Cruise Report ZDLT1-02-2020

2020 Demersal biomass survey

Randhawa HS, Goyot L, Blake, A, Ramos JE, Robert G, Brewin J, Evans D

Fisheries Department
Directorate of Natural Resources
Falkland Islands Government
Stanley, Falkland Islands

(06 May 2020)

ZDLT1-02-2020

DESIRE THE RIGHT

Participating/Contributing Scientific Staff

Haseeb S Randhawa	(Cruise Leader, Biological sampling, text)
Ludovic Goyot	(Factory Manager, Biological sampling, Benthos, text)
Alex Blake	(CTD, Oceanography, Biological sampling, text)
Jorge E Ramos	(Abundance estimates, Biological sampling)
Georgina Robert	(Biological sampling)
Jordan Brewin	(Biological sampling)
Dale Evans	(Biological sampling)

Comments provided by: Alexander Arkhipkin

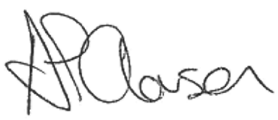
Acknowledgements

We thank Captain Salvador Piñeiro Rial and the crew of the *FV Castelo* for their assistance during the cruise.

For citation purposes this publication should be referenced as follows:

Randhawa HS, Goyot L, Blake A, Ramos JE, Roberts G, Brewin J, Evans D (2020) Cruise Report ZDLT1-02-2020: 2020 Demersal Biomass Survey. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 97 pp.

Distribution: Public Domain



Reviewed and approved on: Date: 06/05/2020

Table of Contents

1.0 Introduction

The Falkland Islands lie in one of the most productive marine ecosystems in the world: the Patagonian Shelf. This shelf extends from the Rio de La Plata estuary (Uruguay/Argentina; 38°S) to the Burdwood Bank and Tierra del Fuego (54°S) and is home to a wide assemblage of commercial species including squid (*Illex argentinus* and *Doryteuthis gahi*), finfish (e.g. *Merluccius hubbsi, Genypterus blacodes, Salilota australis, Macruronus magellanicus, Dissostichus eleginoides*), and elasmobranchs (e.g. Rajiformes). Many species that are exploited commercially migrate into Falkland Island waters and are considered straddling stocks with Argentina. The relative abundance of each species in Falkland Islands waters varies greatly from year to year depending on prevailing currents and water temperatures.

Since 2010, seven surveys have been conducted in February (2010, 2011, 2015-2019) to estimate the biomass of the index species rock cod. An eighth survey was conducted in October and November 2014 and a ninth in July 2017. In recent years, the February demersal survey has focused not only on rock cod, but on all commercial species encountered during the surveys and some non-commercial species (e.g. banded grenadier *Coelorinchus fasciatus* and sharks *Schroederichthys bivius* and *Squalus acanthias*).

The main objective of the 2020 survey was to assess the distribution of common demersal species and to collect their biological data from each research station (length, sex, maturity, otoliths/statoliths). In this report, we present distribution and biological data for 12 finfish, two squid, and 12 elasmobranch species. Biomass estimates, combining data from this survey with the *Doryteuthis gahi* pre-recruitment survey, are presented in a separate report (Ramos & Winter 2020). Secondarily, a description of the oceanography (temperature, salinity, oxygen voltage, and Chlorophyll A) is presented in this report. A third objective was to assess the spatial distribution and population structure of benthos.

A final objective was to repeat four stations in shallow waters to the south of the Falkland Islands where small juvenile (0+) toothfish were recovered during the juvenile toothfish survey in 2017 (Arkhipkin et al 2017); this survey was repeated in 2018 (unpublished data) and during the 2019 demersal survey (Arkhipkin et al 2019). This was done to investigate the abundance and distribution of juvenile toothfish in their nursery grounds. With poor recruitment recorded in 2018 and 2019 onto the southern part of the shelf, there is some urgency to continue monitoring the presence and numbers of juvenile toothfish in these areas.

2.0 Materials and Methods

2.1 Cruise vessel and area surveyed

The demersal biomass survey for 2020 was conducted aboard the *F/V Castelo* (ZDLT1), a Falkland Islands registered commercial demersal trawler (Length 67.8 m; GRT 1,321 t) from February 2nd to 22nd. The vessel departed FIPASS at 06:30 on February 2nd to reach the first shallow water station at mid-afternoon. The first four trawl stations (2968, 2970, 2971, and 2976) (Table 1; Fig 1) were dedicated to surveying for juvenile toothfish in inshore waters in areas identified as recruitment areas (Arkhipkin et al 2017). These stations were the same performed to the south of the Falkland Islands in December 2018 and in February 2019 (Arkhipkin et al 2019). Results from these four trawl stations will be presented herein, but separately. The remaining 80 stations (Table 1; Fig 1) were repeated from the 2018 survey (Gras et al 2018). In 2019, the 83 stations surveyed included 12 stations in shallow waters (Arkhipkin et al 2019). All remaining 71 stations from 2019 were previously explored in 2018 (Gras et al 2018) and repeated in 2020. Generally, four 60-minute trawls were done each day in adjacent grid squares (Table 1). However, on the first day of the cruise, only three trawls were performed in shallow waters. Additionally, on February 17th, 18th, and 19th, given the close proximity between stations, five trawls per day were conducted. On this final day (February 22nd), we performed two trawls and returned to FIPASS in Stanley at 19:00. On February 20th, we experienced strong winds and rough seas and following discussions with the Captain, we determined that fishing activities could continue if we changed the course of the planned trawls. Therefore, no fishing days were lost to bad weather.

2.2 Trawling

The Falkland Islands Government Fisheries Department (FIFD) own bottom trawl net, with rockhopper gear, equipped with the *F/V Castelo*'s Thyborøn 23 VF 5.25 m^2 2,700 kg doors was used. The cod-end had a 90 mm mesh size fitted with a 40 mm cod end liner. The MarPort Net Monitoring System was used to monitor the net geometry successfully on the last 79 of the 84 trawls. In order to maintain a net opening similar to previous surveys, the bridle was extended to 120 m from the 115 m used from 2014 to 2018 (not certain about 2019). Trawl speed ranged from 3.7 to 5.0 knots (mean of 4.2 knots).

2.3 Biological sampling

At each trawl station, the total catch was weighed with an electronic balance (Marel; 80 kg). All species (commercial, non-commercial, benthos) were sorted and weighed individually. All commercial and a selection of common, but non-commercial, species (e.g. *C. fasciatus*, *S. bivius*) were sampled. The sample generally consisted of 100 individuals or all individuals when the total number was less than 100. In a few instances of very large catches, a second sample of 100 individuals was taken from the same catch. Biological sampling of finfish included length (total [T_L] or pre-anal; to the lower cm), sex, and maturity (eight-stage scale – see Observer manual). For skates, all individuals were sampled, including disc width (to the lower cm; total length as well in some instances), weight, sex, and maturity (six-stage scale – see Observer manual). For squid, a sample of approximately 100 individuals (if available) were sampled, including dorsal mantle length (to the lower 0.5 cm), sex, and maturity (six-stage scale – see Observer manual). Lobster krill was sampled only in shallow inshore stations, including measurements of cephalothorax length (to the lowest mm) and sex.

