2021 1st 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 10th to 23rd February 2021. Fifty-five scientific trawls were taken during the survey; 39 fixed-station and 16 adaptive-station trawls. The scientific catch of the survey was 280.21 tonnes *D. gahi*.
2) An estimate of 31,770 tonnes *D. gahi* (95% confidence interval: 27,707 to 50,564 t) was calculated for the fishing zone by inverse distance weighting. This estimate was higher than 1st pre-season biomass last year (2020); but lower than each of the three years before that (2017 – 2019). Of the total, 7541 t were estimated north of 52 ºS, and 24,229 t were estimated south of 52 ºS.
3) Male and female *D. gahi* had significantly greater average mantle lengths, and greater average maturities, north of 52 ºS than south of 52 ºS. Males north: mean mantle length 12.21 cm; mean maturity stage 2.34, south: mean mantle length 11.77 cm; mean maturity stage 2.17. Females north: mean mantle length 11.80 cm; mean maturity stage 2.09, south: mean mantle length 11.29 cm; mean maturity stage 1.97.
4) 103 taxa were identified in the catches. *D. gahi* was the largest species group at 79.1% of total catch by weight, followed by rock cod (15.1%), blue whiting (3.3%), and medusae (0.6%) as the only other taxa comprising >0.5% of total catch. The proportion of rock cod in a pre-season survey was highest since 1st season 2017. Biological measurements and samples were taken from *D. gahi*, rock cod, toothfish, *Illex*, kingclip, hake, grenadier, hoki, and several non-commercial species.

Introduction

A stock assessment survey for *Doryteuthis gahi* (Falkland calamari – Patagonian longfin squid – colloquially *Loligo*) was carried out by FIFD personnel on-board the fishing vessel *Capricorn* from the 10th to 23rd February 2021; experimental license FK022E21. The survey started one day later and was one day shorter than usually allocated, as the *Capricorn* was taken on short notice as a replacement vessel.

This survey continues the series of surveys that have, since February 2006, been conducted immediately prior to season openings to estimate the *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 1st fishing season, 2021.
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 *D. gahi* trawls.
4) Collect biological information on *D. gahi*, rock cod, toothfish and opportunistically 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 (Figure 1). The delineation of the Loligo Box represents an area of approximately 31,517.9 km^2, subtracting the exclusion zone around Beauchêne Island.

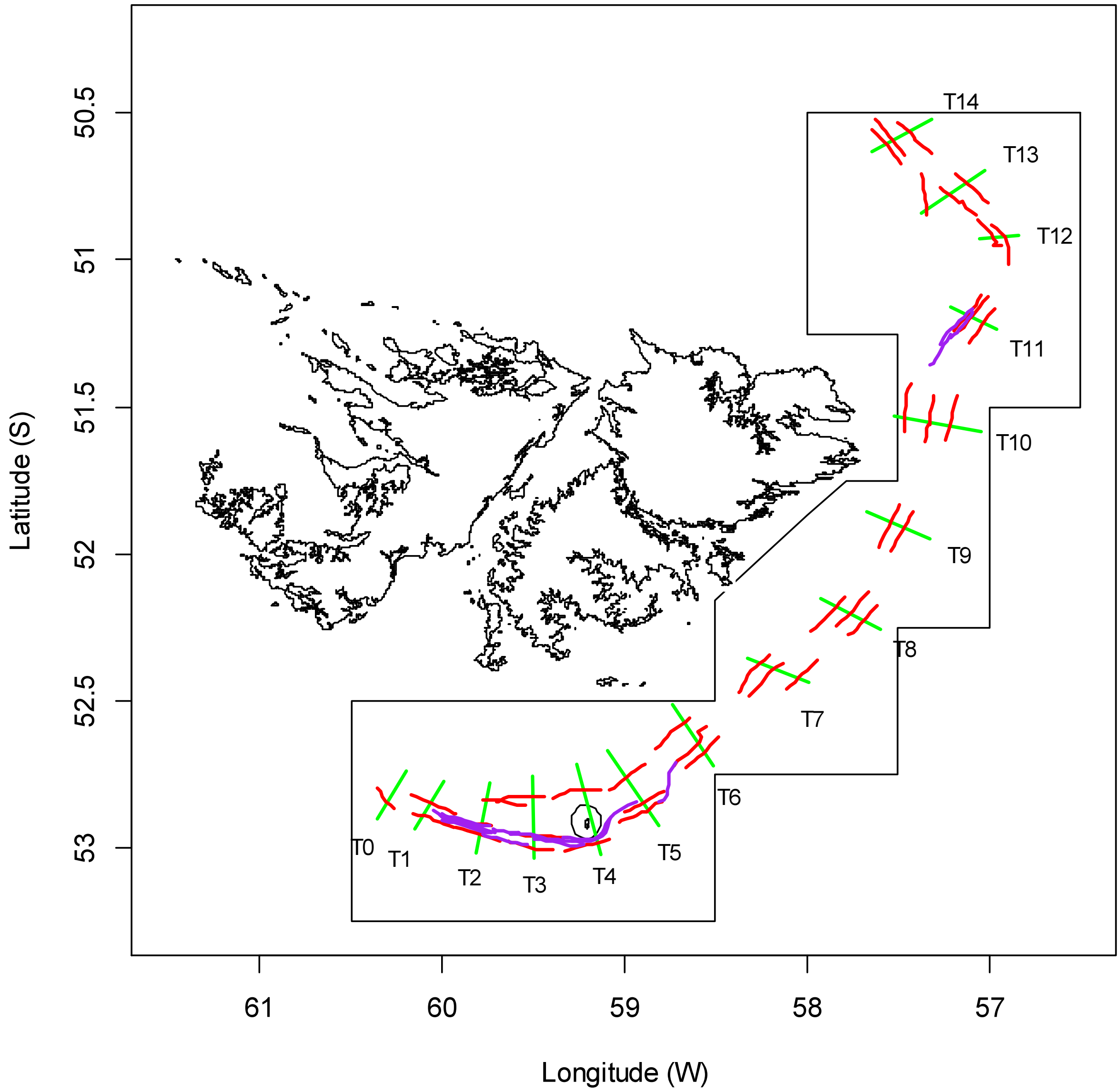

Figure 1. Survey transects (green lines), fixed-station trawls (red lines), and adaptive-station trawls (purple lines) sampled during the 1st pre-season 2021 survey. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone are in black.

