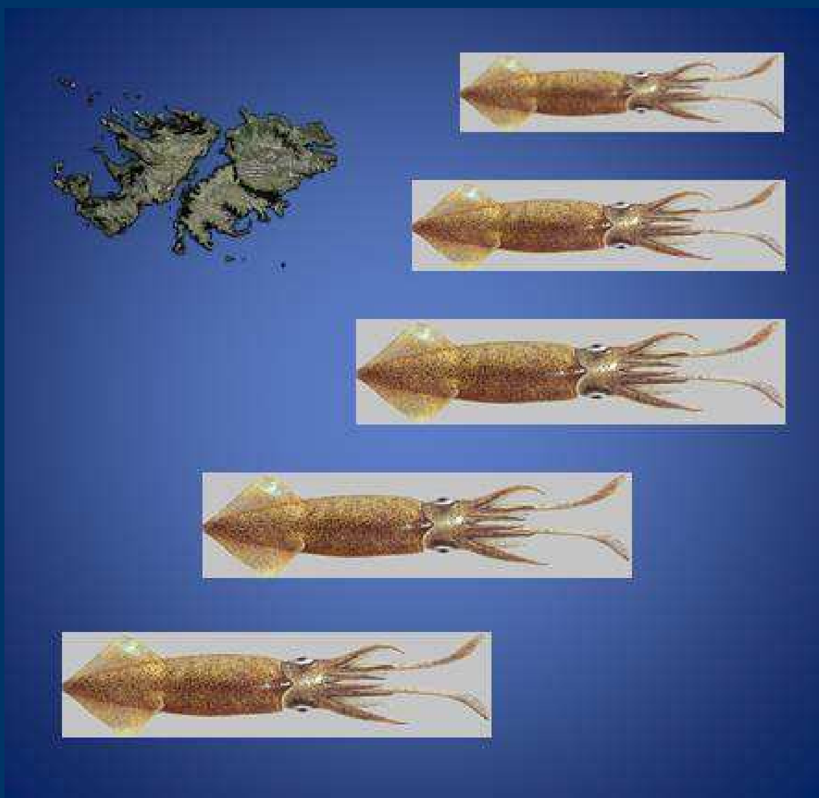
2020 2nd Season Assessment Survey

Falkland calamari

(*Doryteuthis gahi*)



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August 2020

ZDLZ – S2 – 2020

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Summary

1) A stock assessment survey for *Doryteuthis gahi* (Falkland calamari) was conducted in the 'Loligo Box' from 14th to 28th July 2020. Fifty-five scientific trawls were taken during the survey; 39 fixed-station and 16 adaptive-station trawls. The scientific catch of the survey was 575.37 tonnes *D. gahi*.
2) An estimate of 92,194 tonnes *D. gahi* (95% confidence interval: 69,667 to 143,677 t) was calculated for the fishing zone by inverse distance weighting. This estimate represents the second-highest 2nd-season survey biomass in the past 10 years. Of the total, 53,017 t were estimated north of 52 ºS, and 39,177 t were estimated south of 52 ºS; an uncommon distribution of higher biomass north than south.
3) Male but not female *D. gahi* had significantly different average mantle lengths between north of 52 ºS (male: 12.40 cm, female: 11.51 cm) and south of 52 ºS (male: 11.83 cm, female: 11.40 cm). Male maturities were marginally different between north (3.49) and south (3.51); female maturities were highly significantly different between north (2.19) and south (2.13).
4) 91 taxa were identified in the catches. *D. gahi* was the largest species group at 89.1% of total catch by weight, followed by hake (10.2%) and rock cod (0.2%) as the only two other taxa comprising >0.1% of total catch. Biological measurements and samples were taken from *D. gahi*, rock cod, toothfish, kingclip, common hake, southern hake, grenadier, red cod and 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 *Beagle FI* from the 14th to 28th July 2020; experimental license FK101E20. 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, 2020.
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.
5) Monitor the presence of pinnipeds and their interactions with 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.