Otoliths were extracted for 14 different finfish species. Statolith extraction was undertaken ashore from frozen samples for both *Illex argentinus* and *Doryteuthis gahi*. No skate thorns or vertebrae were collected during this cruise, but *Squalus acanthias* dorsal spines and vertebrae were collected from various stations for an age validation study. Length, weight, sex, and maturity information was recorded from each respective individual from which the aforementioned otolith, statolith, spines/vertebrae sample was taken.

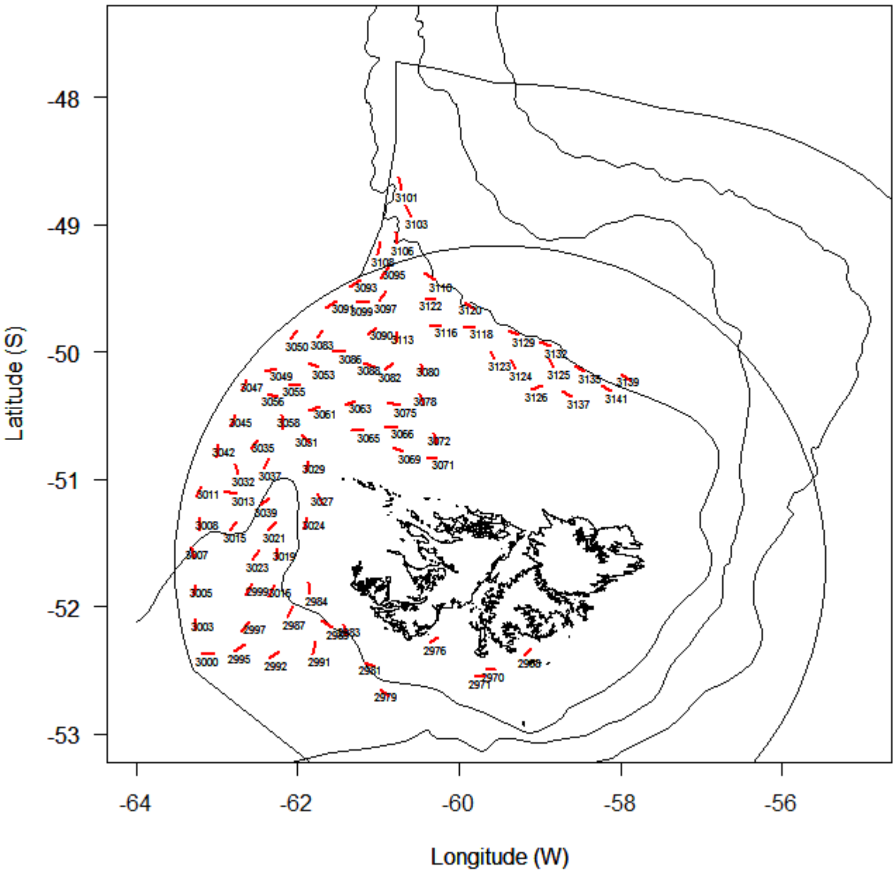


Fig 1. Trawl tracks with station numbers for trawls performed during the 2020 demersal survey (ZDLT1-02-2020).

2.4 Benthos

At each trawl station (Fig 1; Table 1), the benthic invertebrate fauna was sorted to the lowest possible taxon and weighed to the nearest g. The catch per species at each station was standardized as kg caught per km^2. Two difficulties arise when analysing benthos data acquired during the groundfish survey. First, bottom trawling, even fitted with a small mesh liner (40 mm), can only be considered as partly quantitative for benthic invertebrate species. Indeed the probability for an individual to be caught and retained until identified can somewhat be reduced by parameters such as its size, texture, etc. Secondly, some benthic invertebrate species have an individual biomass naturally higher than others, which can make the discrimination of the communities difficult if the naturally abundant species outweigh the scarcer, lighter ones. For these two reasons, the data have been log transformed before analysis [$\log_{10}(x+1)$] to damper the high weight differences whilst keeping the trends between abundant / rare species (Eleftheriou & McIntyre, 2005).

The similarities between stations based on their benthic communities have been assessed using Gower distance coefficients, which present the advantage of taking into account the double absence of a taxon at two compared stations (Brocard et al 2011). This matrix of similarity was then used to conduct a hierarchical clustering analysis (complete linkage), allowing the identification of groups of stations based on their benthic assemblage. The differences of total biomass and species richness between groups were tested with ANOVA. *Indval* tests (De Cáceres & Legendre, 2009) were carried out to detect indicator species for these assemblages, and the groups were mapped to identify the geographic structures of the benthic community. All analyses were carried out with R Version 3.5.1 (R Core Team, 2018).

2.5 Oceanography

A single CTD (SBE-25, Sea-Bird Electronics Inc., Bellevue, USA) instrument, Serial No 0247, was used to collect oceanographic data in the vicinity of most trawl stations (Fig 2). At all CTD stations the CTD was deployed to a depth of *c*.10m below surface for a soak time of more than one minute, this allowed the pump to start circulating water and flush the system. Following this, the CTD was raised to a maximum depth of 5 m below surface. The CTD was then lowered toward sea bed at 1m/sec. The CTD collected pressure in dbar, temperature in °C, conductivity in mS/cm, Oxygen Voltage, and Fluorescence. The raw hex file was converted and processed using SBE Data Processing Version.7.22.5 using the CON file 0247_2019_09.xmlcon with the instruments calibrated in July 2019. Up-cast data was filtered out. Depth was derived from pressure using the latitude of each station, with dissolved oxygen in mL/L derived at the same time as depth. Practical Salinity (PSU) and Density as sigma-t (σ-t) were obtained following derivation of depth. Further derived variables of conservative temperature (°C) and Absolute Salinity (g/kg) were calculated in Ocean Data View version 5.15 (Schlitzer, R., Ocean Data View, http://odv.awi.de, 2013). Due to rough weather on February 20th, no CTDs were done. Additional CTDs were carried out on February 21st in the vicinity of one of the trawl stations from February 20th and equidistant between two others relatively close together.