F/V *Capricorn* is a Falkland Islands - registered stern trawler of 95.43 m length, 2511 gross tonnage, and 4400 main engine bhp. Like all vessels employed for these pre-season surveys, *Capricorn* operates regularly in the Falkland calamari fishery and used its commercial trawl gear for the survey catches. The following personnel from the FIFD participated in the 1st pre-season 2021 survey:

Andreas Winter	lead scientist
Zhanna Shcherbich	fisheries scientist
Neda Matošević	fisheries observer

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 *D. gahi* biomass estimates in high-density or high-variability locations. This dual approach ensures that the scientific requirements of randomization and repeatability are met (via fixed stations) and the spatiotemporal variability of the *D. gahi* population is captured (via adaptive stations) (Gawarkiewicz and Malek Mercer 2018). Trawl tracks were designed for an expected duration of 2 hours each. All trawls were bottom 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 a visual score was assessed 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 *D. gahi* 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 *D. gahi* amounts <100 kg were iteratively aggregated by adjacent intervals (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 data. Two or three observer baskets of unsorted catch were collected from most survey trawls (Table A3), depending on their volume and the sampling schedule. These baskets were hand-sorted by the 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 bycatches 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 thus assumed a catchability coefficient = 1, as commonly used in fishery surveys (Somerton et al. 1999)[a]. Swept area is 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

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[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 will 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.

from the distance between trawl doors (determined per interval) according to the equation (Seafish 2010):

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

Measurements of *Capricorn*'s trawl, provided by the vessel master, were: sweep = 115 m, bridle = 42 m and footrope = 181 m.

Biomass density estimates were extrapolated to the fishing area using an inverse distance weighting algorithm (Ramos and Winter 2020). As previously, the fishing area was 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 fishing 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. Additional specimens of *D. gahi* were collected 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 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 commercial fish species as available.

Results

Catch rates and distribution

The survey started as usual[c] with fixed-station trawls in the north and proceeded throughout the Loligo Box. A schedule of 4 survey trawls per day was maintained except for February 23rd, when a fourth survey trawl was not taken to allow time to prepare equipment and samples for disembarkation. In total 55 scientific trawls were recorded during the survey: 39 fixed station trawls catching 105.17 t *D. gahi*, and 16 adaptive-station trawls catching 175.04

[c] Since at least 2010 (Arkhipkin et al. 2010).

t *D. gahi*. Fourteen optional trawls (directed by the vessel master, after survey hours) yielded an additional 162.97 t *D. gahi*, bringing the total catch for the survey to 443.18 t. The scientific survey catch of 280.21 t is the second-highest for a 1st season in the past ten years (Table 1).

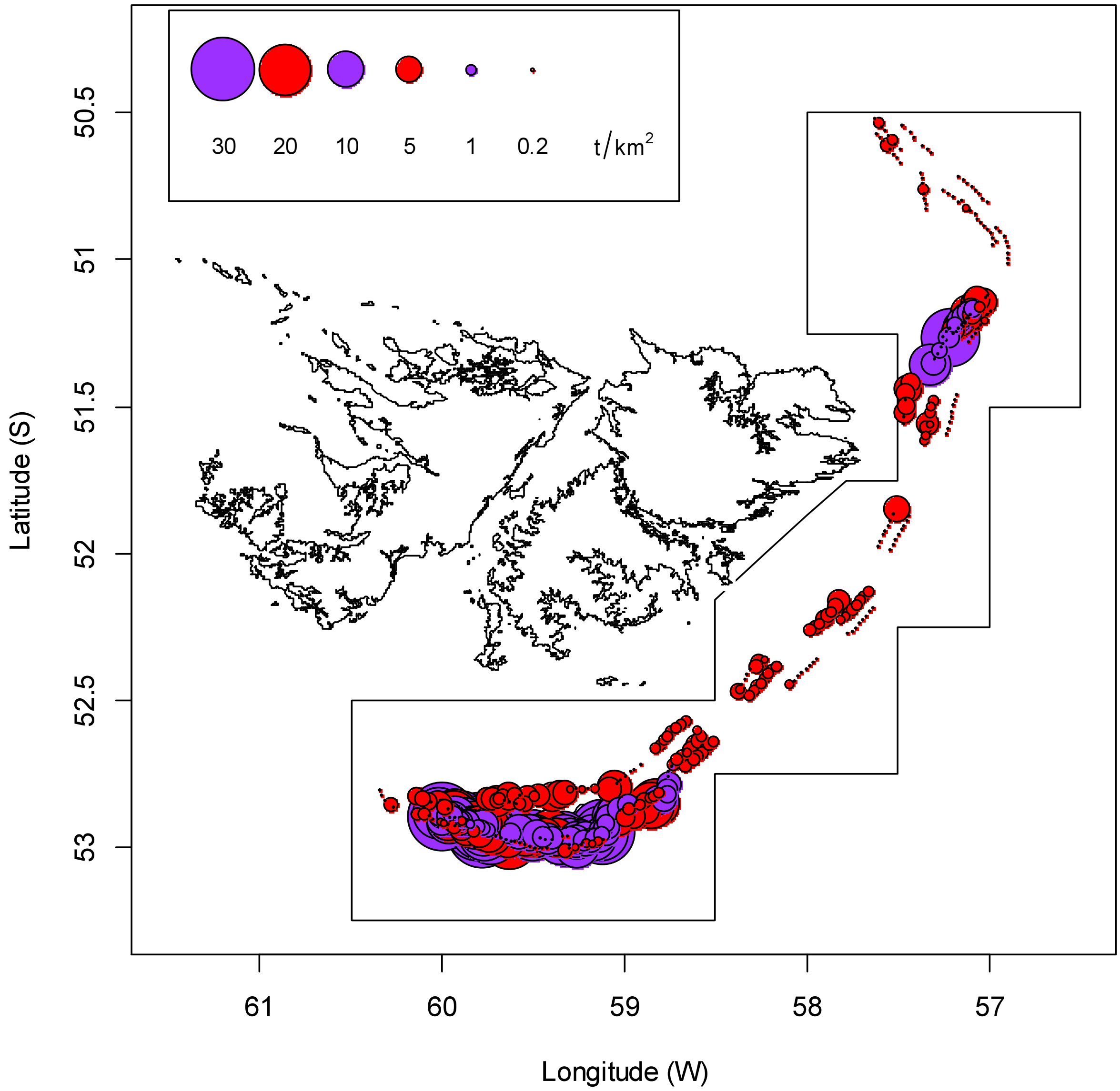

Figure 2. *D. gahi* CPUE (t km^{-2}) of fixed-station (red) and adaptive-station (purple) trawls per 15-minute trawl interval. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone (mostly hidden) are traced in black.