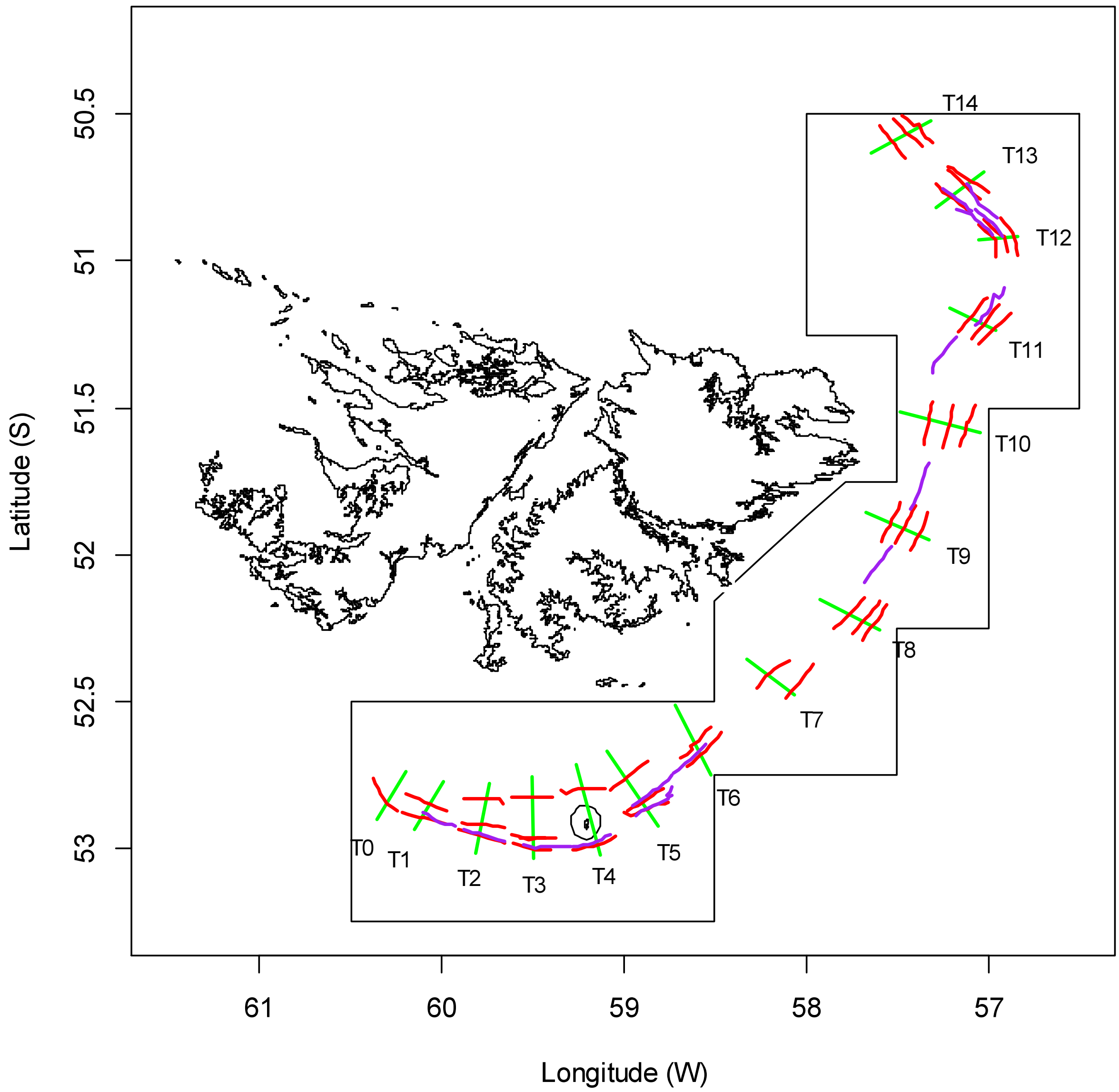


Figure 1. Survey transects (green lines), fixed-station trawls (red lines), and adaptive-station trawls (purple lines) sampled during the 2nd pre-season 2020 survey. Boundaries of the 'Loligo Box' fishing zone and the Beauchêne Island exclusion zone are in black.

The F/V *Beagle FI* (ZDLZ) is a Falkland Islands - registered stern trawler of 100.71 m length, 2849 gt, and 3945 main engine bhp. Like all vessels employed for these pre-season surveys, *Beagle FI* operates regularly in the Falklands calamari fishery and used its commercial trawl gear for the survey catches. *Beagle FI* has previously been employed for the pre-season surveys of 1st season 2010 (Arkhipkin et al. 2010) and 2nd season 2012 (Winter et al. 2012), and for a bycatch mitigation monitoring trip (Iriarte 2019). The following personnel from the FIFD participated in the 2nd pre-season 2020 survey:

Jorge E. Ramos	lead scientist
Zhanna Shcherbich	fisheries scientist
Vasana Tutjavi	fisheries observer
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, and ranged in distance from 13.6 to 18.1 km (median 16.1 km). 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. One or two observer baskets of unsorted catch were collected from survey trawls that showed mixed species composition (unless the catch was small enough to be sorted entirely). 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). 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. Trawl width was derived from the distance between trawl doors (determined per interval) according to the equation (Seafish 2010):

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

Measurements of *Beagle FI*'s trawl, provided by the vessel master, were: bridle = 125 m and footrope = 181.2 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-cm, 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 station, as far as available. All catches of toothfish were collected from trawls to maximize the time series catch and biological information base for juvenile toothfish. Otoliths were taken from rock cod and toothfish that corresponded to required size categories, and other commercial fish species as available.