During the first CTD on the Research cruise an issue came to light with the crane on the Castelo. The CTD was lifted and swung out over the side of the vessel. Power (or Hydraulic pump or something else) was then switched from the crane to the CTD winch. The crane then began to swing back towards the CTD winch of its own accord and eventually in-line with the vessels side. This resulted in the CTD winch cable jumping off the pulley that measures the cable being deployed. To reseat the cable it was necessary to swing the crane back in line with the CTD winch and release tension on the cable. The moment power was switched to the CTD winch the crane rotated of its own accord. Eventually the bosom fixed a rope to the end of the crane arm and secured it to the forward part of the vessel to stop it swinging back towards the aft and the CTD winch. For all subsequent CTDs the process was to swing the crane out from the vessel and secure it with a rope before switching power over. The issues were that:

- The CTD was left swinging at the end of the crane whilst it was secured in place. Whilst in calm seas this would not be an issue, there was potential for the CTD to strike the vessel in rougher seas (depending on length of CTD cable) whist the crane was secured or once the CTD had begun to swing (akin to a pendulum) as the cable was released to lower the CTD.

- In rough weather, whilst the crane was stopped from swinging towards the aft there was nothing to stop the crane swinging forward as the Castelo pitched bow down, and when the vessel pitched up the crane swung backward, loading the securing rope.

Additionally, there was also an issue with the counter on the CTD winch, and it may be in need of calibration. On at least 2 CTDs the CTD was on the bottom for a short period of time, even though the display on the bridge suggested it was five metres from the bottom. Given that the vessel was drifting with this safety margin the CTD should have been further from the bottom.

It should be noted that neither the crane nor the calibration of the CTD winch prevented the deployment of the CTD and associated data gathering. However, a series of recommendations are made in section 5.0 to resolve these issues in time for the next research cruise.

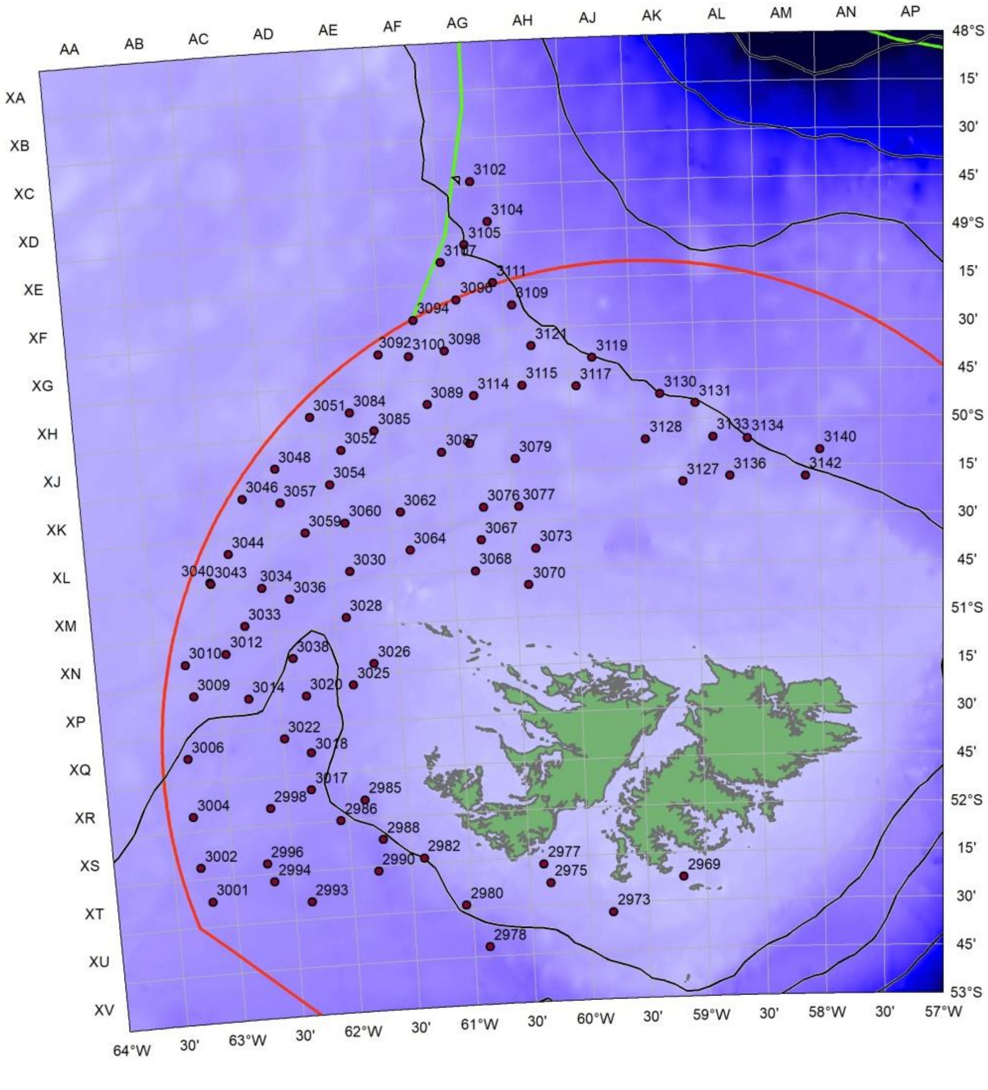


Fig 2. Station numbers for CTDs performed during the 2020 demersal survey (ZDLT1-02-2020).

Table 1. Trawl stations with station number, date, coordinates, modal depth, and duration. Stations highlighted in grey correspond to shallow inshore stations for which data are presented separately (Section 3.6).