Average *D. gahi* catch density (Figure 2) among fixed-station trawls north of 52° S was 0.64 t km^{-2}, and south of 52° S was 2.31 t km^{-2}. The north fixed-station density was the third-highest for a 1st season of the past 11 years, after 2016 and 2020, and the south fixed-station density was median among the past 11 years. Average *D. gahi* catch density among adaptive-station trawls north of 52° S was 2.00 t km^{-2}; below average for the past 11 years. However, adaptive trawls in the north were taken partially for the logistic purpose of placing the vessel back within range of Port William on the last survey day. Average *D. gahi* catch density among adaptive-station trawls south of 52º S was 7.51 t km^{-2}; above median among the past 11 years.

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*	314	56807
2018	59*	115	32194	53	510	183593
2019	55	382	49618	51	298	50880
2020	59	268	27991	55	575	92194
2021	55	280	31770			

* Includes four juvenile toothfish transect trawls.

Biomass estimation

Total *D. gahi* biomass in the fishing area was estimated at 31,770 tonnes, with a 95% confidence interval of [27,707 to 50,564 t]. Distribution of the estimated biomass was as usual preponderant towards the south: 24,229 tonnes with a 95% c.i. of [23,556 to 41,787 t], vs. north: 7541 tonnes with a 95% c.i. of [4655 to 12,779 t]. Within the south sub-area 50% of *D. gahi* density was aggregated in 69 of 392 5×5 km area units[d], and 95% of density was aggregated in 264 of the 392 5×5 km area units (Figure 3). Within the north sub-area 50% of *D. gahi* density was aggregated in 43 of 368 5×5 km area units, and 95% of density was aggregated in 150 of the 368 5×5 km area units (Figure 3). The total estimate of 31,770 t was higher than in 2020, but lower than each of the three years before (2017 – 2019)[e] (Table 1).

Biological data

One hundred and three taxa were identified in the survey catches (Appendix Table A2). *D. gahi* was the predominant catch with the lowest proportion for a first season since 2018 (79.1%, Table A2), whereby all first pre-season surveys from 2012 to 2018 had a lower *D. gahi* proportion than 79.1%. Second- and third-highest catch species were rock cod and southern blue whiting *Micromesistius australis*, as typical in recent first pre-season surveys (e.g., Winter et al. 2019, 2020). Rock cod catch was the highest for a first pre-season survey since 2017 (Winter et al. 2017), while blue whiting catch was median among the last five first

[d] Excluding depths <90 m or >400 m.
[e] Note that biomass estimates from earlier years may not be explicitly equivalent because the definition of the fishing area over which the geostatistic algorithm is applied has been revised several times.

pre-season surveys. Medusae (jellyfish) was the only other taxon comprising as much as 0.5% of total catch (Table A2); the highest in a first pre-season since 2018, when it was the highest catch (Winter et al. 2018).

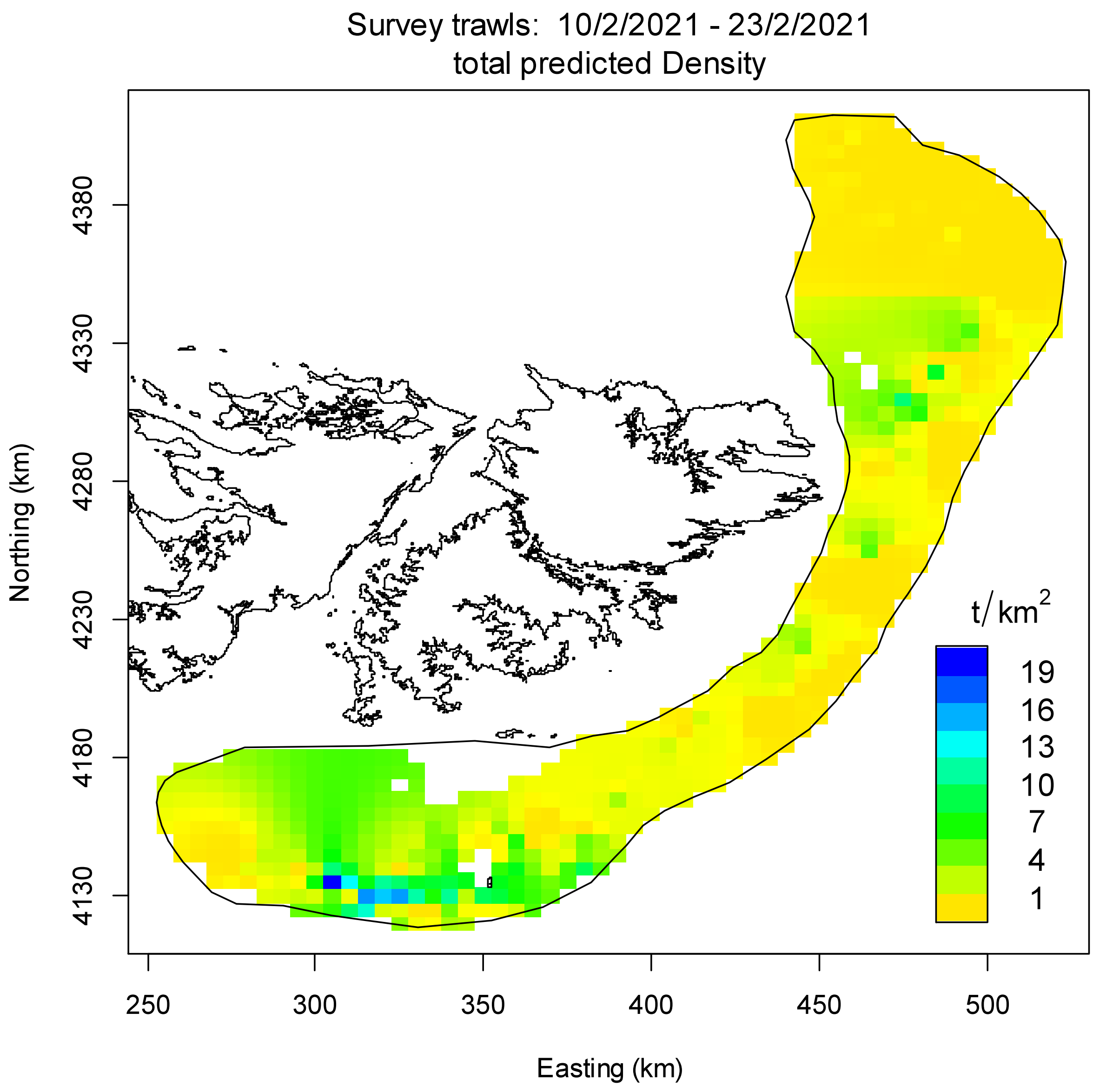

Figure 3. *D. gahi* predicted density estimates per 5 km^2 area units. Blank area units within the perimeter are either <90 or >400 m average depth. Coordinates were converted to WGS 84 projection in UTM sector 21F using the R library rgdal (proj.maptools.org).