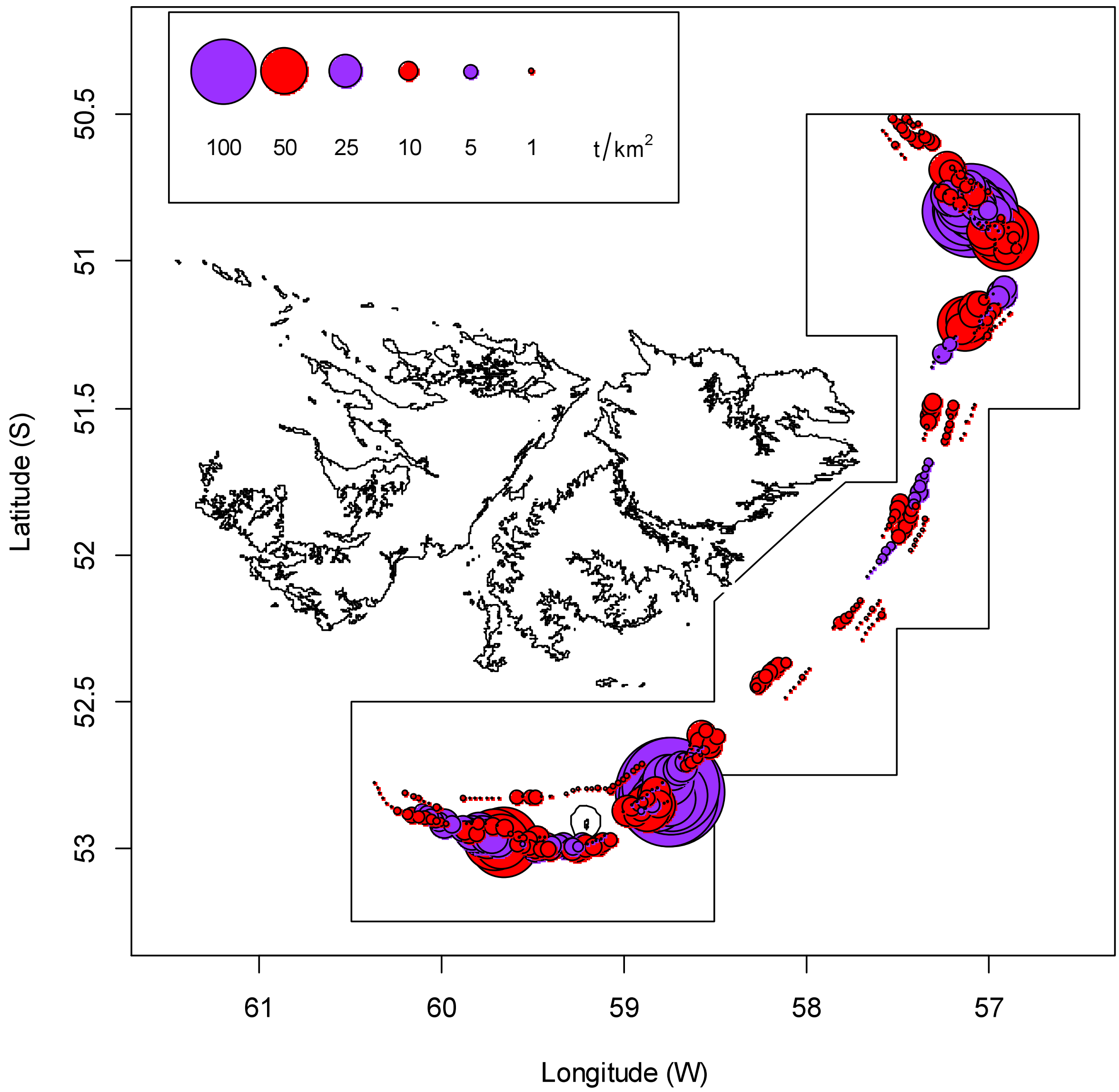
Pinniped monitoring

Before the haul of every fixed-station and adaptive-station survey trawl, the area surrounding the vessel was surveilled from the bridge by the lead scientist. More intensified monitoring actions (e.g., Goyot et al. 2019) were deferred as the bridge surveillance showed very few pinnipeds around the vessel.

Results

Catch rates and distribution

The survey started as usual with fixed-station trawls in the north and proceeded throughout the Loligo Box. Adaptive-station trawls were then started in the south and continued northward (Figure 1), as substantial *D. gahi* catches had been obtained on the fixed stations both north and south (Figure 2). A schedule of four survey trawls per day was maintained except for July 17th, when four trawls were undertaken but one trawl was disqualified because the net was found to have been entangled[a], July 27th when the large catches of the first three trawls exceeded capacity to take a fourth trawl, and July 28th when bad weather prevented more than one trawl in the morning. As the commercial *D. gahi* 2nd season was not scheduled to start until July 30th, July 29th was allocated as an additional day, but also could not be fished because of the weather (Figure 3). In total 55 scientific trawls were recorded during the survey: 39 fixed station trawls catching 245.20 t *D. gahi*, and 16 adaptive-station trawls catching 330.17 t *D. gahi*. Fourteen optional trawls (made after survey hours) yielded an additional 205.19 t *D. gahi*, bringing the total catch for the survey to 780.56 t. The scientific survey catch of 575.37 t is the highest for a 2nd season in the past ten years (Table 1).



[a] This was a fixed-station trawl, and was repeated the next day. The observer station number of the repeat was re-assigned from the original trawl on that station, and therefore observer station numbers are out of sequence (Appendix Table A1).

Figure 2 [previous page]. *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 are traced in black.

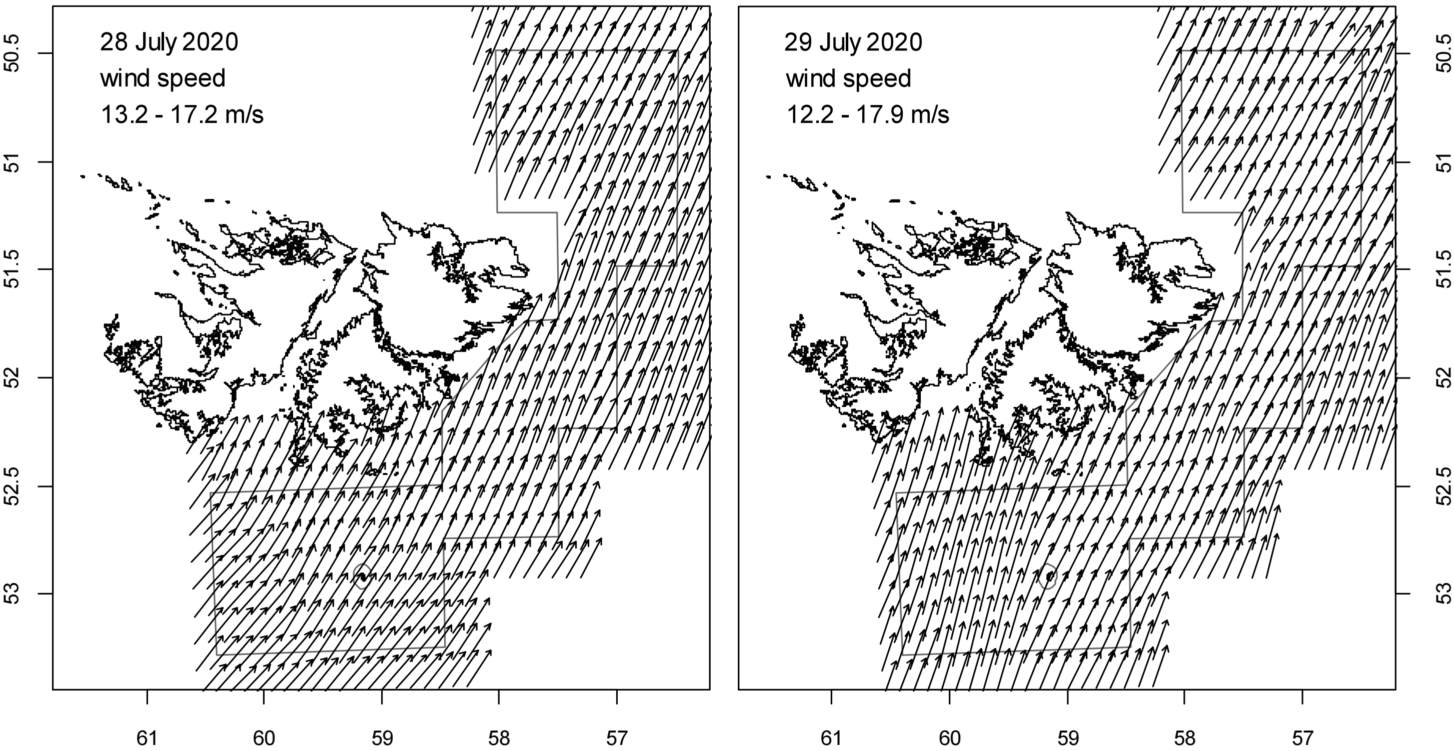


Figure 3. Wind speed vector plots (Copernicus Marine Service) on July 28th and July 29th, the last two (intended) days of the survey.

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

* Includes four juvenile toothfish transect trawls.