Station	Date	Latitude (Start)	Longitude (Start)	Latitude (Finish)	Longitude (Finish)	Modal Depth (m)	Trawl duration (min)
2968	02/02/20	-52.3328	-59.1080	-52.3818	-59.2062	62	60
2970	02/02/20	-52.4997	-59.5443	-52.4998	-59.6635	112	60
2971	02/02/20	-52.5385	-59.6787	-52.5507	-59.8058	112	60
2976	03/02/20	-52.2405	-60.2577	-52.2878	-60.3752	97	60
2979	03/02/20	-52.7032	-60.8743	-52.6537	-60.9820	383	60
2981	03/02/20	-52.4770	-61.0530	-52.4383	-61.1762	275	60
2983	03/02/20	-52.2193	-61.3892	-52.1435	-61.4352	183	60
2984	04/02/20	-51.8067	-61.8655	-51.9010	-61.8447	186	60
2987	04/02/20	-52.0005	-62.0635	-52.0837	-62.1238	283	60
2989	04/02/20	-52.1140	-61.7113	-52.1600	-61.5797	249	60
2991	04/02/20	-52.2748	-61.7737	-52.3717	-61.8108	321	60
2992	05/02/20	-52.3567	-62.2400	-52.4080	-62.3525	294	59
2995	05/02/20	-52.2938	-62.6600	-52.3485	-62.7907	270	60
2997	05/02/20	-52.1983	-62.7088	-52.1218	-62.6013	255	60
2999	05/02/20	-51.9105	-62.6487	-51.8250	-62.5708	228	60
3000	06/02/20	-52.3632	-63.0395	-52.3703	-63.1937	259	60
3003	06/02/20	-52.1915	-63.2700	-52.1028	-63.2615	227	60
3005	06/02/20	-51.9228	-63.2990	-51.8293	-63.2648	201	60
3007	06/02/20	-51.6220	-63.2875	-51.5313	-63.3238	179	60
3008	07/02/20	-51.3992	-63.2077	-51.3055	-63.2080	167	60
3011	07/02/20	-51.1357	-63.2605	-51.0573	-63.1905	155	60
3013	07/02/20	-51.0952	-62.9100	-51.1138	-62.7555	168	60
3015	07/02/20	-51.3363	-62.7563	-51.4015	-62.8532	181	60
3016	08/02/20	-51.9218	-62.3548	-51.8340	-62.2937	262	60
3019	08/02/20	-51.6372	-62.2710	-51.5505	-62.2455	249	60
3021	08/02/20	-51.3340	-62.2785	-51.4038	-62.3673	209	59
3023	08/02/20	-51.5597	-62.4852	-51.6353	-62.5665	210	60
3024	09/02/20	-51.3945	-61.9237	-51.3032	-61.8825	198	60
3027	09/02/20	-51.1932	-61.7008	-51.1137	-61.7653	179	60
3029	09/02/20	-50.9500	-61.9082	-50.8633	-61.8668	172	60
3031	09/02/20	-50.7145	-61.8563	-50.6533	-61.9552	179	60
3032	10/02/20	-50.8778	-62.7683	-50.9597	-62.7460	163	60
3035	10/02/20	-50.7652	-62.5778	-50.6918	-62.5040	165	60
3037	10/02/20	-50.8387	-62.3567	-50.9203	-62.4225	182	60
3039	10/02/20	-51.1455	-62.3645	-51.2060	-62.4590	187	60
3042	11/02/20	-50.8252	-63.0070	-50.7290	-62.9903	150	60
3045	11/02/20	-50.5810	-62.8322	-50.5012	-62.7788	148	60
3047	11/02/20	-50.3023	-62.6833	-50.2232	-62.6372	147	60
3049	11/02/20	-50.1555	-62.4175	-50.1283	-62.2725	147	60
3050	12/02/20	-49.8282	-62.0042	-49.9020	-62.0907	146	60
3053	12/02/20	-50.0837	-61.8617	-50.1257	-61.7522	157	60
3055	12/02/20	-50.2592	-61.9740	-50.2503	-62.1128	158	60
3056	12/02/20	-50.3552	-62.2538	-50.3353	-62.3785	153	60
3058	13/02/20	-50.6043	-62.1845	-50.5015	-62.1953	164	60
3061	13/02/20	-50.4610	-61.8645	-50.4292	-61.7368	165	60
3063	13/02/20	-50.4225	-61.4118	-50.3890	-61.2915	162	60
3065	13/02/20	-50.6208	-61.3493	-50.6145	-61.1905	149	60
3066	14/02/20	-50.5923	-60.9303	-50.5877	-60.7710	150	60
3069	14/02/20	-50.7500	-60.8252	-50.7813	-60.6932	132	60

Station	Date	Latitude (Start)	Longitude (Start)	Latitude (Finish)	Longitude (Finish)	Modal Depth (m)	Trawl duration (min)
3071	14/02/20	-50.8340	-60.4007	-50.8323	-60.2742	135	60
3072	14/02/20	-50.7153	-60.2775	-50.6450	-60.3233	144	60
3075	15/02/20	-50.3920	-60.8925	-50.4205	-60.7390	151	60
3078	15/02/20	-50.4235	-60.4447	-50.3318	-60.4865	152	60
3080	15/02/20	-50.1768	-60.4597	-50.0973	-60.4642	158	60
3082	15/02/20	-50.0873	-60.8212	-50.1395	-60.9287	160	60
3083	16/02/20	-49.8305	-61.7005	-49.8925	-60.7713	158	60
3086	16/02/20	-49.9927	-61.5807	-49.9945	-61.4200	156	60
3088	16/02/20	-50.1208	-61.0547	-50.0855	-61.1943	159	60
3090	16/02/20	-49.8717	-61.1437	-49.8060	-61.0393	163	59
3091	17/02/20	-49.6545	-61.6528	-49.6012	-61.5162	158	60
3093	17/02/20	-49.4908	-61.3578	-49.4333	-61.2210	161	60
3095	17/02/20	-49.4198	-60.9703	-49.3398	-60.8275	167	60
3097	17/02/20	-49.5190	-60.9025	-49.5977	-60.9873	165	60
3099	17/02/20	-49.6027	-61.1187	-49.6178	-61.2722	162	60
3101	18/02/20	-48.6290	-60.7477	-48.7258	-60.7222	245	59
3103	18/02/20	-48.8485	-60.6600	-48.9378	-60.5995	241	60
3106	18/02/20	-49.0545	-60.7850	-49.1448	-60.7743	190	61
3108	18/02/20	-49.1383	-60.9792	-49.2323	-61.0147	172	60
3110	18/02/20	-49.3767	-60.4288	-49.4325	-60.3047	197	60
3113	19/02/20	-49.9287	-60.7807	-49.8390	-60.7682	163	60
3116	19/02/20	-49.7965	-60.3752	-49.7928	-60.2262	168	60
3118	19/02/20	-49.8095	-59.9475	-49.8048	-59.8017	166	60
3120	19/02/20	-49.6662	-59.8137	-49.6160	-59.9320	185	60
3122	19/02/20	-49.5938	-60.2965	-49.5803	-60.4253	172	60
3123	20/02/20	-49.9940	-59.6212	-50.0585	-59.5692	162	60
3124	20/02/20	-50.0642	-59.3630	-50.1285	-59.3062	157	60
3125	20/02/20	-50.0505	-58.8878	-50.1197	-58.8357	155	60
3126	20/02/20	-50.2617	-58.9707	-50.2940	-59.1085	150	60
3129	21/02/20	-49.8312	-59.3933	-49.8653	-59.2725	188	60
3132	21/02/20	-49.9167	-58.9990	-49.9528	-58.8708	196	60
3135	21/02/20	-50.1067	-58.5770	-50.1570	-58.4478	167	60
3137	21/02/20	-50.3032	-58.7260	-50.3485	-58.5997	143	60
3139	22/02/20	-50.2348	-57.8697	-50.1728	-57.9877	275	60
3141	22/02/20	-50.2645	-58.2410	-50.3072	-58.1153	167	60

3.0 Results

3.1 Catch composition

During the survey, a total of 54,289.2 kg of biomass (representing 124 taxa) was caught (Table 2). The most abundant species by weight was the squid *I. argentinus* (caught mostly to the north and northeast), followed by *M. magellanicus* and *D. gahi* (Table 2). Overall, the total catch of two species exceeded 10,000 kg, catches for six species were between 1,000 kg and 9,999 kg, and catches were less than 1 kg for 53 species (Table 2).

