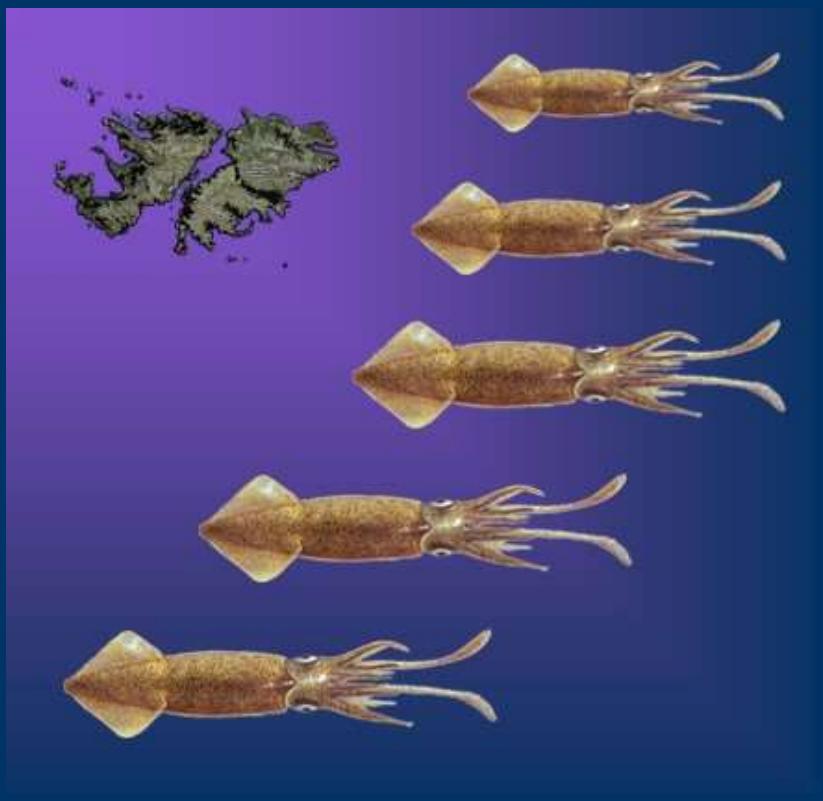
2021 2nd Pre-Season Assessment Survey

Falkland calamari

(*Doryteuthis gahi*)



Andreas Winter · Toni Trevizan
Zhanna Shcherbich · Jolien Claes

Natural Resources - Fisheries
Falkland Islands Government

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Index

Summary

1) A stock assessment survey for *Doryteuthis gahi* (Falkland calamari) was conducted in the 'Loligo Box' from 12th to 26th July 2021. This was the first ever *D. gahi* survey to be conducted with seal exclusion devices (SED) in all trawls. Fifty-nine scientific trawls were taken during the survey; 39 fixed-station and 20 adaptive-station trawls. The scientific catch of the survey was 534.08 tonnes *D. gahi*.
2) An estimate of 77,526 tonnes *D. gahi* (95% confidence interval: 49,463 to 146,433 t) was calculated for the fishing zone by inverse distance weighting. This estimate was lower than 2nd pre-season biomass last year (2020); but still the third-highest for a 2nd pre-season since at least 2006. Of the total, 52,024 t were estimated north of 52 ºS, and 25,502 t were estimated south of 52 ºS.
3) Male and female *D. gahi* had significantly greater average mantle lengths north of 52 ºS than south of 52 ºS. Males had significantly greater average maturity north, and females had significantly greater average maturity south. Males north: mean mantle length 12.16 cm; mean maturity stage 3.43, south: mean mantle length 11.81 cm; mean maturity stage 3.36. Females north: mean mantle length 11.44 cm; mean maturity stage 2.24, south: mean mantle length 11.39 cm; mean maturity stage 2.29.
4) 98 taxa were identified in the catches. *D. gahi* was the largest species group at 89.7% of total catch by weight, followed by hake (7.9%) and rock cod (1.6%) as the only other taxa comprising >1% of total catch. Biological measurements and samples were taken from *D. gahi*, rock cod, toothfish, kingclip, grenadier, hoki, red cod, southern blue whiting, Patagonian redfish and frogmouth.

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 *Argos Cíes* from the 12th to 26th July 2021; experimental license FK041E21. 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 2nd 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.
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.