7552 *D. gahi* were measured for length and maturity in the survey (2924 males, 4628 females, from 45 of the trawls). The total sex ratio was significantly ($p < 0.0001$) majority female. Thirty-one individual trawls had a significant preponderance of females, whereas one trawl in the south, north-west of Beauchêne Island, had a significant preponderance of males. Preponderance of females had a slight significant positive correlation with depth ($p < 0.05$), concurring with earlier studies that have found females move deeper (Hatfield et al. 1990, Arkhipkin and Middleton 2002).

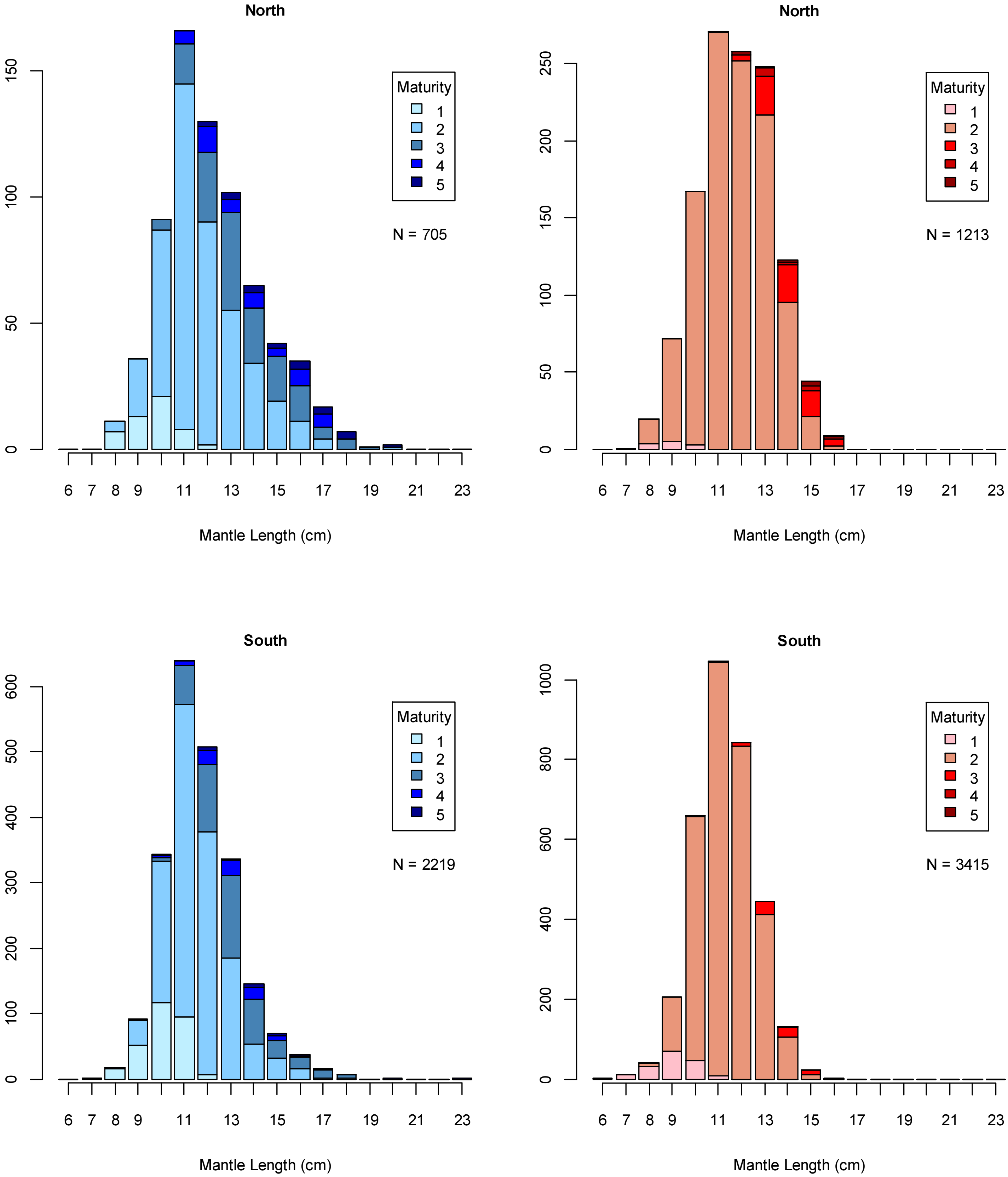

Figure 4. Length-frequency distributions by maturity stage of male (blue) and female (red) *D. gahi* from trawls north (top) and south (bottom) of latitude 52 ºS.

D. gahi mantle length and maturity distributions north and south of 52° S are plotted in Figure 4. For males north: mean mantle length 12.21 cm; mean maturity stage 2.34 (on a scale of 1 to 5, Lipinski 1979), males south: mean mantle length 11.77 cm; mean maturity stage 2.17. Females north: mean mantle length 11.80 cm; mean maturity stage 2.09, females south: mean mantle length 11.29 cm; mean maturity stage 1.97. Mantle length distributions were significantly different between north and south for both males and females (Kruskal-Wallis test, $p < 0.01$). In contrast to the previous two first pre-seasons (Winter et al. 2019, 2020), gonad maturity distributions were also significantly different between north and south for both males or females ($p < 0.01$).

D. gahi were collected and frozen from 18 stations for statolith sampling ashore. Otoliths and *Illex argentinus* statoliths taken during the survey are summarized in Table A4. Additional length / weight measurements were taken from patchy benthoctopus (*Muusoctopus eureka*), Patagonian bobtail squid (*Semirossia patagonica*), porbeagle (*Lamna nasus*), grey-tailed skate (*Bathyraja griseocauda*), cuphead skate (*Bathyraja scaphiops*), yellownose skate (*Zearaja chilensis*), white spotted skate (*Bathyraja albomaculata*), and blonde skate (*Bathyraja brachyurops*).

Pinniped monitoring

Several pinnipeds were sighted by survey scientists, but no interactions or incidental catches occurred. Correspondingly, no seal exclusion device (SED) was used in the trawl gear throughout the survey.

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Appendix

Table A1. Survey stations with total *Doryteuthis gahi* catch. Time: Stanley FI time. The actual fishing schedule operated on ship time, one hour advanced. Latitude: °S, longitude: °W. Transects labelled A were adaptive-station trawls.