Average *D. gahi* catch density among fixed-station trawls north of 52° S was 5.86 t km^{-2}, and south of 52° S was 5.82 t km^{-2}. This marks only the second 2nd-season survey of the past 10 years (after 2014; Winter et al. 2014) that obtained higher average fixed-station density north than south. Average *D. gahi* catch density among adaptive-station trawls north of 52° S was 12.11 t km^{-2}, and south of 52° S was 12.80 t km^{-2}. The adaptive-station density north (as well as the fixed-station density north) was the highest of the past 10 years' 2nd-season surveys.

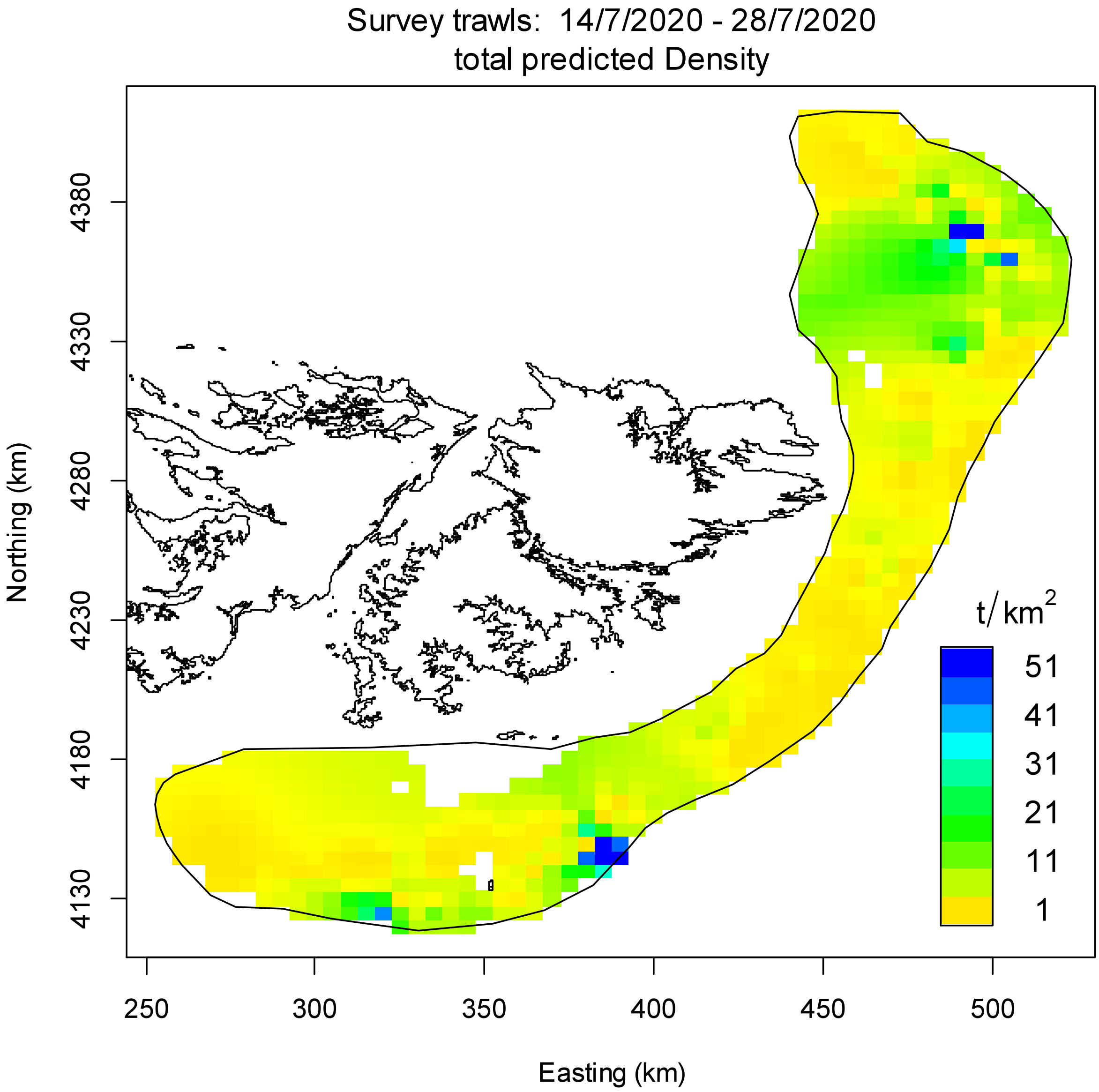


Figure 4. *D. gahi* predicted density estimates per 5 km^2 area units. Blank area units within the perimeter are either <90 or >400 m average depth. Coordinates were converted to WGS 84 projection in UTM sector 21F using the R library rgdal (proj.maptools.org).