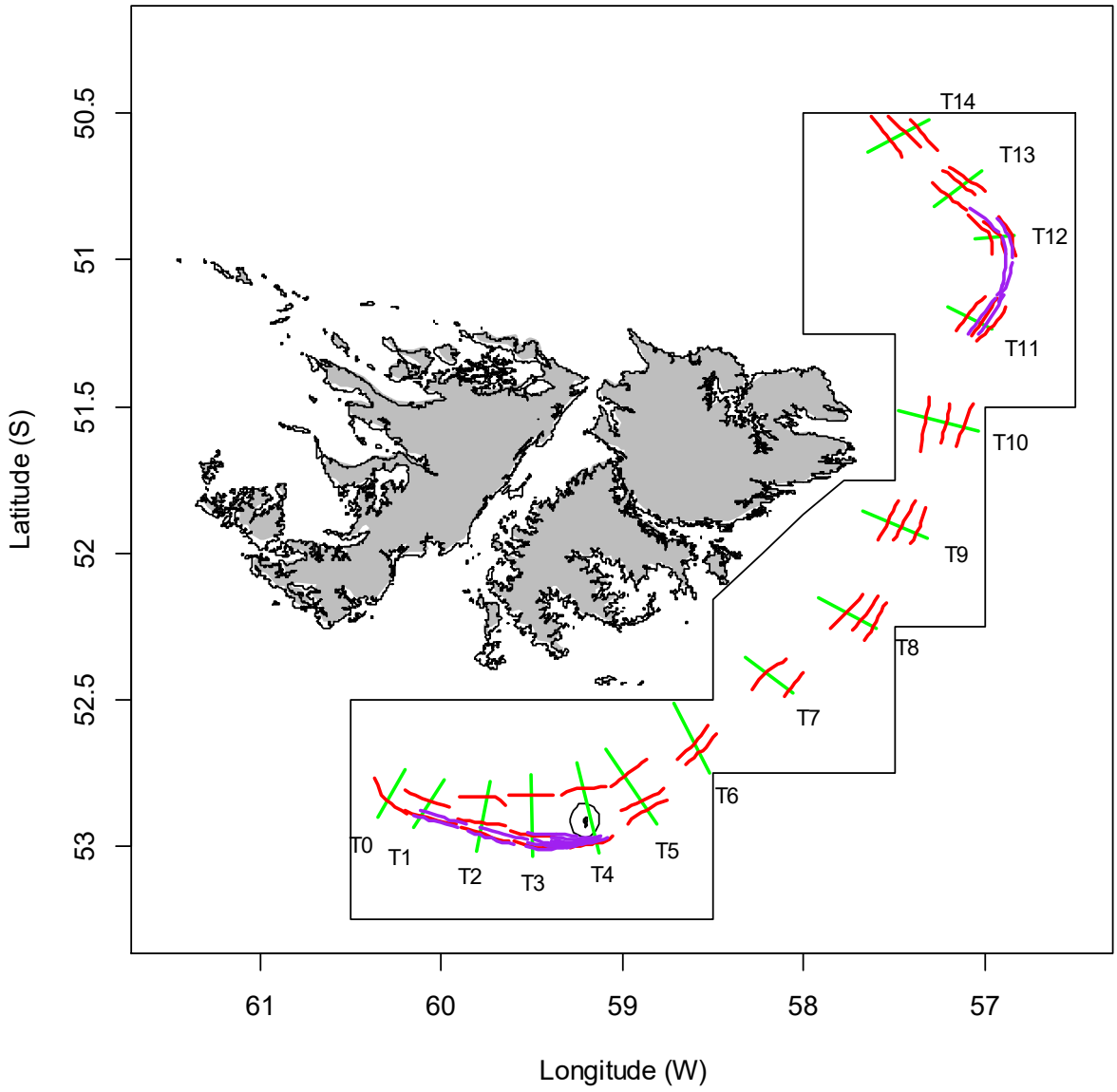


Figure 1. Survey transects (green lines), fixed-station trawls (red lines), and adaptive-station trawls (purple lines) sampled during the 2nd pre-season 2021 survey. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone are in black.

F/V *Argos Cíes* is a Falkland Islands - registered stern trawler of 75 m length, 1999 gross tonnage, and 3000 main engine bhp. Like all vessels employed for these pre-season surveys, *Argos Cíes* operates regularly in the Falkland calamari fishery and used its commercial trawl gear for the survey catches. *Argos Cíes* has previously been used for the preseason surveys of the 1st season 2019 and 2020 (Winter et al. 2019, 2020a). The following personnel from the FIFD participated in the 2nd pre-season 2021 survey:

Toni Trevizan	lead scientist
Zhanna Shcherbich	fisheries scientist
Jolien Claes	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 spatio-temporal 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 (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 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 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 (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. 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 from the distance between trawl doors (determined per interval) according to the equation (Seafish 2010):

[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.

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

Measurements of *Argos Cíes*' trawl, provided by the vessel master, were: bridle = 181 m and footrope = 180 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 was started near the centre of the Loligo Box (transects T8, T9 and T10, Figure 1, Table A1) to gain shelter from strong wind conditions, then moved north on the third day (leaving one T10 station for later; Table A1). From there the survey proceeded southward with fixed-station trawls throughout the Loligo Box, and finished south- to northward with adaptive trawls. A schedule of 4 survey trawls per day was maintained except for July 22nd, when high catches on the preceding day would have excessively delayed the schedule for a fourth trawl. In total 59 scientific trawls were recorded during the survey: 39 fixed station trawls catching 170.18 t *D. gahi*, and 20 adaptive-station trawls catching 363.89 t *D. gahi*. Thirteen optional trawls (directed by the vessel master, after survey hours) yielded an additional 171.21 t *D. gahi*, bringing the total catch for the survey to 705.29 t. The scientific survey catch of 534.08 t is the second-highest for a 2nd season since 2006 (Table 1).