Transect / Trawl	Data Station	Date	Start			End			Depth (m)	*D. gahi* (kg)
			Time	Lat	Lon	Time	Lat	Lon		
14 - 37	715	10/02/2021	06:00	50.56	57.64	08:00	50.67	57.48	137	242
14 - 38	716	10/02/2021	09:00	50.64	57.47	11:00	50.52	57.62	146	378
14 - 39	717	10/02/2021	11:55	50.53	57.50	13:55	50.64	57.31	249	0
13 - 36	718	10/02/2021	14:50	50.71	57.19	16:50	50.80	57.01	264	21
13 - 34	719	11/02/2021	05:35	50.85	57.34	07:35	50.71	57.37	130	168
13 - 35	720	11/02/2021	08:25	50.75	57.27	10:25	50.84	57.07	130	147
12 - 33	721	11/02/2021	11:15	50.88	56.98	13:15	51.02	56.89	118	2
12 - 32	722	11/02/2021	14:05	50.95	56.93	16:05	50.86	57.06	118	0
11 - 31	723	12/02/2021	05:30	51.16	56.97	07:31	51.28	57.11	140	84
11 - 30	724	12/02/2021	08:20	51.24	57.16	10:20	51.12	57.01	128	1911
11 - 29	725	12/02/2021	11:10	51.12	57.05	13:10	51.24	57.19	121	8041
10 - 26	726	12/02/2021	15:40	51.58	57.47	17:40	51.42	57.43	126	3465
10 - 28	727	13/02/2021	05:35	51.61	57.24	07:35	51.46	57.17	226	3
10 - 27	728	13/02/2021	08:40	51.46	57.30	10:40	51.62	57.35	147	1382
9 - 24	729	13/02/2021	12:10	51.84	57.49	14:10	51.98	57.61	157	1071
9 - 25	730	13/02/2021	15:40	51.86	57.42	17:41	51.99	57.53	215	20
8 - 23	731	14/02/2021	05:30	52.17	57.61	07:30	52.27	57.77	261	0
8 - 22	732	14/02/2021	08:25	52.25	57.84	10:25	52.13	57.66	200	1575
8 - 21	733	14/02/2021	11:15	52.15	57.79	13:15	52.27	57.98	138	2919
7 - 18	734	14/02/2021	14:25	52.35	58.20	16:30	52.47	58.37	146	1134
7 - 20	735	15/02/2021	05:30	52.46	58.11	07:30	52.36	57.94	252	147
7 - 19	736	15/02/2021	08:35	52.38	58.13	10:35	52.49	58.32	174	1596
6 - 16	737	15/02/2021	11:50	52.59	58.55	14:03	52.72	58.73	155	2793
5 - 13	738	15/02/2021	14:55	52.81	58.78	16:55	52.88	59.00	145	2226
6 - 17	739	16/02/2021	05:25	52.62	58.49	07:25	52.73	58.66	230	1848
5 - 14	740	16/02/2021	08:35	52.84	58.79	10:40	52.91	59.03	155	12000
4 - 11	741	16/02/2021	11:35	52.97	59.08	13:35	53.01	59.32	227	831
3 - 8	742	16/02/2021	15:20	52.95	59.58	17:20	52.97	59.30	173	14322
0 - 1	743	17/02/2021	05:40	52.80	60.35	*6:55	52.87	60.26	256	315
1 - 2	744	17/02/2021	07:55	52.82	60.17	10:10	52.89	59.93	187	7308
1 - 3	745	17/02/2021	11:25	52.88	60.16	13:25	52.93	59.93	222	1029
2 - 5	746	17/02/2021	14:20	52.91	59.99	16:20	52.92	59.72	176	13020
6 - 15	747	18/02/2021	05:30	52.56	58.65	07:30	52.67	58.83	131	1344
5 - 12	748	18/02/2021	08:10	52.71	58.89	10:10	52.80	59.08	119	2100
4 - 10	749	18/02/2021	10:50	52.80	59.13	12:50	52.83	59.39	113	3336
3 - 7	750	18/02/2021	13:45	52.83	59.43	15:50	52.84	59.70	152	4074
3 - 9	751	19/02/2021	05:25	53.00	59.39	07:30	52.98	59.63	242	4536
2 - 6	752	19/02/2021	08:20	52.98	59.68	10:25	52.93	59.93	234	7707
2 - 4	753	19/02/2021	11:35	52.84	59.78	13:35	52.86	59.54	156	2079
A - 1	754	19/02/2021	14:40	52.93	59.74	16:40	52.89	59.99	175	15099
A - 2	755	20/02/2021	05:40	52.99	59.53	07:50	52.96	59.78	232	11151
A - 3	756	20/02/2021	09:05	52.95	59.73	11:20	52.91	59.99	193	22113
A - 4	757	20/02/2021	12:25	52.88	60.05	14:30	52.94	59.79	185	23646
A - 5	758	20/02/2021	15:50	52.92	59.77	17:50	52.89	60.00	179	9240

A - 6	759	21/02/2021	05:50	52.97	59.49	07:49	52.99	59.23	184	9240
A - 7	760	21/02/2021	08:35	52.98	59.23	10:46	52.96	59.50	175	14784
A - 8	761	21/02/2021	11:40	52.96	59.45	13:50	52.94	59.72	175	20097
A - 9	762	21/02/2021	14:45	52.95	59.71	16:45	52.90	59.95	183	1386
A - 10	763	22/02/2021	05:30	52.71	58.72	07:28	52.84	58.81	150	3654
A - 11	764	22/02/2021	08:25	52.85	58.94	10:29	52.95	59.12	146	11088
A - 12	765	22/02/2021	11:15	52.94	59.10	13:15	52.97	59.33	165	16632
A - 13	766	22/02/2021	14:00	52.98	59.29	16:08	52.90	59.07	158	9240
A - 14	767	23/02/2021	06:00	51.28	57.27	08:00	51.16	57.09	121	3176
A - 15	768	23/02/2021	08:50	51.18	57.09	10:50	51.26	57.21	125	2625
A - 16	769	23/02/2021	11:40	51.25	57.21	13:50	51.36	57.32	128	1869

* Trawl 0 – 1 was hauled early after the net appeared to touch bottom, following a heavy catch spike that turned out to be mostly blue whiting.