Table 2. Catch composition by weight (with sample weights and discards) of all species caught during the demersal survey (ZDLT1-02-2020), excluding shallow inshore stations.

Species code	Latin name	Total catch (kg)	Total sampled (kg)	Total discarded (kg)	No. Stations	% of catch
ILL	*Illex argentinus*	17,853.398	1,245.724	1.333	72	34.05
WHI	*Macruronus magellanicus*	14,323.132	497.783	0.900	28	27.32
LOL	*Doryteuthis gahi*	3,694.399	239.438	232.782	78	7.05
KIN	*Genypterus blacodes*	3,398.104	2,415.424	-	75	6.48
BAC	*Salilota australis*	3,334.178	1,103.016	120.347	74	6.36
GRF	*Coelorinchus fasciatus*	2,419.302	235.958	2,419.302	17	4.61
PAR	*Patagonotothen ramsayi*	1,774.019	506.644	841.786	80	3.38
BUT	*Stromateus brasiliensis*	1,352.715	660.003	1,331.973	64	2.58
HAK	*Merluccius hubbsi*	714.122	714.122	-	51	1.36
DGS	*Squalus acanthias*	494.482	364.147	494.482	32	0.94
PYM	*Physiculus marginatus*	416.822	-	416.822	10	0.79
RBR	*Bathyraja brachyurops*	405.400	404.870	82.397	49	0.77
RGR	*Bathyraja griseocauda*	280.720	280.720	1.320	14	0.54
TOO	*Dissostichus eleginoides*	263.358	257.458	0.001	27	0.50
SPN	Porifera	205.334	-	205.334	72	0.39
RFL	*Zearaja chilensis*	203.459	203.459	3.540	26	0.39
GRC	*Macrourus carinatus*	168.440	166.880	-	4	0.32
DGH	*Schroederichthys bivius*	146.567	138.127	146.567	55	0.28
ALG	Algae	145.166	-	145.166	71	0.28
CGO	*Cottoperca gobio*	96.746	1.51	95.122	53	0.18
PAT	*Merluccius australis*	89.380	89.380	-	10	0.17
MED	Medusae	68.148	-	65.842	32	0.13
ILF	*Iluocoetes fimbriatus*	57.108	-	57.108	7	0.11
COP	*Congiopodus peruvianus*	51.380	-	51.380	19	0.10
RMU	*Bathyraja multispinis*	38.560	38.560	-	3	0.07
STA	*Sterechinus agassizi*	36.247	-	36.247	54	0.07
RMC	*Bathyraja macloviana*	34.400	34.400	1.860	24	0.07
BRY	Bryozoa	27.280	-	27.280	30	0.05
RAL	*Bathyraja albomaculata*	26.140	26.140	0.100	14	0.05
RBZ	*Bathyraja cousseauae*	25.824	25.824	-	4	0.05
SQT	Ascidiacea	25.475	-	25.475	38	0.05
BLU	*Micromesistius australis*	24.328	23.421	23.396	17	0.05
ING	*Moroteuthis ingens*	23.945	0.400	17.960	22	0.05
NEM	*Neophyrnichthys marmoratus*	21.733	-	20.073	14	0.04
SEP	*Seriolella porosa*	17.720	17.720	-	2	0.03
RED	*Sebastes oculatus*	14.906	14.880	1.600	6	0.03
RPX	*Psammobatis* spp.	11.835	11.835	7.189	16	0.02
HYD	Hydrozoa	11.636	-	11.636	42	0.02
CIR	Cirripedia	11.028	-	11.028	10	0.02
RDO	*Amblyraja doellojuradoi*	10.545	10.545	8.140	11	0.02
RSC	*Bathyraja scaphiops*	9.020	9.020	-	4	0.02
ANM	Anemone	8.988	-	8.988	46	0.02

Species code	Latin name	Total catch (kg)	Total sampled (kg)	Total discarded (kg)	No. Stations	% of catch
MUG	*Munida gregaria*	7.266	-	7.266	40	0.01
ALC	Alcyoniina	5.984	-	5.984	36	0.01
GYN	*Gymnoscopelus nicholsi*	5.486	-	5.408	5	0.01
EEL	*Iluocoetes/Patagolycus* mix	5.483	-	5.483	23	0.01
CTA	*Ctenodiscus australis*	5.184	-	5.184	63	<0.01
FUM	*Fusitriton m. magellanicus*	5.130	-	5.130	28	<0.01
OPV	*Ophiacanta vivipara*	4.701	-	3.575	64	<0.01
AUL	*Austrolycus laticinctus*	4.308	-	4.308	3	<0.01
MLA	*Muusoctopus longibrachus akambei*	4.008	-	4.008	2	<0.01
GOR	Alcyonacea	3.695	-	3.695	31	<0.01
OCT	*Octopus* spp.	3.638	-	3.244	7	<0.01
SHT	Mixed invertebrates	3.412	-	3.412	3	<0.01
UHH	Heart urchin	3.210	-	3.210	25	<0.01
CAZ	*Calyptraster* sp.	3.071	-	2.743	54	<0.01
GOC	*Gorgonocephalus chilensis*	2.866	-	2.866	14	<0.01
OCM	*Enteroctopus megalocyathus*	2.648	-	2.648	4	<0.01
AUC	*Austrocidaris canaliculata*	2.370	-	2.370	35	<0.01
PAG	*Paralomis granulosa*	2.134	-	2.134	2	<0.01
COT	*Cottunculus granulosus*	1.820	-	1.440	2	<0.01
MUU	*Munida subrugosa*	1.626	-	0.918	20	<0.01
ZYP	*Zygochlamys patagonica*	1.604	-	1.604	24	<0.01
MAM	*Mancopsetta milfordi*	1.420	-	1.420	1	<0.01
SSA	*Salmo salar*	1.320	1.320	1.320	1	<0.01
EGG	Eggmass	1.295	-	1.295	50	<0.01
PES	*Peltarion spinosulum*	1.289	-	1.289	26	<0.01
POA	*Porania antarctica*	1.276	-	1.276	19	<0.01
HOL	Holothuroidea	1.221	-	1.221	10	<0.01
AST	Asteroidea	1.061	-	1.061	24	<0.01
PYX	Pycnogonida	1.042	-	1.022	68	<0.01
SRP	*Semirossia patagonica*	0.865	-	0.865	38	<0.01
COL	*Cosmasterias lurida*	0.844	-	0.844	15	<0.01
WRM	*Chaetopterus variopedatus*	0.753	-	0.753	29	<0.01
ASA	*Astrotoma agassizii*	0.683	-	0.683	6	<0.01
ANT	Anthozoa	0.681	-	0.681	34	<0.01
CEX	*Ceramaster* sp.	0.665	-	0.665	14	<0.01
SUN	*Labidaster radiosus*	0.651	-	0.635	17	<0.01
OPL	*Ophiuroglypha lymanii*	0.589	-	0.190	52	<0.01
MAV	*Magellania venosa*	0.530	-	0.530	14	<0.01
BAL	*Bathydomus longisetosus*	0.439	-	0.439	10	<0.01
ODM	*Odontocymbiola magellanica*	0.420	-	0.420	10	<0.01
NUD	Nudibranchia	0.301	-	0.301	22	<0.01
BAO	*Bathybiaster loripes*	0.287	-	0.287	6	<0.01
ACS	*Acanthoserolis schythei*	0.241	-	0.241	39	<0.01
EUL	*Eurypodius latreillei*	0.201	-	0.201	22	<0.01
PSX	Psolidae sp.	0.137	-	0.137	7	<0.01
HEX	*Henricia* sp.	0.124	-	0.124	10	<0.01
CYX	*Cycethra* sp.	0.122	-	0.122	13	<0.01
ICA	*Icichthys australis*	0.105	-	0.052	6	<0.01
PYR	Pyrosome	0.098	-	0.098	1	<0.01
CAS	*Campylonotus semistriatus*	0.083	-	0.083	6	<0.01
EUO	*Eurypodius longirostris*	0.082	-	0.082	10	<0.01
ISO	Isopoda	0.054	-	0.054	20	<0.01
OPH	Ophiuroidea	0.052	-	0.023	20	<0.01
POL	Polychaeta	0.051	-	0.051	17	<0.01
CHE	*Champsocephalus esox*	0.048	-	0.048	1	<0.01