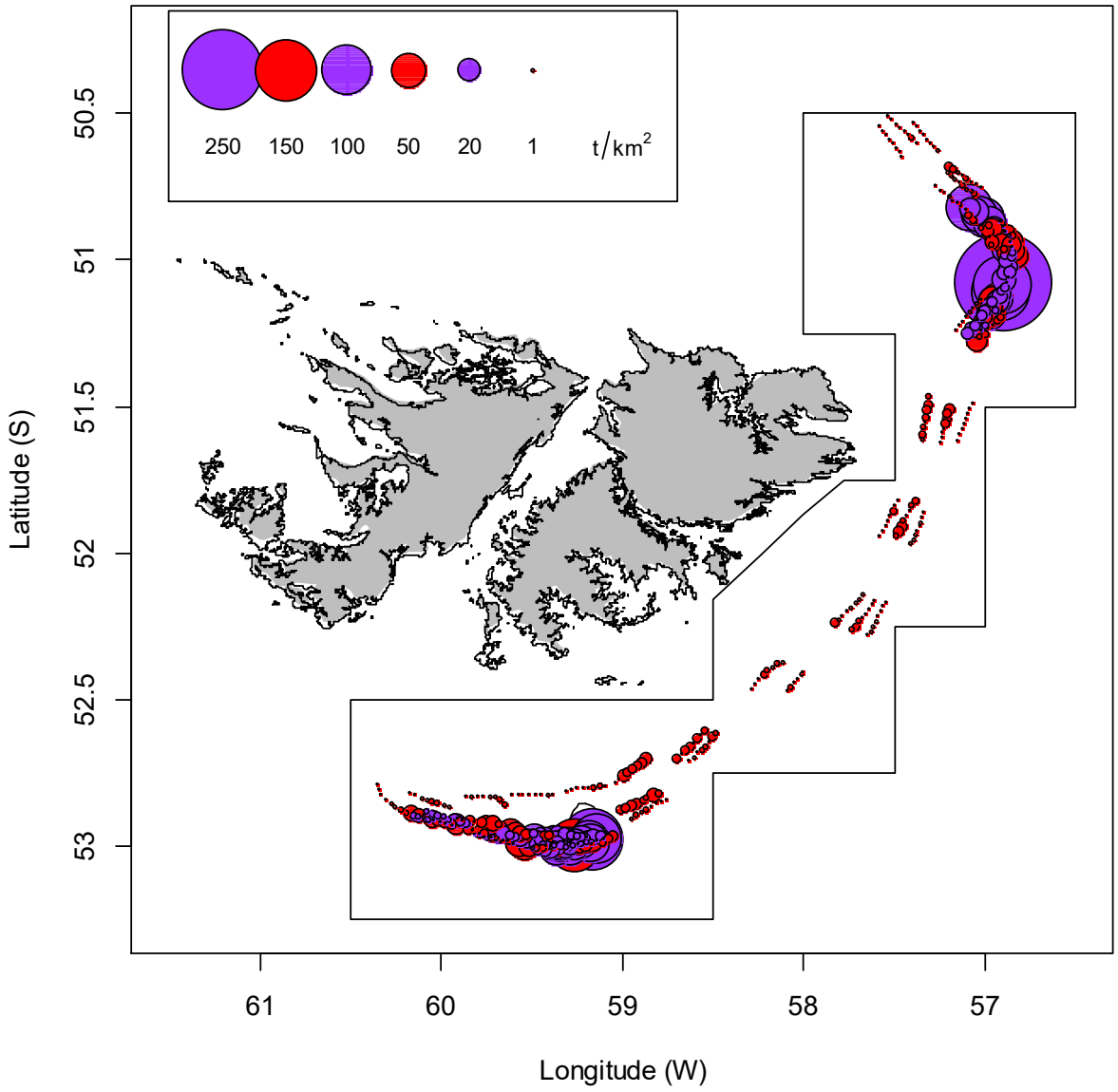


Figure 2. *D. gahi* CPUE (t km^{-2}) of fixed-station (red) and adaptive-station (purple) trawls per 15-minute trawl interval. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone (mostly hidden) are traced in black.

Average *D. gahi* catch density (Figure 2) among fixed-station trawls north of 52º S was 2.70 t km^{-2}; lower than last year and median for 2nd seasons among the past 5 years. Average *D. gahi* catch density among fixed-station trawls south of 52º S was 3.16 t km^{-2}; lowest of the past five 2nd seasons. Average *D. gahi* catch density among adaptive-station trawls north of 52º S was 15.88 t km^{-2}; the highest on record for a 2nd pre-season survey. Average *D. gahi* catch density among adaptive-station trawls south of 52º S was 10.48 t km^{-2}; lower than last year and median among the past 5 years. Accordingly for both north and south, the average density ratios between adaptive and fixed stations were the highest on record (since 2012): 5.89× north and 3.32× south.

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	59	534	77526

***** Includes four juvenile toothfish transect trawls.

Biomass estimation

Total *D. gahi* biomass in the fishing area was estimated at 77,526 tonnes, with a 95% confidence interval of [49,463 to 146,433 t]. Partition of the estimated biomass was 52,024 tonnes north [22,430 to 116,078 t] vs. 25,502 tonnes south [20,128 to 42,880 t]. At 67.1% of the total, this partition represents by far the highest preponderance of biomass north on record for 2nd pre-seasons, and only the third time since 2010 that it exceeds 50% (in 2010: 52.6%, Winter et al. 2010, in 2020: 57.5%, Winter et al. 2020b). 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 209 of the 368 5×5 km area units (Figure 3). Within the south sub-area 50% of *D. gahi* density was aggregated in 50 of 392 5×5 km area units[c], and 95% of density was aggregated in 267 of the 392 5×5 km area units (Figure 3). The total estimate of 77,526 t was lower than in 2020, but median among the last five years (2017 – 2021)[d] (Table 1).

Biological data

Ninety-eight taxa were identified in the survey catches (Appendix Table A2). *D. gahi* was the predominant catch with the highest proportion for a 2nd pre-season since 2018 (89.7%, Table A2), and higher than 1st pre-season 2021 at 79.1% (Winter et al. 2021). The second-highest catch species was hake *Merluccius hubbsi* with 7.9% of the total, proportionally lower than 2nd pre-season last year (Winter et al. 2020b) but part of a trend (Figure 4) consistent with increasing hake catches overall in Falkland Islands fisheries (FIG 2021). Rock cod *Patagonotothen ramsayi* was the only other species with >1% of the survey catch (Table A2), and the highest percentage in a 2nd pre-season survey since 2018 (Winter et al. 2018).

[c] Excluding depths <90 m or >400 m.

[d] 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.