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

Species Code	Species / Taxon	Total catch (kg)	Total catch (%)	Sample (kg)	Discard (kg)
LOL	*Doryteuthis gahi*	280214	79.1	446	0
PAR	*Patagonotothen ramsayi*	53349	15.1	239	52882
BLU	*Micromesistius australis*	11831	3.3	164	2789
MED	Medusae	2139	0.6	0	2139
CGO	*Cottoperca gobio*	1580	0.4	0	1580
ILL	*Illex argentinus*	689	0.2	46	135
PTE	*Patagonotothen tessellata*	634	0.2	0	634
KIN	*Genypterus blacodes*	439	0.1	14	0
TOO	*Dissostichus eleginoides*	405	0.1	299	0
WHI	*Macruronus magellanicus*	374	0.1	134	60
BAC	*Salilota australis*	359	0.1	18	79
GRC	*Macrourus carinatus*	280	0.1	46	28
ING	*Moroteuthis ingens*	239	0.1	0	239
GOC	*Gorgonocephalus chilensis*	233	0.1	0	233
CHE	*Champsocephalus esox*	187	0.1	27	98
ZYP	*Zygochlamys patagonica*	183	0.1	0	183
GRF	*Coelorinchus fasciatus*	172	<0.1	2	172
PAU	*Patagolycus melastomus*	162	<0.1	0	162
POR	*Lamna nasus*	110	<0.1	55	55
ALG	Algae	97	<0.1	0	97
DGH	*Schroederichthys bivius*	74	<0.1	0	74
SPN	Porifera	69	<0.1	0	69
RFL	*Zearaja chilensis*	61	<0.1	11	30
RBR	*Bathyraja brachyurops*	38	<0.1	3	13
BUT	*Stromateus brasiliensis*	32	<0.1	16	32
RGR	*Bathyraja griseocauda*	31	<0.1	22	0
ILF	*Iluocoetes fimbriatus*	30	<0.1	0	30
SQT	Ascidiacea	24	<0.1	0	24
PAT	*Merluccius australis*	24	<0.1	22	0
EGG	Eggmass	21	<0.1	0	21
HYD	Hydrozoa	19	<0.1	0	19

MUG	*Munida gregaria*	16	<0.1	0	16
WRM	*Chaetopterus variopedatus*	11	<0.1	0	11
STA	*Sterechinus agassizi*	11	<0.1	0	11
ANM	Anemone	11	<0.1	0	11
PMB	*Protomictophum bolini*	10	<0.1	0	10
GYN	*Gymnoscopelus nicholsi*	10	<0.1	0	10
RAL	*Bathyraja albomaculata*	8	<0.1	2	2
LIC	*Lithodes confundens*	8	<0.1	0	8
CAZ	*Calyptraster* sp.	8	<0.1	0	8
ALF	*Allothunnus fallai*	8	<0.1	8	0
ODM	*Odontocymbiola magellanica*	7	<0.1	0	7
OCC	Octocoralia	7	<0.1	0	7
FUM	*Fusitriton m. magellanicus*	7	<0.1	0	7
SAL	*Salpa* sp.	6	<0.1	0	6
RDO	*Amblyraja doellojuradoi*	6	<0.1	0	6
POA	*Porania antarctica*	6	<0.1	0	6
OPV	*Ophiacanta vivipara*	5	<0.1	0	5
MIR	*Mirostenella* sp.	5	<0.1	0	5
ASA	*Astrotoma agassizii*	5	<0.1	0	5
GOR	Gorgonacea	4	<0.1	0	4
AST	Asteroidea	4	<0.1	0	4
SUN	*Labidaster radiosus*	3	<0.1	0	3
PSX	Psolidae	3	<0.1	0	3
MUE	*Muusoctopus eureka*	3	<0.1	2	0
HAK	*Merluccius hubbsi*	3	<0.1	2	0
BRY	Bryozoa	3	<0.1	0	3
TRP	*Tripilaster philippi*	2	<0.1	0	2
RSC	*Bathyraja scaphiops*	2	<0.1	2	0
RMC	*Bathyraja macloviana*	2	<0.1	0	2
OPL	*Ophiuroglypha lymanii*	2	<0.1	0	2
MAV	*Magellania venosa*	2	<0.1	0	2
ELE	Eledoninae-like octopod	2	<0.1	0	2
BAL	*Bathydomus longisetosus*	2	<0.1	0	2
RPX	*Psammobatis* spp.	1	<0.1	0	1
RED	*Sebastes oculatus*	1	<0.1	1	0
RBZ	*Bathyraja cousseauae*	1	<0.1	0	1
NUD	Nudibranchia	1	<0.1	0	1
NEM	*Neophyrnichthys marmoratus*	1	<0.1	0	1
MYX	*Myxine* sp.	1	<0.1	0	1
MUN	*Munida* sp.	1	<0.1	0	1
EUL	*Eurypodius latreillei*	1	<0.1	0	1
CTA	*Ctenodiscus australis*	1	<0.1	0	1
COL	*Cosmasterias lurida*	1	<0.1	0	1
AUC	*Austrocidaris canaliculata*	1	<0.1	0	1
THN	*Thysanopsetta naresi*	<1	<0.1	0	0
SRP	*Semirossia patagonica*	<1	<0.1	0	0
SAR	*Sprattus fuegensis*	<1	<0.1	0	0
PYX	Pycnogonida	<1	<0.1	0	0
PYM	*Physiculus marginatus*	<1	<0.1	0	0
PRX	*Paragorgia* sp.	<1	<0.1	0	0
POL	Polychaeta	<1	<0.1	0	0

PES	*Peltarion spinosulum*	<1	<0.1	0	0
PEN	Pennatulacea	<1	<0.1	0	0
OPS	*Ophiactis asperula*	<1	<0.1	0	0
OPH	Ophiuroidea	<1	<0.1	0	0
NOW	*Paranotothenia magellanica*	<1	<0.1	0	0
MUU	*Munida subrugosa*	<1	<0.1	0	0
MLA	*Muusoctopus longibrachus akambei*	<1	<0.1	0	0
MAM	*Mancopsetta milfordi*	<1	<0.1	0	0
ISO	Isopoda	<1	<0.1	0	0
ICA	*Icichthys australis*	<1	<0.1	0	0
HEX	*Henricia* sp.	<1	<0.1	0	0
GYB	*Gymnoscopelus bolini*	<1	<0.1	0	0
FLX	*Flabellum* spp.	<1	<0.1	0	0
DEG	*Dendrobathypathes* cf. *grandis*	<1	<0.1	0	0
CRY	*Crossaster* sp.	<1	<0.1	0	0
CRI	Crinoidea	<1	<0.1	0	0
COT	*Cottunculus granulosus*	<1	<0.1	0	0
COG	*Patagonotothen guntheri*	<1	<0.1	0	0
BAO	*Bathybiaster loripes*	<1	<0.1	0	0
ANT	Anthozoa	<1	<0.1	0	0
ACS	*Acanthoserolis schythei*	<1	<0.1	0	0
		354,305.0		1584.7	62,062.4

Table A3. Basket samples per station, in kg, with minor or occasional species groups summarized in the 'other' category.

