magellanica</i>	1	<0.1	1	1
NUD	Nudibranchia	1	<0.1	0	1
PES	<i>Peltarion spinulosum</i>	1	<0.1	0	1
SAR	<i>Sprattus fuegensis</i>	1	<0.1	1	1
SRP	<i>Semirossia patagonica</i>	1	<0.1	0	1
ACS	<i>Acanthoserolis schythei</i>	<1	<0.1	0	0
AGO	<i>Agonopsis chiloensis</i>	<1	<0.1	0	0
ANT	Anthozoa	<1	<0.1	0	0
BAL	<i>Americominella longisetosus</i>	<1	<0.1	0	0
BAO	<i>Bathybiaster loripes</i>	<1	<0.1	0	0
CAV	<i>Campylonotus vagans</i>	<1	<0.1	0	0
COG	<i>Patagonotothen guntheri</i>	<1	<0.1	0	0
CRI	Crinoidea	<1	<0.1	0	0
ERR	Errina sp.	<1	<0.1	0	0
FLX	Flabellum spp.	<1	<0.1	0	0
HCR	Paguroidea	<1	<0.1	0	0
HOL	Holothuroidea	<1	<0.1	0	0
ISO	Isopoda	<1	<0.1	0	0
MAN	Mancopsetta sp.	<1	<0.1	0	0
MAT	<i>Achirosetta tricholepis</i>	<1	<0.1	0	0
MUE	<i>Muusoctopus eureka</i>	<1	<0.1	0	0
MUN	<i>Grimothea gregaria</i>	<1	<0.1	0	0
MUU	<i>Munida subrugosa</i>	<1	<0.1	0	0
NEB	<i>Nemadactylus bergi</i>	<1	<0.1	0	0
OCC	Octocorallia sp	<1	<0.1	0	0
ODP	<i>Odontaster penicillatus</i>	<1	<0.1	0	0
OPD	<i>Ophiosabine densispina</i>	<1	<0.1	0	0
OPS	<i>Ophiactis asperula</i>	<1	<0.1	0	0
PAV	<i>Patagonotothen brevicauda</i>	<1	<0.1	0	0

Species Code	Species/Taxon	Total catch (kg)	Total catch (%)	Sample (kg)	Discard (kg)
PLX	Paralepis spp.	<1	<0.1	0	0
PYX	Pycnogonida	<1	<0.1	0	0
RMU	<i>Bathyrja multispinis</i>	<1	<0.1	0	0
SOR	<i>Solaster regularis</i>	<1	<0.1	0	0
TRP	<i>Tripylaster philippii</i>	<1	<0.1	0	0
URB	<i>Urophycis brasiliensis</i>	<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
TOO	Patagonian Toothfish	<i>Dissostichus eleginoides</i>	32	53	0
PAR	Common Rockcod	<i>Patagonotothen ramsayi</i>	33	48	0
HAK	Common Hake	<i>Merluccius hubbsi</i>	14	39	0
BAC	Redcod	<i>Salilota australis</i>	19	31	0
KIN	Pink Cusk-eel	<i>Genypterus blacodes</i>	11	33	0
GRC	Grenadier-Ridge Scaled Rattail	<i>Macrourus carinatus</i>	5	36	0
WHI	Whiptail Hake, Hoki	<i>Macruronus magellanicus</i>	11	15	0
SAR	Falkland sprat	<i>Sprattus fuegensis</i>	6	9	0
CHE	Icefish	<i>Champocephalus esox</i>	8	5	0
COG	Yellowfin Rockcod	<i>Patagonotothen guntheri</i>	9	2	0
BLU	Southern Blue Whiting	<i>Micromesistius australis</i>	9	2	0
MMA	Spotted Flounder	<i>Mancopsetta maculata</i>	8	1	0
ILF	Eelpout	<i>Iluocoetes fimbriatus</i>	6	3	0
MUL	Falkland Mullet	<i>Eleginops maclovinus</i>	5	3	0
RED	Patagonian Redfish	<i>Sebastes oculatus</i>	2	5	0
NOW	Yellowbelly	<i>Paranotothenia magellanica</i>	6	1	0
NEM	Blobfish	<i>Psychrolutes marmoratus</i>	6	1	1
MAM	Finless Flounder	<i>Neoachirosetta milfordi</i>	0	6	0
AGO	Crocodile Fish	<i>Agonopsis chiloensis</i>	3	2	0
PAT	Patagonian Hake	<i>Merluccius australis</i>	0	4	0
COT	Fathead	<i>Cottunculus granulatus</i>	3	1	0
PAU	Black-mouthed eelpout	<i>Patagolycus melastomus</i>	3	0	0
NEB	Castaneta	<i>Nemadactylus bergi</i>	1	0	0
MAT	Flounder	<i>Achirosetta tricholepis</i>	1	0	0