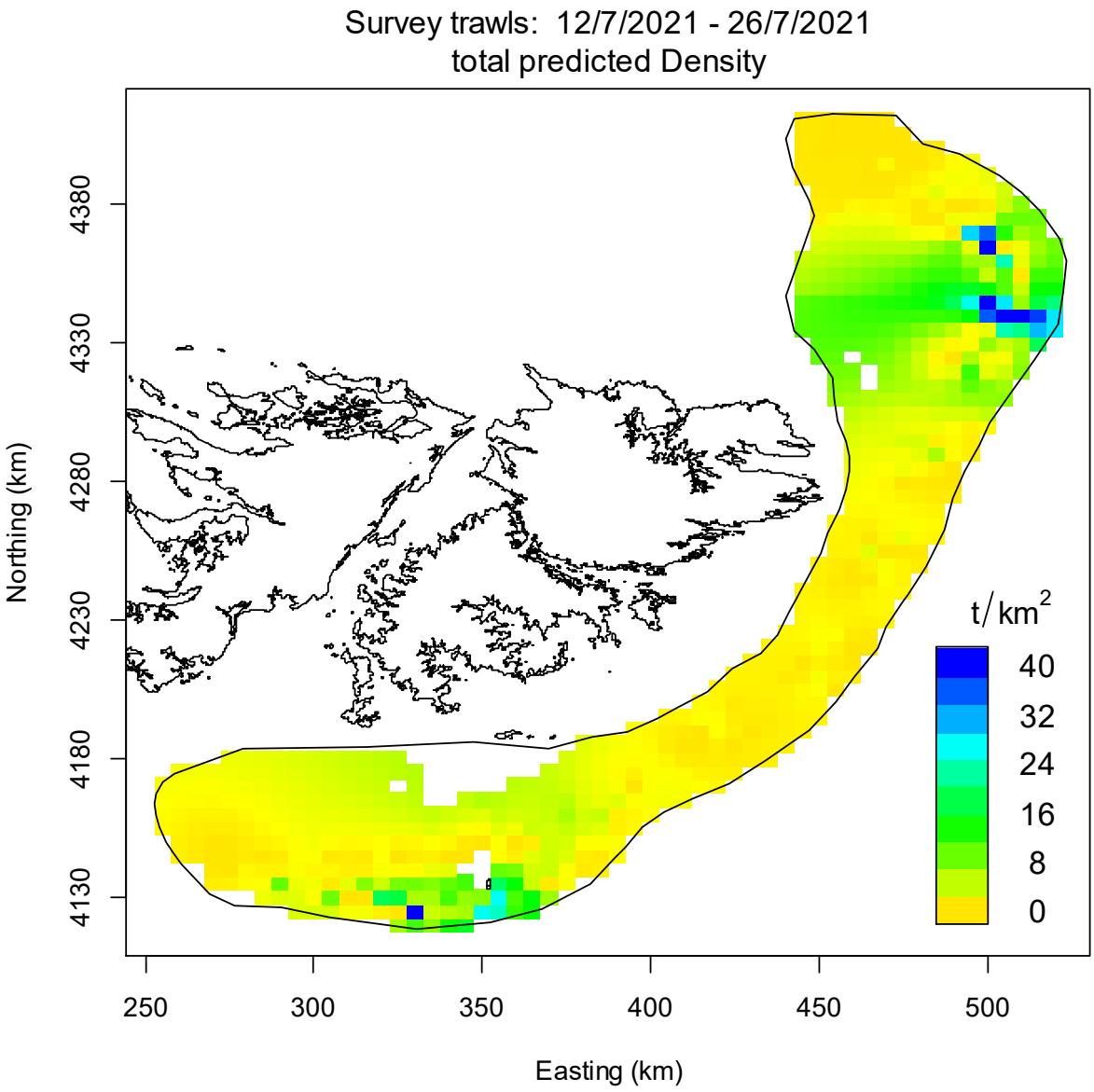


Figure 3. *D. gahi* predicted density estimates per 5 km^2 area units. Blank area units within the perimeter are either <90 or >400 m average depth. Coordinates were converted to WGS 84 projection in UTM sector 21F using the R library rgdal (proj.maptools.org).

D. gahi were collected and frozen from 18 stations for statolith sampling ashore. During the survey 9740 *D. gahi* were measured for length and maturity (4645 males, 5095 females, from 57 of the trawls). The total sex ratio was significantly ($p < 0.0001$) majority female. Eighteen individual trawls had a significant preponderance of females, concentrated in the north and south-west, whereas nine trawls throughout the Loligo Box had a significant preponderance of males. Preponderance of females had a significant positive correlation with depth ($p < 0.01$), concurring with earlier studies that have found females move deeper (Hatfield et al. 1990, Arkhipkin and Middleton 2002).

Figure 4 [next page]. *Merluccius hubbsi* total catches in 2nd pre-season surveys, 2012 to 2021. Black lines: 95% confidence interval of LOESS smooth.