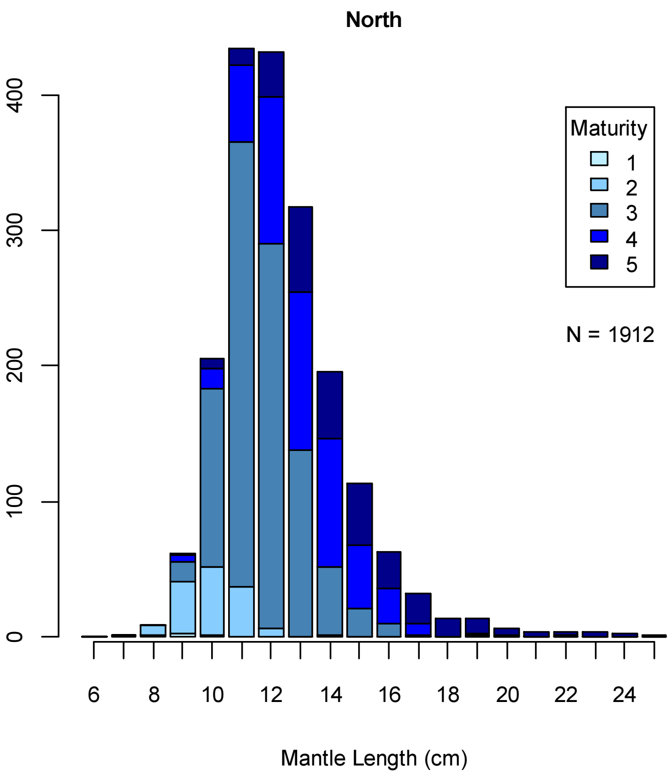
Biomass estimation

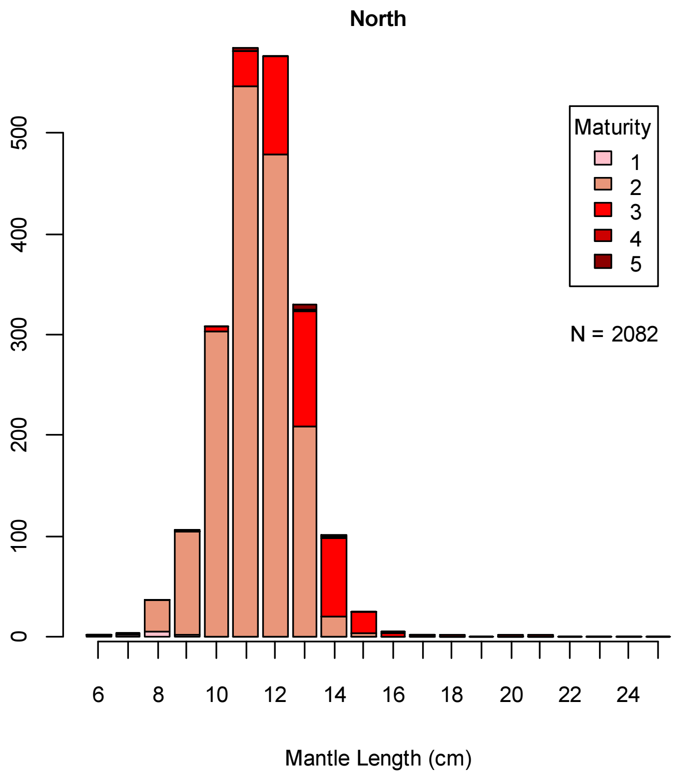
Total *D. gahi* biomass in the fishing area was estimated at 92,194 tonnes, with a 95% confidence interval of [69,667 to 143,677 t]. Estimated biomass north was 53,017 t [31,516 to

86,476 t], thus 57.5% of the total, representing the first time since 2010 (Winter et al. 2010) that a 2nd-season biomass estimate was higher north than south. Estimated biomass south was 39,177 t [25,608 to 76,321 t]. Within the south sub-area 50% of *D. gahi* density was aggregated in 39 of 392 5×5 km area units[b], and 95% of density was aggregated in 240 of the 392 5×5 km area units (Figure 4). Within the north sub-area 50% of *D. gahi* density was aggregated in 66 of 368 5×5 km area units, and 95% of density was aggregated in 245 of the 368 5×5 km area units (Figure 4). The total estimate of 92,194 t was the second-highest for a 2nd season in the past ten years[c] (Table 1).

Biological data

Ninety-one taxa were identified in the survey catches and basket samples (Appendix Table A2, Table A3). *D. gahi* was the predominant catch with the second-highest proportion for a 2nd season survey since at least 2011 (89.1%, Table A2); following 2018 (90.5% – Winter et al. 2018). Hake *Merluccius hubbsi* was the second-highest catch species for only the second time in a 2nd season survey since 2011 (the other one also being 2018), but at 65.7 tonnes this survey hake catch was more than twice of 2018 (29.5 t – Winter et al. 2018). Rock cod *Patagonotothen ramsayi* was the third-highest catch species; a typical ranking, but the first time in a 2nd season since 2014 that rock cod survey catch was not decreased from the year before.





[b] Excluding depths <90 m or >400 m.
[c] However, note that biomass estimates from previous 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.