Species code	Latin name	Total catch (kg)	Total sampled (kg)	Total discarded (kg)	No. Stations	% of catch
COG	*Patagonotothen guntheri*	0.048	0.048	0.048	1	<0.01
THN	*Thysanopsetta naresi*	0.042	0.042	0.042	1	<0.01
LIS	*Lithodes santolla*	0.034	-	0.030	3	<0.01
OCC	Octocorals	0.034	-	0.034	6	<0.01
MUR	Ribbed mussel	0.027	-	0.027	2	<0.01
BEO	*Beroe ovata*	0.024	-	0.022	5	<0.01
LIR	*Limopsis marionensis*	0.024	-	0.024	2	<0.01
MUN	*Munida* spp.	0.024	-	0.024	2	<0.01
NUH	*Nuttallochiton hyadesi*	0.022	-	0.022	3	<0.01
THB	*Thymops birsteini*	0.020	-	0.020	1	<0.01
BUC	*Falsilunatia carcellesi*	0.018	-	0.018	4	<0.01
ASF	*Asternia fimbriata*	0.017	-	0.017	3	<0.01
OPS	*Ophiactis asperula*	0.017	-	0.014	7	<0.01
HCR	Paguroidea	0.014	-	0.014	3	<0.01
TRX	*Trophon* sp.	0.011	-	0.011	2	<0.01
AMP	Amphipod	0.009	-	0.007	4	<0.01
BRP	Brachiopod spp.	0.008	-	0.008	2	<0.01
PLU	Primnoidae sp.1	0.008	-	0.008	1	<0.01
GAY	Gastropoda	0.007	-	0.007	3	<0.01
PRI	Priapulida	0.007	-	0.007	2	<0.01
NED	*Neolithodes diomedeae*	0.006	-	0.006	1	<0.01
PLB	Primnoidae sp.2	0.006	-	0.006	1	<0.01
CRI	Crinoidea	0.002	-	0.002	2	<0.01
MXX	Myctophid spp.	0.002	-	0.002	2	<0.01
BIV	Bivalve	0.001	-	0.001	1	<0.01
CAV	*Campylonotus vagans*	0.001	-	0.001	1	<0.01
DIX	*Diplospinus* sp.	0.001	-	0.001	1	<0.01

3.2 Biological information on finfish species

3.2.1 *Salilota australis* – Red cod

The total catch of *S. australis* was 3,334 kg (Table 2). It was caught at 74 of the 80 stations sampled during this cruise (92.5%) (Fig 3a). Catches ranged from 0.04 to 661.00 kg. Of the 74 stations, 28 yielded > 10kg (37.8%), six > 100 kg (8.1%), and none > 1 t. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 0.17 to 3,119.21 kg/km^2 (Fig 3a), while CPUE ranged from 0.04 to 661.00 kg/hr. Catches of *S. australis* occurred throughout the survey area, but primarily to the west of West Falklands (Fig 3a). The number of *S. australis* sampled for otoliths was 481 (range = 1 to 42 per station) (Fig 3b) and covered the entire length frequency for both females (Fig 4a) and males (Fig 4b). Overall, otoliths were collected from 270 females (T_L = 13 to 76 cm), 210 males (T_L = 14 to 74 cm), and one juvenile (Fig 4). The number of fish sampled for length frequency was 2,548 (1,519 females and 1,029 males). Female T_L ranged from 13 to 76 cm (mean of 34.48 cm) (Fig 5a), whereas males measured between 14 and 79 cm (mean of 30.23 cm) (Fig 5b). The histograms show a series of modes; the first two are fairly obvious (at 16-18 and 23-25 cm for females and 17 and 23-34 cm for males), while the remainder are difficult to distinguish due to overlap between them (Figs 5). Females were observed Stage I (12%), Stage II (61%), Stage III (< 1%), Stage VII (< 1%), and Stage VIII (26%) (Fig 5a). Males were observed Stage I (23%), Stage II (56%), Stage III (9%), Stage IV (< 1%), Stage VII (2%), and Stage VIII (9%) (Fig 5b). Most small individuals, smaller or equal to the median T_L of 34 cm for females (N = 1,405) and 27 cm for males (N = 1,176), were found to the northwest or north of the sampling area (Fig 6a), whereas larger individuals (1,131 females and 825 males) were caught mostly to the southwest of the sampling area in deeper waters (Fig 6b).