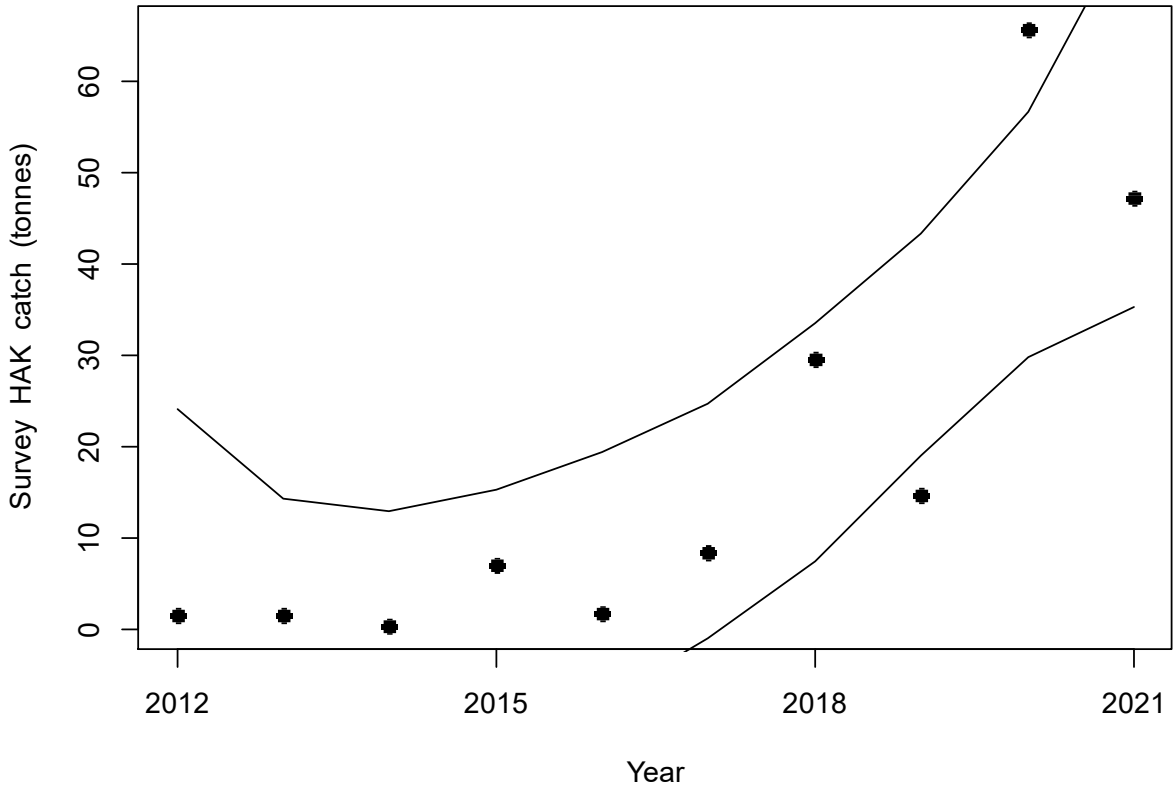
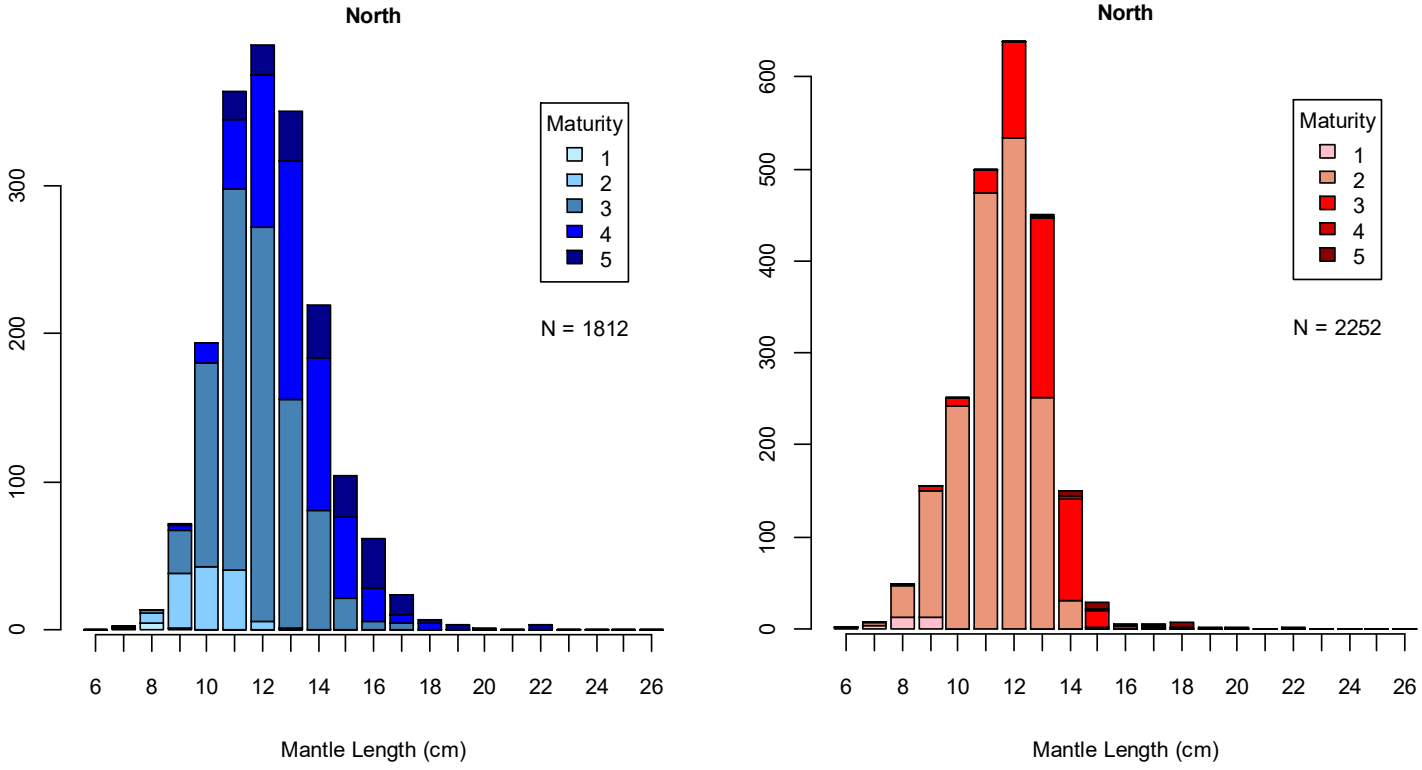
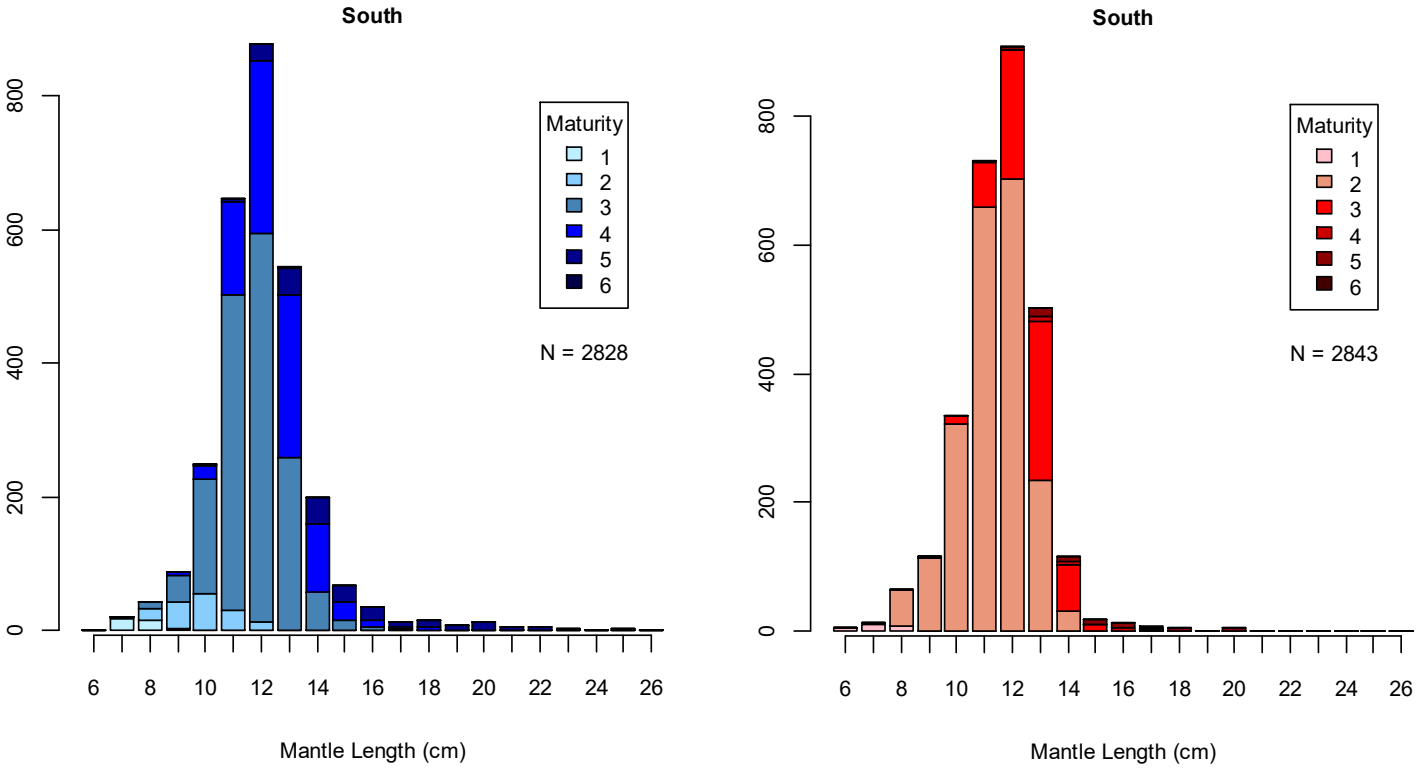