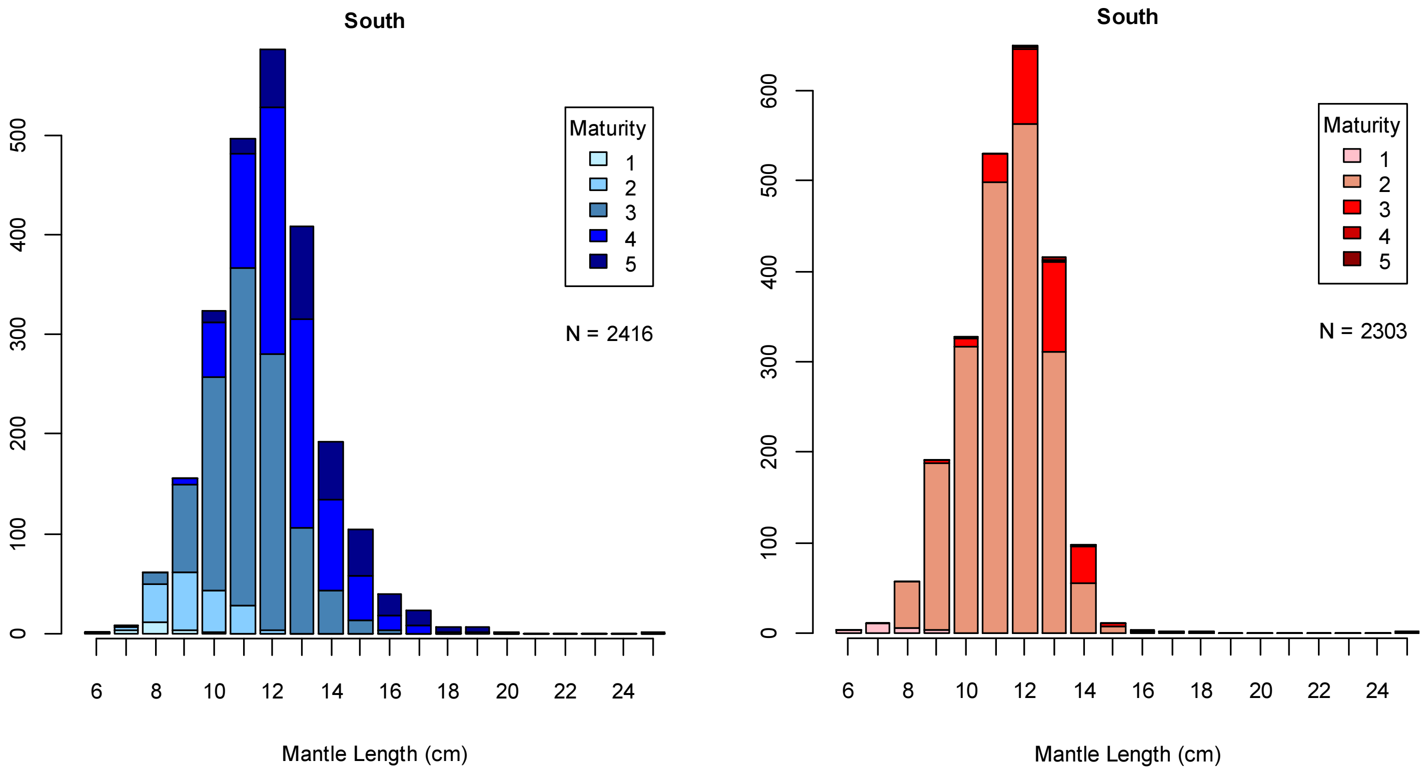


Figure 5. Length-frequency distributions by maturity stage of male (blue) and female (red) *D. gahi* from trawls north (top) and south (bottom) of latitude 52 ºS.

8713 *D. gahi* were measured for length and maturity in the survey (4328 males, 4385 females, from 54 of the trawls). The total sex ratio was not significantly different from 50/50 ($p > 0.10$). Ten individual trawls had a significant preponderance of females, and eleven trawls had a significant preponderance of males. Trawls with preponderance of females appeared to be clustered north and further offshore south, but the general relationship between sex ratio and depth was only marginal ($p = 0.085$).

D. gahi mantle length and maturity distributions north and south of 52° S are plotted in Figure 5. Mantle length distributions were significantly different between north and south for males (Kruskal-Wallis test, $p < 0.01$), but not females ($p > 0.10$). Gonad maturity distributions were marginally different between north and south for males ($p = 0.08$) and significantly different for females ($p < 0.001$). For males north: mean mantle length 12.40 cm; mean maturity stage 3.49 (on a scale of 1 to 5), males south: mean mantle length 11.83 cm; mean maturity stage 3.51. Females north: mean mantle length 11.51 cm; mean maturity stage 2.19, females south: mean mantle length 11.40 cm; mean maturity stage 2.13.

Otoliths taken during the survey are summarized in Table A4. Additional data were collected for marine biology / ecology special projects as follows:

Stable isotopes: Small and large individuals of each species caught in trawls north of 52°S and south of 52°S were frozen for analysis. Water samples were also collected and frozen from each sub-area.

Common hake stomachs: Approximately 100 stomachs of common hake *Merluccius hubbsi* were targeted from shallow (< 130 m) and deep (>200 m) stations from the north, central and south sub-areas of the Loligo Box. Only few individuals were caught in the shallow stations to the south, therefore a number of hake stomachs were also collected from medium depth (~150 m) stations in that area. Length-frequency measurements were taken from approximately 100 individuals on the remaining stations per area, once the stomach collection was completed (N ~ 719).

Butterfish population distribution: A collection of 120 butterfish *Stromateus brasiliensis* from the Loligo Box was targeted. However, <5 individual butterfish were caught during the survey.

Pinniped monitoring

Only few 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. Latitude: °S, longitude: °W. Transects labelled A were adaptive-station trawls.

Transect	Obs	Date	Start			End			Depth	*D. gahi*
Station	Code		Time	Lat	Lon	Time	Lat	Lon	(m)	(kg)
14 - 37	1081	14/07/2020	06:15	50.54	57.59	08:00	50.65	57.46	140	218
14 - 38	1082	14/07/2020	09:00	50.61	57.36	10:45	50.52	57.52	250	3462
14 - 39	1083	14/07/2020	11:30	50.50	57.47	13:30	50.60	57.31	290	2896
13 - 34	1084	14/07/2020	14:35	50.73	57.28	16:30	50.83	57.1	130	2914
13 - 32	1085	15/07/2020	06:05	50.86	57.02	07:55	50.97	56.89	120	20637
12 - 33	1086	15/07/2020	08:45	50.98	56.84	10:30	50.85	56.93	247	3311
13 - 35	1087	15/07/2020	11:30	50.79	57.04	13:30	50.69	57.22	258	14829
13 - 36	1088	15/07/2020	14:20	50.68	57.22	16:20	50.76	57	295	792
09 - 22	1089	16/07/2020	06:05	51.95	57.59	07:50	51.82	57.48	161	3331
10 - 02	1090	16/07/2020	09:10	51.64	57.25	10:55	51.49	57.19	226	2159
11 - 28	1091	16/07/2020	12:20	51.24	57.16	14:15	51.12	57.01	127	27117
12 - 31	1092	16/07/2020	15:10	50.99	56.96	16:50	50.87	57.05	116	10381
08 - 20	1093	17/07/2020	06:05	52.27	57.74	07:45	52.16	57.59	265	273
10 - 27	1095	17/07/2020	12:05	51.63	57.16	13:45	51.49	57.07	288	0
11 - 29	1096	17/07/2020	15:05	51.26	57.09	16:50	51.15	56.94	151	1813
09 - 24	1094	18/07/2020	06:05	51.86	57.34	07:50	51.98	57.42	285	726
09 - 23	1097	18/07/2020	08:40	51.96	57.51	10:25	51.83	57.39	219	5865
10 - 25	1098	18/07/2020	11:45	51.63	57.35	13:40	51.48	57.31	148	5262
11 - 30	1099	18/07/2020	15:15	51.28	57.05	17:10	51.18	56.87	283	217
08 - 21	1100	19/07/2020	06:00	52.17	57.56	07:45	52.29	57.69	309	198
08 - 19	1101	19/07/2020	09:00	52.14	57.67	10:55	52.25	57.85	198	1875
07 - 17	1102	19/07/2020	12:05	52.36	58.09	14:00	52.46	58.27	182	6956
06 - 15	1103	19/07/2020	15:15	52.59	58.53	17:00	52.7	58.69	167	4883
07 - 18	1104	20/07/2020	06:00	52.38	57.96	07:45	52.49	58.11	262	134
06 - 16	1105	20/07/2020	09:25	52.61	58.46	11:25	52.72	58.65	232	6433
05 - 14	1106	20/07/2020	12:30	52.80	58.79	14:15	52.87	58.98	145	12612
05 - 13	1107	20/07/2020	15:05	52.89	58.96	14:25	52.88	59	178	20769
05 - 12	1108	21/07/2020	06:00	52.70	58.87	08:00	52.8	59.07	121	1124
04 - 11	1109	21/07/2020	09:10	52.96	59.04	11:10	53.01	59.28	246	12159
03 - 08	1110	21/07/2020	11:55	52.97	59.37	13:55	52.95	59.61	179	3639
03 - 09	1111	21/07/2020	14:45	52.98	59.61	16:30	53	59.4	240	6808
00 - 01	1112	22/07/2020	06:05	52.76	60.37	07:50	52.87	60.24	254	294
01 - 03	1113	22/07/2020	08:50	52.88	60.22	10:50	52.92	59.97	220	4208
02 - 05	1114	22/07/2020	11:40	52.91	59.89	13:25	52.93	59.65	170	3138
04 - 10	1115	22/07/2020	14:45	52.80	59.34	16:30	52.8	59.1	110	761
02 - 04	1116	23/07/2020	05:50	52.85	59.66	07:35	52.83	59.88	161	130
01 - 02	1117	23/07/2020	08:30	52.87	59.97	10:20	52.81	60.19	194	760
02 - 06	1118	23/07/2020	12:00	52.94	59.90	14:00	52.98	59.65	233	50043
03 - 07	1119	23/07/2020	15:45	52.83	59.61	17:25	52.83	59.39	147	2079
A - 01	1120	24/07/2020	06:05	52.95	59.08	08:05	53	59.28	191	2673
A - 02	1121	24/07/2020	09:00	53.00	59.29	11:00	52.99	59.55	217	14686
A - 03	1122	24/07/2020	12:00	52.98	59.65	20:00	52.94	59.88	230	26943
A - 04	1123	24/07/2020	14:50	52.92	59.93	16:35	52.88	60.1	207	7796
A - 05	1124	25/07/2020	06:00	52.65	58.55	08:00	52.74	58.72	195	12292
A - 06	1125	25/07/2020	09:00	52.75	58.74	11:00	52.85	58.95	146	9373