Station Basket	LOL	PAR	TOO	BLU	CHE	RAY	WHI	KIN	ILL	CGO	PTE	Other
715 - 1	4.99	5.37	0	0	0.04	4.32	0	3.22	0.04	0.33	0	15.19
715 - 2	6.11	7.62	0	0	0.04	3.84	0	0	0	0	0	14.08
716 - 1	12.96	18.32	0	0	0.00	2.45	0	0.63	0.02	0.58	0.01	4.74
716 - 2	7.49	8.97	1.92	0	0	7.01	0	0	0	0.75	0	1.35
717 - 1	0	0.27	0	24.95	0	0	0.75	3.11	0	0	0	0.36
717 - 2	0	0.23	0	35.04	0	0	0.33	4.02	0	0	0	0.29
718 - 1	0	1.64	1.29	19.45	0	3.89	0	3.65	0	0	0	6.30
718 - 2	0	1.96	0	33.34	0	0	0.75	1.15	0	0	0	2.24
718 - 3	0	0.41	7.64	24.95	0	0	0	0.67	0	0	0	1.98
719 - 1	4.92	21.11	0	0	0.04	0	0	0	0.03	2.07	0.13	11.13
719 - 2	2.90	12.55	0	0	0	0	0	0	0	1.56	0	12.90
720 - 1	4.28	24.82	0	0.08	0	0	0	0	0	0.04	0.02	0.41
720 - 2	3.50	30.76	1.36	0	0	0	0	0	0	1.01	0.03	0.09
721 - 1	1.17	33.40	1.12	0	0	0	0	0	0	2.35	0.16	1.52
722 - 1	0.13	8.85	0	0	0	0	0	0	0	3.12	0.40	13.69
723 - 1	0.14	22.21	0	0	0	0	0	0	0	0.32	0	0.03
723 - 2	0.26	25.23	0	0	0	0	0	0	0	0.52	0	0.33
724 - 1	33.20	6.20	0	0	0	0	0	0	0.71	0	0.42	0.21
724 - 2	29.58	6.38	0	0	0	2.00	0	0	0.30	0.17	0.15	0.30

725 - 1	31.80	0.23	0	0	0	0	0	0	0.11	0	0.26	0.03
725 - 2	30.48	0.48	0	0	0	0	0	0	0.39	0	0.25	0
725 - 3	33.20	0.64	0	0	0	0	0	0	0.33	0	0.20	0.28
726 - 1	30.02	0.27	0	0	0	0	0	0	0	0	0.15	0.16
726 - 2	32.04	0.25	0	0	0	0	0	0	0.03	0	0.15	0.39
727 - 1	3.21	11.99	1.28	1.13	0	0	0	0	0	0.45	0	9.77
727 - 2	8.84	21.33	0.71	0.06	0	0	0	0	0	0.57	0.13	4.05
728 - 1	18.54	13.45	0	0	0	0.14	0	0	0.15	0	0.16	0.26
728 - 2	15.64	18.76	0	0	0	0	0	0	0.06	0	0.16	0.29
728 - 3	21.17	14.82	0	0	0	0	0	0	0.38	0.11	0.01	0.65
729 - 1	17.84	11.85	0	0	0	0	0	0	0.25	0.65	0.05	1.78
729 - 2	17.43	15.05	0	0	0	0	0	0	0.26	1.06	0.03	2.90
730 - 1	3.52	30.12	0	0.70	0	0	0.77	0	0	1.88	0	1.83
730 - 2	1.52	8.02	0	0	0	0	0	0	0	0.87	0	0.42
731 - 1	0.08	18.26	0.75	8.62	0	0	1.41	0	0	0.47	0	3.11
731 - 2	0	16.80	1.28	6.28	0	0.16	3.91	0	0	0.19	0	1.92
732 - 1	23.49	15.87	0	0.07	0	0	0	0	0	0.73	0	0.19
732 - 2	18.76	13.74	0	0.15	0	0	1.17	0	0	0.91	0	0.25
733 - 1	34.00	2.66	0	0	0.03	0	0	0	0.03	0	0.04	0.53
733 - 2	31.10	2.78	0	0	0.17	0	0	0	0.07	0.30	0.01	0.08
734 - 1	20.52	18.00	0	0	0.69	0	0	0	0.05	1.04	0	0.48
734 - 2	17.10	13.19	0	0	0.48	0	0	0	0.09	0.71	0	0.35
735 - 1	5.31	27.00	0	1.04	0	0	0	0	0	0	0	0.63
735 - 2	4.08	27.66	0	0.97	0	0	0.99	0	0	0.44	0	1.06
736 - 1	24.71	12.53	0	0.07	0	0	0	0	0.05	0.05	0	0.23
736 - 2	25.33	9.97	0	0	0	0	0	0	0	0.57	0	0.29
737 - 1	21.86	12.49	0	0	0	0	0	0	0	0.73	0	0.02
737 - 2	20.73	11.52	0	0	0	0	0	0	0	0.03	0	0.02
737 - 3	24.67	9.83	0	0	0	0	0	0	0	0.22	0	0.03
738 - 1	29.80	10.50	0	0	0	0	0	0	0	0.17	0	0.04
738 - 2	25.82	6.85	0	0	0	0	1.41	0	0.37	0.17	0	0.07
739 - 1	20.40	15.72	0	0.06	0	0	0	0	0	0.09	0	0.33
739 - 2	22.98	7.35	0	0.18	0	0	0	0	0.07	0.08	0	0.84
740 - 1	27.25	10.46	0	0	0	0	0	0	0	0	0	0
740 - 2	24.75	12.95	0	0	0	0	0	0	0	0.05	0.03	0.01
741 - 1	7.08	24.43	0	0	0	0	4.22	0	0	0.21	0	0
741 - 2	5.59	24.21	0	0	0	0	3.18	0	0	0.79	0.02	0
742 - 2	40.78	0.72	0	0	0	0	0	0	0	0.04	0	0
743 - 1	0.15	3.35	4.33	28.12	0	0	0	0	0	0.08	0	1.51
743 - 2	1.07	1.29	1.07	30.05	0	0	0	0	0	0.83	0	0.47
743 - 3	0.14	0.64	0	22.30	0	4.81	0	2.53	0.11	0	0	1.79
743 - 4	0	1.27	13.08	18.93	0	0	0	2.01	0	0	0	0.24
743 - 5	0.30	0.75	0	22.89	0	0	0	2.81	0	0	0	0.41
744 - 1	22.42	5.78	0	0	0.31	0	0	0	0.03	1.09	0	0.04
744 - 2	22.65	4.39	0	0	0	0	0	0	0	0.77	0	0
745 - 1	21.39	12.01	0	1.44	0	0	0	0	0.14	0.57	0	0.45
745 - 2	11.92	7.13	0	0.95	0	0	0	0	0.38	2.01	0	6.51
746 - 1	37.31	0.71	0	0	0	0	0	0	0	0.19	0	0
746 - 2	30.69	0.76	0	0	0.39	0	0	0	0	0	0	0
746 - 3	30.47	0.73	0	0	0	0	0	0	0.04	0	0	0
747 - 1	29.59	7.18	0	0	0	0	0	0	0.10	0	0.84	1.21