Figure 5 [below]. Length-frequency distributions by maturity stage of male (blue) and female (red) *D. gahi* from trawls north (top) and south (bottom) of latitude 52 ºS. Five males in the north were mantle length = 42 cm (maturity: 4× 5 and 1× 4), and are excluded from the plot.





D. gahi mantle length and maturity distributions north and south of 52° S are plotted in Figure 5. For males north: mean mantle length 12.16 cm; mean maturity stage 3.43 (on a scale of 1 to 6, Lipinski 1979), males south: mean mantle length 11.81 cm; mean maturity stage 3.36. Females north: mean mantle length 11.44 cm; mean maturity stage 2.24, females south: 11.39 cm; stage 2.29. Mantle length distributions were significantly different between north and south for both males and females (Kruskal-Wallis test, $p < 0.05$). Gonad maturity distributions were also significantly different between north and south for both males and females ($p < 0.05$), presenting the contrast that females were larger but younger in the north. Mantle lengths and maturities of males and females were also positively correlated with the sampling day (i.e., they grew continuously), suggesting no immigration during the survey itself.

Otoliths taken during the survey are summarized in Table A3.

Pinniped monitoring

The 2nd pre-season survey 2021 was the first ever *Loligo* survey to be conducted with seal exclusion devices (SED) in the trawls, following the regulatory decision to require SEDs through the entire following X-licence commercial season. Pinniped monitoring during the survey was carried out by Argos compliance officer Kyran Evans. Two pinnipeds during the survey were observed escaping through the SED. No pinniped was brought onboard in a trawl, dead or alive.