A - 07	1126	25/07/2020	12:00	52.89	58.93	13:45	52.82	58.74	172	45976
A - 08	1127	25/07/2020	14:45	52.82	58.76	15:10	52.79	58.74	171	49840
A - 09	1128	26/07/2020	05:55	52.10	57.68	07:40	51.97	57.53	180	1329
A - 10	1129	26/07/2020	08:45	51.85	57.42	10:45	51.69	57.32	206	4731
A - 11	1130	26/07/2020	12:30	51.38	57.31	12:25	51.26	57.17	130	2086
A - 12	1131	26/07/2020	15:05	51.22	57.07	17:05	51.09	56.91	135	6726
A - 13	1132	27/07/2020	05:55	50.92	56.92	07:40	50.82	57.07	126	41218
A - 14	1133	27/07/2020	08:55	50.85	56.95	10:55	50.73	57.12	250	25238
A - 15	1134	27/07/2020	12:00	50.75	57.25	13:40	50.83	57.09	130	52311
A - 16	1135	28/07/2020	05:50	50.91	56.98	07:50	50.82	57.17	126	26950

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*	575373	89.1	426	428
HAK	*Merluccius hubbsi*	65730	10.2	3184	37
PAR	*Patagonotothen ramsayi*	1177	0.2	234	972
KIN	*Genypterus blacodes*	709	0.1	224	0
CGO	*Cottoperca gobio*	587	0.1	3	576
SHT	Mixed invertebrates	486	0.1	0	486
BAC	*Salilota australis*	419	0.1	87	223
WHI	*Macruronus magellanicus*	232	<0.1	42	91
DGH	*Schroederichthys bivius*	208	<0.1	2	206
ZYP	*Zygochlamys patagonica*	165	<0.1	0	165
TOO	*Dissostichus eleginoides*	138	<0.1	138	2
LAR	*Lampris immaculatus*	123	<0.1	123	0
SPN	Porifera	121	<0.1	0	121
RBR	*Bathyraja brachyurops*	83	<0.1	3	74
BLU	*Micromesistius australis*	56	<0.1	6	52
GRF	*Coelorinchus fasciatus*	51	<0.1	2	49
MUU	*Munida subrugosa*	46	<0.1	0	46
SQT	Ascidiacea	33	<0.1	0	33
MUG	*Munida gregaria*	32	<0.1	0	32
PTE	*Patagonotothen tessellata*	31	<0.1	0	31
ALG	Algae	31	<0.1	0	31
RMC	*Bathyraja macloviana*	24	<0.1	0	23
ING	*Moroteuthis ingens*	23	<0.1	6	19
RFL	*Zearaja chilensis*	21	<0.1	0	15
STA	*Sterechinus agassizi*	19	<0.1	0	19
RAL	*Bathyraja albomaculata*	19	<0.1	1	16
GRC	*Macrourus carinatus*	18	<0.1	18	17
GOC	*Gorgonocephalus chilensis*	18	<0.1	0	18
RDO	*Amblyraja doellojuradoi*	12	<0.1	0	12
MUL	*Eleginops maclovinus*	11	<0.1	6	8
MED	Medusae	11	<0.1	0	11
OCM	*Octopus megalocyathus*	10	<0.1	10	3
ILL	*Illex argentinus*	10	<0.1	3	7
RSC	*Bathyraja scaphiops*	9	<0.1	0	9