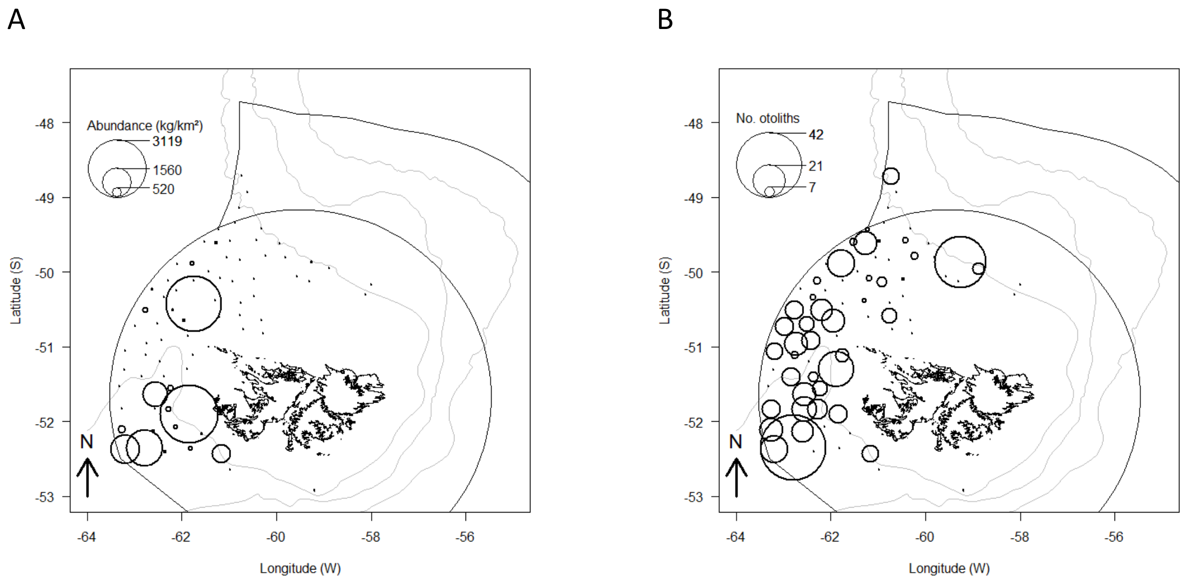


Fig 3. Distribution of (A) densities and (B) otolith samples (N = 481) of *Salilota australis*.

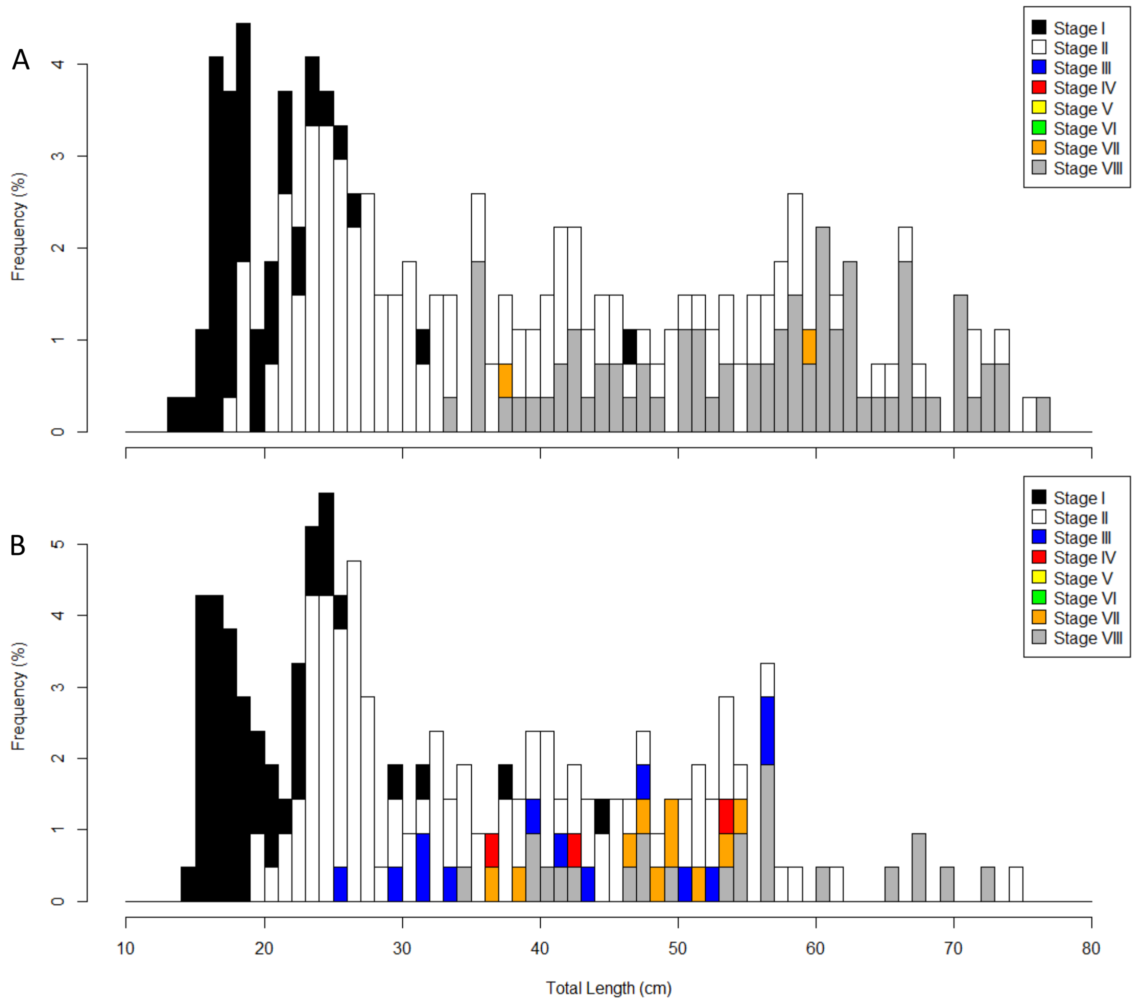


Fig 4. Length frequency (percentage of the total sample collected) of *Salilota australis* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 270) and (B) males (N = 210).