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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		
8 - 21	264	12/07/2021	07:30	52.30	57.66	09:28	52.17	57.55	323	[a] 326
8 - 20	265	12/07/2021	10:20	52.15	57.59	12:20	52.26	57.74	265	1099
8 - 19	266	12/07/2021	13:20	52.26	57.85	15:20	52.14	57.67	198	1421
9 - 22	267	12/07/2021	17:15	51.95	57.59	19:15	51.82	57.48	162	480
9 - 24	268	13/07/2021	07:30	51.84	57.33	09:30	51.97	57.41	285	595
9 - 23	269	13/07/2021	10:25	51.96	57.50	12:25	51.82	57.38	221	2842
10 - 25	270	13/07/2021	13:35	51.65	57.36	15:35	51.47	57.31	148	3018
10 - 26	271	13/07/2021	16:30	51.49	57.19	18:30	51.63	57.25	224	2554
14 - 39	272	14/07/2021	07:30	50.52	57.42	09:30	50.63	57.26	297	109
14 - 38	273	14/07/2021	10:15	50.61	57.35	12:15	50.51	57.53	251	299
14 - 37	274	14/07/2021	13:00	50.51	57.63	15:00	50.65	57.45	142	66
13 - 34	275	14/07/2021	16:00	50.74	57.30	18:00	50.83	57.11	130	119
13 - 36	276	15/07/2021	07:30	50.77	57.00	09:30	50.68	57.20	299	1486
13 - 35	277	15/07/2021	10:10	50.69	57.23	12:10	50.78	57.06	251	1371
12 - 31	278	15/07/2021	13:00	50.87	57.01	15:00	50.98	56.89	119	15793
12 - 32	279	15/07/2021	15:40	50.98	56.96	17:40	50.85	57.09	117	3155
12 - 33	280	16/07/2021	07:30	50.85	56.93	09:30	50.99	56.83	247	12321
11 - 30	281	16/07/2021	10:45	51.16	56.89	12:45	51.28	57.05	276	3982
11 - 29	282	16/07/2021	13:30	51.26	57.08	15:30	51.13	56.93	142	20034
11 - 28	283	16/07/2021	16:10	51.12	57.00	18:10	51.24	57.16	126	332
7 - 18	284	17/07/2021	07:30	52.49	58.11	08:50	52.41	58.01	262	[b] 403
7 - 17	285	17/07/2021	09:40	52.36	58.09	11:40	52.47	58.28	182	1075
6 - 15	286	17/07/2021	12:55	52.59	58.53	14:55	52.70	58.70	164	2641
6 - 16	287	17/07/2021	15:30	52.72	58.66	17:30	52.62	58.48	228	1574
4 - 10	288	18/07/2021	07:26	52.83	59.34	09:26	52.80	59.09	109	[c] 456
5 - 12	289	18/07/2021	10:05	52.80	59.07	12:05	52.70	58.87	121	4658
5 - 13	290	18/07/2021	13:00	52.80	58.77	15:00	52.88	59.01	144	5701
5 - 14	291	18/07/2021	15:45	52.92	58.97	17:45	52.84	58.75	237	937
3 - 7	292	19/07/2021	07:25	52.83	59.63	09:25	52.83	59.38	150	428
3 - 8	293	19/07/2021	10:30	52.96	59.37	12:30	52.95	59.62	176	12267
3 - 9	294	19/07/2021	13:15	52.98	59.60	15:15	53.00	59.35	238	17407
4 - 4	295	19/07/2021	16:00	53.01	59.29	18:00	52.97	59.05	244	23843
0 - 1	296	20/07/2021	07:30	52.77	60.37	09:30	52.89	60.19	249	1085
1 - 3	297	20/07/2021	10:15	52.88	60.20	12:15	52.93	59.92	226	13543
2 - 6	298	20/07/2021	12:55	52.94	59.89	14:55	52.98	59.62	238	4030
2 - 5	299	20/07/2021	15:50	52.93	59.65	17:50	52.91	59.91	170	5789
1 - 2	300	21/07/2021	07:30	52.81	60.20	09:30	52.87	59.95	195	1248
2 - 4	301	21/07/2021	10:10	52.83	59.90	12:10	52.86	59.65	161	1138
A - 1	302	21/07/2021	13:30	52.98	59.39	15:10	52.98	59.17	181	[d] 44131
A - 2	303	21/07/2021	16:10	52.98	59.12	18:10	53.00	59.37	207	29857
A - 3	304	22/07/2021	07:45	52.94	59.91	09:45	52.90	60.16	245	1338
A - 4	305	22/07/2021	10:30	52.88	60.12	12:30	52.93	59.86	191	4759
A - 5	306	22/07/2021	15:10	52.94	59.79	17:10	52.98	59.52	196	18786
A - 6	307	23/07/2021	07:30	52.95	59.85	09:30	52.99	59.60	254	163

A - 7	308	23/07/2021	10:15	53.00	59.53	12:15	53.00	59.26	242	35193
A - 8	309	23/07/2021	13:15	53.00	59.29	15:15	52.98	59.49	199	29297
A - 9	310	23/07/2021	16:20	52.95	59.52	18:20	52.97	59.25	169	9467
A - 10	311	24/07/2021	07:30	52.97	59.08	09:30	53.00	59.32	222	6737
A - 11	312	24/07/2021	10:25	52.98	59.38	12:25	52.97	59.12	170	18914
A - 12	313	24/07/2021	13:30	52.97	59.16	15:30	52.97	59.39	171	9516
A - 13	314	24/07/2021	16:40	52.99	59.52	18:40	52.99	59.24	224	5016
10 - 27	315	25/07/2021	07:30	51.64	57.16	09:30	51.49	57.07	286	559
A - 14	316	25/07/2021	10:55	51.26	57.04	12:55	51.12	56.90	227	20237
A - 15	317	25/07/2021	13:45	51.13	56.94	15:45	51.25	57.09	135	7375
A - 16	318	25/07/2021	16:55	51.12	56.93	17:30	51.08	56.90	137	[d] 52339
A - 17	319	26/07/2021	07:30	50.86	56.94	09:30	50.99	56.85	220	1191
A - 18	320	26/07/2021	10:10	51.01	56.85	12:10	51.14	56.92	213	8699
A - 19	321	26/07/2021	13:00	51.09	56.91	15:00	50.92	56.91	120	21869
A - 20	322	26/07/2021	15:40	50.91	56.92	17:12	50.82	57.09	125	[d] 39009

[a] Trawl gear damage on haul, but catch considered representative.

[b] Hauled early; SED full of stones.

[c] Broken net, but catch considered representative.

[d] Hauled early due to high catch.

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*	534078	89.7	457	0
HAK	*Merluccius hubbsi*	47295	7.9	1947	20
PAR	*Patagonotothen ramsayi*	9543	1.6	228	9534
SHT	Mixed invertebrates	1000	0.2	0	1000
DGH	*Schroederichthys bivius*	434	0.1	0	433
CGO	*Cottoperca gobio*	401	0.1	6	401
BAC	*Salilota australis*	373	0.1	25	38
GOC	*Gorgonocephalus chilensis*	292	<0.1	0	292
SPN	Porifera	234	<0.1	0	234
RFL	*Zearaja chilensis*	202	<0.1	0	8
MED	Medusae	194	<0.1	0	194
TOO	*Dissostichus eleginoides*	163	<0.1	150	2
ZYP	*Zygochlamys patagonica*	157	<0.1	0	157
RAY	Rajiformes	145	<0.1	0	38
RBR	*Bathyraja brachyurops*	141	<0.1	0	121
RGR	*Bathyraja griseocauda*	114	<0.1	0	3
ALG	Algae	80	<0.1	0	80
KIN	*Genypterus blacodes*	69	<0.1	39	0
PTE	*Patagonotothen tessellata*	62	<0.1	0	62
RAL	*Bathyraja albomaculata*	60	<0.1	0	33
ING	*Moroteuthis ingens*	55	<0.1	1	55
STA	*Sterechinus agassizi*	54	<0.1	0	54
SQT	Ascidiacea	48	<0.1	0	48
ANM	Anemone	48	<0.1	0	48