PAU	*Patagolycus melastomus*	8	<0.1	1	8
PAT	*Merluccius australis*	8	<0.1	8	0
SEP	*Seriolella porosa*	7	<0.1	5	2
RBZ	*Bathyraja cousseauae*	7	<0.1	0	6
OCC	Octocoralia	7	<0.1	0	7
LIC	*Lithodes confundens*	6	<0.1	0	2
ANM	Anemone	6	<0.1	0	6
ODM	*Odontocymbiola magellanica*	3	<0.1	0	3
BUT	*Stromateus brasiliensis*	3	<0.1	2	0
BRY	Bryozoa	3	<0.1	0	3
SUN	*Labidaster radiosus*	2	<0.1	0	2
RGR	*Bathyraja griseocauda*	2	<0.1	0	2
POA	*Porania antarctica*	2	<0.1	0	2
PAP	*Paralomis spinosissima*	2	<0.1	0	0
NED	*Neolithodes diomedeae*	2	<0.1	0	0
SAR	*Sprattus fuegensis*	1	<0.1	1	0
SAL	*Salpa* sp.	1	<0.1	0	1
RPX	*Psammobatis* spp.	1	<0.1	1	1
OPV	*Ophiacanta vivipara*	1	<0.1	0	1
NOW	*Paranotothenia magellanica*	1	<0.1	1	0
MYX	*Myxine* spp.	1	<0.1	1	0
MLA	*Muusoctopus longibrachus akambei*	1	<0.1	0	1
MAT	*Achiropsetta tricholepis*	1	<0.1	1	0
LIA	*Lithodes antarcticus*	1	<0.1	0	0
HYD	Hydrozoa	1	<0.1	0	1
GOR	Gorgonacea	1	<0.1	0	1
FUM	*Fusitriton m. magellanicus*	1	<0.1	0	1
EGG	Eggmass	1	<0.1	0	1
CAZ	*Calyptraster* sp.	1	<0.1	0	1
WRM	*Chaetopterus variopedatus*	<1	<0.1	0	0
PYX	Pycnogonida	<1	<0.1	0	0
POE	*Pogonolycus elegans*	<1	<0.1	0	0
PES	*Peltarion spinosulum*	<1	<0.1	0	0
PAV	*Patagonotothen brevicauda*	<1	<0.1	0	0
OPL	*Ophiuroglypha lymanii*	<1	<0.1	0	0
OPD	*Ophiacantha densispina*	<1	<0.1	0	0
NUH	*Nuttallochiton hyadesi*	<1	<0.1	0	0
NUD	Nudibranchia	<1	<0.1	0	0
MUE	*Muusoctopus eureka*	<1	<0.1	0	0
MAV	*Magellania venosa*	<1	<0.1	0	0
GYN	*Gymnoscopelus nicholsi*	<1	<0.1	0	0
GON	*Gonatus antarcticus*	<1	<0.1	0	0
EUL	*Eurypodius latreillei*	<1	<0.1	0	0
CYX	*Cycethra* sp.	<1	<0.1	0	0
CTA	*Ctenodiscus australis*	<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
COL	*Cosmasterias lurida*	<1	<0.1	0	0
CHE	*Champsocephalus esox*	<1	<0.1	0	0
CAS	*Campylonotus semistriatus*	<1	<0.1	0	0

BAO	*Bathybiaster loripes*	<1	<0.1	0	0
AUC	*Austrocidaris canaliculata*	<1	<0.1	0	0
AST	Asteroidea	<1	<0.1	0	0
ASA	*Astrotoma agassizii*	<1	<0.1	0	0
ANT	Anthozoa	<1	<0.1	0	0
AGO	*Agonopsis chilensis*	<1	<0.1	0	0
		646,118.3		4539.4	3889.0

Table A3. Basket samples per station, in kg, with minor species summarized in the 'other' species category. Includes baskets taken from some stations which were subsequently sampled entirely.

Station - Basket	Total	LOL	PAR	RBR	BAC	WHI	HAK	BLU	CGO	Other
1081 - 1+2	59.35	28.06	0.28		1.76		26.97			2.28
1082 - 1	28.69	10.31				0.60	17.78			
1082 - 2	30.27	8.60					21.67			
1083 - 1	25.76	16.18				0.57	8.98	0.03		
1083 - 2	27.83	4.45	0.27				23.11			
1083 - 3	33.97	5.01		4.00		0.32	24.64			
1084 - 1	36.43	28.70	0.04	0.53			7.10		0.04	0.02
1089 - 1	26.05	17.42					4.42		0.08	4.13
1089 - 2	27.29	11.15					14.00			2.14
1090 - 1	28.90	9.51					19.23	0.03		0.13
1090 - 2	27.86	10.63					17.02			0.21
1091 - 1	36.04	33.56					2.48			
1092 - 1	28.24									28.24
1097 - 1	22.54	15.47					7.06			0.01
1097 - 2	30.90	21.95	0.08				8.74			0.13
1097 - 3	34.05	30.12	0.03				3.89			0.01
1098 - 1	25.26	25.19								0.07
1099 - 1	32.91	6.86	1.06			1.37	18.17	0.65		4.80
1100 - 1	49.78	7.76	1.50				39.42			1.10
1101 - 1	47.93	26.16					21.77			
1102 - 1	25.09	25.06	0.02							0.01
1102 - 2	30.95	25.56	0.04				5.35			
1103 - 1	23.40	23.31	0.09							
1103 - 2	28.24	26.19	0.48				1.51			0.06
1104 - 1	52.31	4.50	3.11		2.05		41.22	0.16		1.27
1105 - 1	27.96	26.09	0.32				1.55			
1105 - 2	26.80	20.32	0.27				6.20			0.01
1106 - 1	26.80	26.72	0.08							
1106 - 2	26.43	26.42	0.01							
1108 - 1	24.89	17.58								7.31
1108 - 2	28.47	19.54								8.93

Table A4. Numbers of fish by species by sex (M, F, J = juvenile, U = undetermined) from which otoliths were taken during the survey.

Species		N			
		M	F	J	U
Common Hake	*Merluccius hubbsi*	64	656		
Common Rock cod	*Patagonotothen ramsayi*	249	268	46	
Kingclip	*Genypterus blacodes*	67	103		
Patagonian Toothfish	*Dissostichus eleginoides*	51	51	1	
Hoki	*Macruronus magellanicus*	38	58		
Red cod	*Salilota australis*	29	38		
Southern Blue Whiting	*Micromesistius australis*	23	19	5	
Ridge scaled Rattail	*Macrourus carinatus*	3	7		1
Banded Whiptail	*Coelorinchus fasciatus*	1	5		
Yellow belly	*Paranotothenia magellanica*	5	1		
Icefish	*Champsocephalus esox*	2	2		
Southern Hake	*Merluccius australis*	2	2		
Falkland Mullet	*Eleginops maclovinus*	2	1		
Falkland Herring	*Sprattus fuegensis*	1	1		
Moonfish	*Lampris immaculatus*	1	1		
Driftfish	*Seriolella porosa*	2			
PAE rock cod	*Patagonotothen elegans*				1