747 - 2	23.45	8.31	0	0	0.03	0	0	0	0	0.26	0.38	0.52
748 - 1	20.72	4.88	0	0	0	0	0	0	0.13	0	0.39	0.57
748 - 2	26.65	4.41	0	0	0.15	0	0	0	0.05	0.49	0.34	1.79
749 - 1	36.15	0	0	0	0.02	0	0	0	0.04	0	0.41	0.77
749 - 2	32.08	0.61	0	0	0	0	0	0	0.03	0	0.86	0.23
750 - 1	31.48	2.16	0	0	0.14	0	0	0	0	0.14	0.01	0.44
750 - 2	29.72	2.03	0	0	0.72	0	0	0	0.02	0.11	0.01	0.37
750 - 3	36.86	5.15	0	0	0.15	0	0	0	0	0.41	0.28	0.36
751 - 1	25.83	6.23	0	0	0	0	0.50	0	0.86	0.12	0	1.11
751 - 2	25.43	5.99	0	0	0	0	0.77	0	0	0.43	0	1.76
752 - 1	38.67	2.40	0	0	0	0	0	0	0.05	0	0	0.17
752 - 2	38.92	2.76	0	0	0	0	0	0	0.13	0	0	0.09
753 - 1	32.90	7.72	0	0	0.71	0	0	0	0.09	0.44	0.16	0.85
753 - 2	31.06	6.15	0	0	0.27	0.02	0	0	0	1.28	0.14	3.06
754 - 1	39.27	1.00	0	0	0	0	0	0	0.05	0	0	0.02
754 - 2	40.44	0.65	0	0	0	0	0	0	0.16	0.12	0	0.05
754 - 3	31.80	0.56	0.54	0	0	0	0	0	0.11	0.19	0	0
755 - 1	37.49	0.57	0	0	0	0	0	0	0	0	0	0.05
755 - 2	33.48	0.53	0	0	0	0	0	0	0	0	0	0.26
756 - 1	35.73	2.15	0	0	0	0	0	0	0	0	0	0
756 - 2	29.00	1.76	0	0	0	0	0	0	0	0	0	0
756 - 3	30.66	1.88	0	0	0	0	0	0	0	0	0	0
757 - 1	37.84	0.19	0	0	0	0	0	0	0	0	0	0
757 - 2	34.22	0.58	0	0	0	0	0	0	0	0	0	0
757 - 3	35.26	0.32	0	0	0	0	0	0	0.29	0	0	0
758 - 1	36.39	0.90	0	0	0	0	0	0	0	0	0	1.67
759 - 1	32.01	4.79	0	0	0	0	0	0	0.17	0	0	0.13
759 - 2	30.19	5.07	0	0	0	0	0	0	0.08	0	0	0.10
760 - 1	37.08	0.80	0	0	0	0	0	0	0.05	0	0	0.02
760 - 2	35.88	1.14	0	0	0	0	0	0	0	0.06	0.01	0
761 - 1	36.72	0.88	0	0	0	0	0	0	0	0.81	0.18	0.24
761 - 2	18.08	0.38	0	0	0	0	0	0	0	0	0	0
762 - 1	21.92	15.76	0	0	0	0	0	0	0	0	0.03	0.27
762 - 2	21.90	15.54	0	0	0.19	0	0	0	0.04	0.33	0.06	0.28
763 - 1	9.94	28.14	0	0	0	0	0	0	0	0	0	0
763 - 2	8.35	28.20	0	0	0	0	0	0	0.07	0.24	0.04	0
764 - 1	39.36	0.91	0	0	0	0	0	0	0.05	0.04	0.05	0.01
764 - 2	40.28	0.82	0	0	0	0	0	0	0.25	0	0.04	0.07
764 - 3	31.72	1.93	0	0	0.14	0	0	0	0.05	0.04	0	2.40
765 - 1	37.92	0.31	0	0	0	0	0	0	0	0	0	0
765 - 2	37.20	0.61	0	0	0	0	0	0	0.15	0	0	0.05
766 - 1	36.66	1.25	0	0	0	0	0	0	0.30	0	0	0.08
766 - 2	35.56	0.89	0	0	0	0	0	0	0.35	0.17	0	0
767 - 1	34.81	0.28	0	0	0	0	0	0	0.51	0	0.03	2.61
767 - 2	30.42	0.24	0	0	0	0	0	0	0.41	0	0.05	2.39
768 - 1	33.02	0.46	0	0	0	0	0	0	0.24	0	0.55	2.06
768 - 2	24.35	0.33	0	0	0	0.82	0	0	0.46	0.71	0.32	4.98
769 - 1	41.48	0.69	0	0	0	0.13	0	0	0.39	0	0.27	4.75

Table A4. Summary of otolith / statolith numbers by species by sex taken during the survey (other than *D. gahi*).

Species		N otoliths	
		M	F
Patagonian Toothfish	*Dissostichus eleginoides*	122	121
Common Rock cod	*Patagonotothen ramsayi*	143	100
Icefish	*Champsocephalus esox*	67	67
Hoki	*Macruronus magellanicus*	13	28
Southern Blue Whiting	*Micromesistius australis*	26	13
Red cod	*Salilota australis*	9	13
Ridge- Scaled Rattail	*Macrourus carinatus*	2	18
Banded Whiptail	*Coelorinchus fasciatus*	1	10
Patagonian Hake	*Merluccius australis*	2	7
Kingclip	*Genypterus blacodes*	3	4
Small Flounder	*Thysanopsetta naresi*	1	1
Patagonian Redfish	*Sebastes oculatus*	2	0
Common Hake	*Merluccius hubbsi*	0	2
Yellowfin Rock cod	*Patagonotothen guntheri*	2	0
Dwarf codling	*Physiculus marginatus*	0	1
Yellowbelly	*Paranotothenia magellanica*	1	0
Largemouth Flounder	*Mancopsetta milfordi*	1	0
		N statoliths	
Argentine shortfin squid	*Illex argentinus*	59	46