GRC	*Macrourus carinatus*	44	<0.1	41	20
SUN	*Labidaster radiosus*	39	<0.1	0	39
LIS	*Lithodes santolla*	35	<0.1	1	18
RMG	*Bathyraja magellanica*	34	<0.1	0	34
PAU	*Patagolycus melastomus*	32	<0.1	5	32
ODM	*Odontocymbiola magellanica*	32	<0.1	0	32
WHI	*Macruronus magellanicus*	25	<0.1	21	12
RMC	*Bathyraja macloviana*	24	<0.1	0	24
BLU	*Micromesistius australis*	24	<0.1	4	23
RSC	*Bathyraja scaphiops*	21	<0.1	0	17
RPX	*Psammobatis* spp.	14	<0.1	0	14
RBZ	*Bathyraja cousseauae*	14	<0.1	0	4
ILL	*Illex argentinus*	11	<0.1	10	5
GRF	*Coelorinchus fasciatus*	11	<0.1	11	8
NEM	*Neophyrnichthys marmoratus*	9	<0.1	0	9
MUL	*Eleginops maclovinus*	9	<0.1	6	9
CAZ	*Calyptraster* sp.	9	<0.1	0	9
OCM	*Octopus megalocyathus*	8	<0.1	4	5
RDO	*Amblyraja doellojuradoi*	7	<0.1	0	7
DGS	*Squalus acanthias*	7	<0.1	0	7
THA	*Thyrsites atun*	6	<0.1	6	0
POA	*Porania antarctica*	6	<0.1	0	6
OCT	*Octopus* sp.	6	<0.1	0	6
BUT	*Stromateus brasiliensis*	6	<0.1	0	6
MLA	*Muusoctopus longibrachus akambei*	5	<0.1	5	0
FUM	*Fusitriton m. magellanicus*	5	<0.1	0	5
ALF	*Allothunnus fallai*	5	<0.1	0	0
SEP	*Seriolella porosa*	4	<0.1	4	0
LOS	*Lophaster stellans*	4	<0.1	0	4
ILF	*Iluocoetes fimbriatus*	4	<0.1	0	4
HYD	Hydrozoa	3	<0.1	0	3
CHE	*Champsocephalus esox*	3	<0.1	3	0
AST	Asteroidea	3	<0.1	0	3
OPV	*Ophiacanta vivipara*	2	<0.1	0	2
EGG	Eggmass	2	<0.1	0	2
AUC	*Austrocidaris canaliculata*	2	<0.1	0	2
SOR	*Solaster regularis*	1	<0.1	0	1
RMU	*Bathyraja multispinis*	1	<0.1	0	1
OPL	*Ophiuroglypha lymanii*	1	<0.1	0	1
NUD	Nudibranchia	1	<0.1	0	1
MYX	*Myxine* sp.	1	<0.1	0	1
MUE	*Muusoctopus eureka*	1	<0.1	1	0
EUL	*Eurypodius latreillei*	1	<0.1	0	1
CTA	*Ctenodiscus australis*	1	<0.1	0	1
CEX	*Ceramaster* sp.	1	<0.1	0	1
ASA	*Astrotoma agassizii*	1	<0.1	0	1
WRM	*Chaetopterus variopedatus*	<1	<0.1	0	0
THN	*Thysanopsetta naresi*	<1	<0.1	0	0
RED	*Sebastes oculatus*	<1	<0.1	0	0
PYX	Pycnogonida	<1	<0.1	0	0

PES	*Peltarion spinosulum*	<1	<0.1	0	0
OPS	*Ophiactis asperula*	<1	<0.1	0	0
OPH	Ophiuroidea	<1	<0.1	0	0
OCC	Octocoralia	<1	<0.1	0	0
NOW	*Paranotothenia magellanica*	<1	<0.1	0	0
MUO	*Muraenolepis orangiensis*	<1	<0.1	0	0
MUN	*Munida* sp.	<1	<0.1	0	0
MUG	*Munida gregaria*	<1	<0.1	0	0
MAV	*Magellania venosa*	<1	<0.1	0	0
MAT	*Achiropsetta tricholepis*	<1	<0.1	0	0
ISO	Isopoda	<1	<0.1	0	0
ICA	*Icichthys australis*	<1	<0.1	0	0
GYN	*Gymnoscopelus nicholsi*	<1	<0.1	0	0
GAT	*Gaimardia trapesina*	<1	<0.1	0	0
EUO	*Eurypodius longirostris*	<1	<0.1	0	0
ERR	*Errina* sp.	<1	<0.1	0	0
CRY	*Crossaster* sp.	<1	<0.1	0	0
COT	*Cottunculus granulosus*	<1	<0.1	0	0
COG	*Patagonotothen guntheri*	<1	<0.1	0	0
BRY	Bryozoa	<1	<0.1	0	0
BIV	Bivalve	<1	<0.1	0	0
BAO	*Bathybiaster loripes*	<1	<0.1	0	0
AGO	*Agonopsis chilensis*	<1	<0.1	0	0
ACY	*Armadillogorgia cyathella*	<1	<0.1	0	0
		595,729		2976	13,235

Table A3. Summary of otolith / statolith numbers by species by sex taken during the survey (other than *D. gahi*).

Species		N otoliths	
		M	F
Common Hake	*Merluccius hubbsi*	45	199
Common Rock cod	*Patagonotothen ramsayi*	80	95
Patagonian Toothfish	*Dissostichus eleginoides*	50	65
Kingclip	*Genypterus blacodes*	13	27
Grenadier-Ridge Scaled Rattail	*Macrourus carinatus*	8	18
Hoki	*Macruronus magellanicus*	9	7
Red cod	*Salilota australis*	5	8
Southern Blue Whiting	*Micromesistius australis*	2	2
Patagonian Redfish	*Sebastes oculatus*	0	1
Frogmouth	*Cottoperca gobio*	1	0