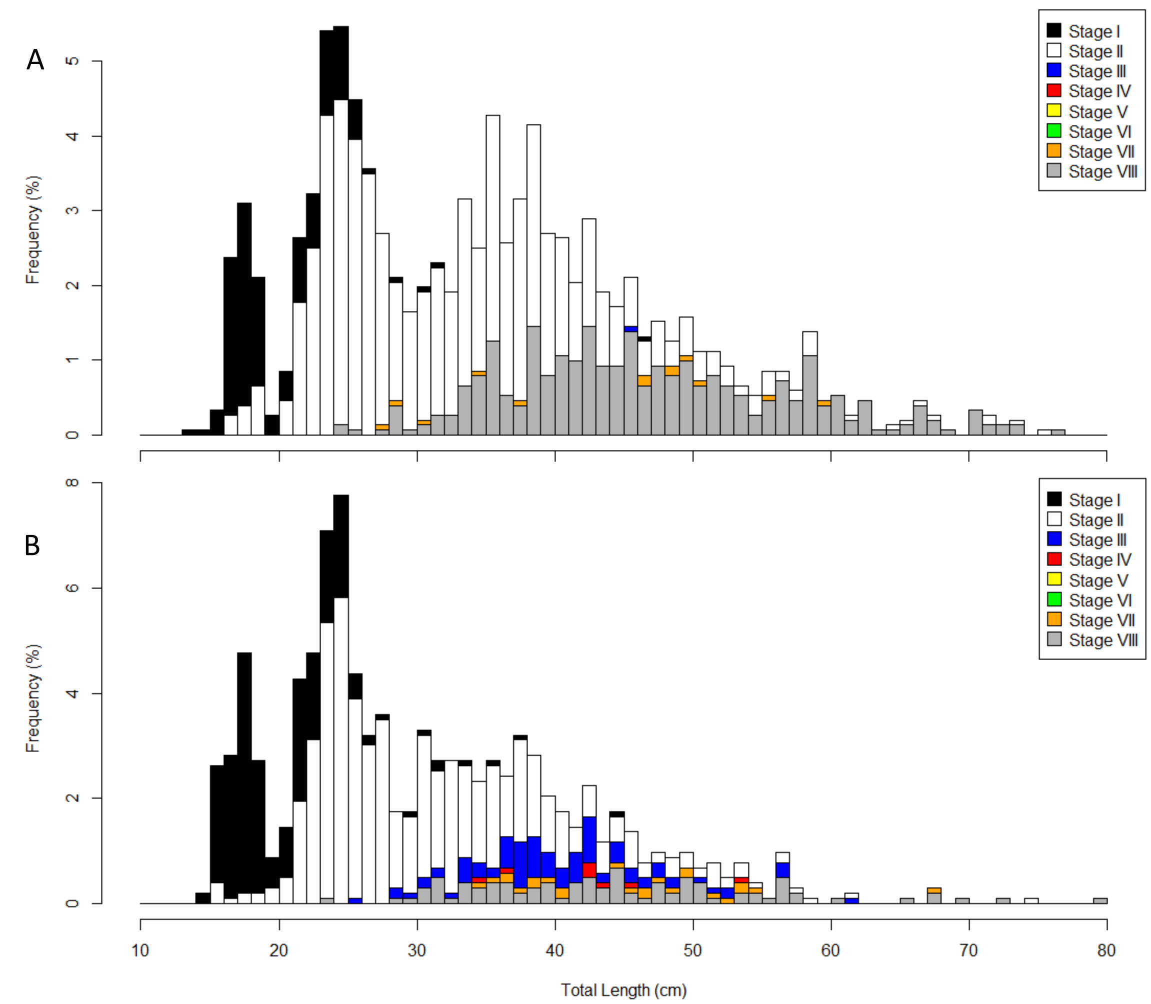


Fig 5. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Salilota australis* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 1,519) and (B) males (N = 1,029).

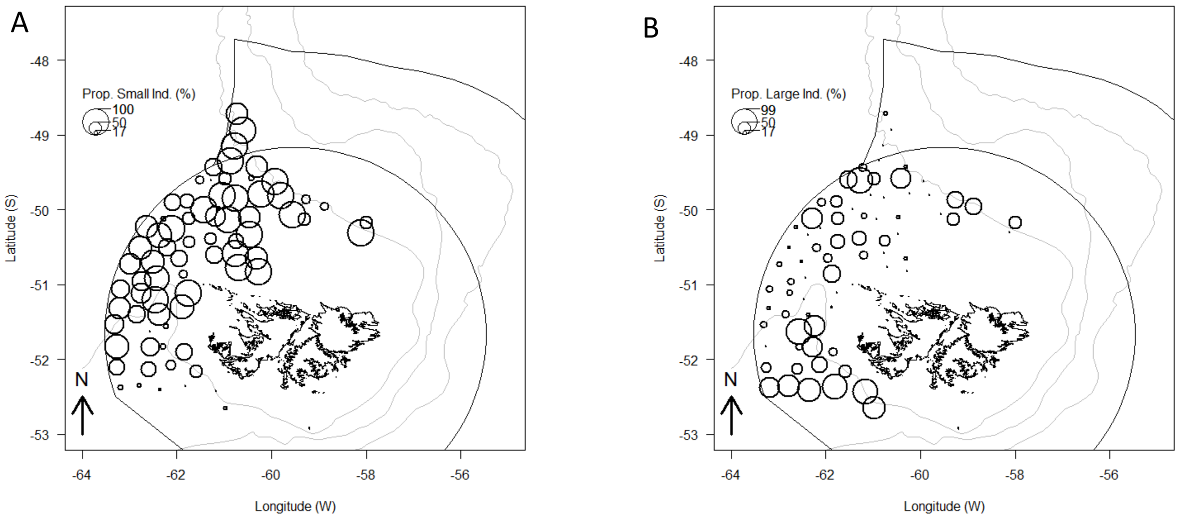


Fig 6. Distribution of the proportion (%) of (A) small (N = 2,581) and (B) large (N = 1,956) *Salilota australis* individuals.

3.2.2 *Micromesistius australis australis* – Southern blue whiting

The total catch of *M. a. australis* was 24 kg (Table 2). It was caught at 17 of the 80 stations sampled during this cruise (21.3%) (Fig 7a). Catches ranged from 0.001 to 21.26 kg. Of the 17 stations two yielded > 1kg (11.8%), one > 10 kg (5.9%), and none > 100 kg. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from < 0.01 to 119.14 kg/km^2 (Fig 7a), while CPUE ranged from < 0.01 to 21.26 kg/hr. Catches of *M. a. australis* occurred throughout the survey area, but primarily to the southwest of West Falklands (Fig 7a). The number of *M. a. australis* sampled for otoliths was 12 (range = 1 to 6 per station) (Fig 7b) and did not cover the entire length frequency for both sexes. Overall, otoliths were collected from five females (T_L = 20 to 53 cm) and seven males (T_L = 21 to 24 cm). The number of fish sampled for length frequency was 56 (20 females and 36 males). Female T_L ranged from 20 to 59 cm (mean of 38.05 cm) (Fig 8a), whereas males measured between 21 and 59 cm (mean of 37.92 cm) (Fig 8b). From the histograms, due to the low number of fish sampled, it was not possible to distinguish between different cohorts (Figs 8). Females were observed Stage I (20%), Stage II (40%), and Stage VIII (40%) (Fig 8a). Males were observed Stage I (33%), Stage II (28%), Stage VII (3%), and Stage VIII (36%) (Fig 8b).

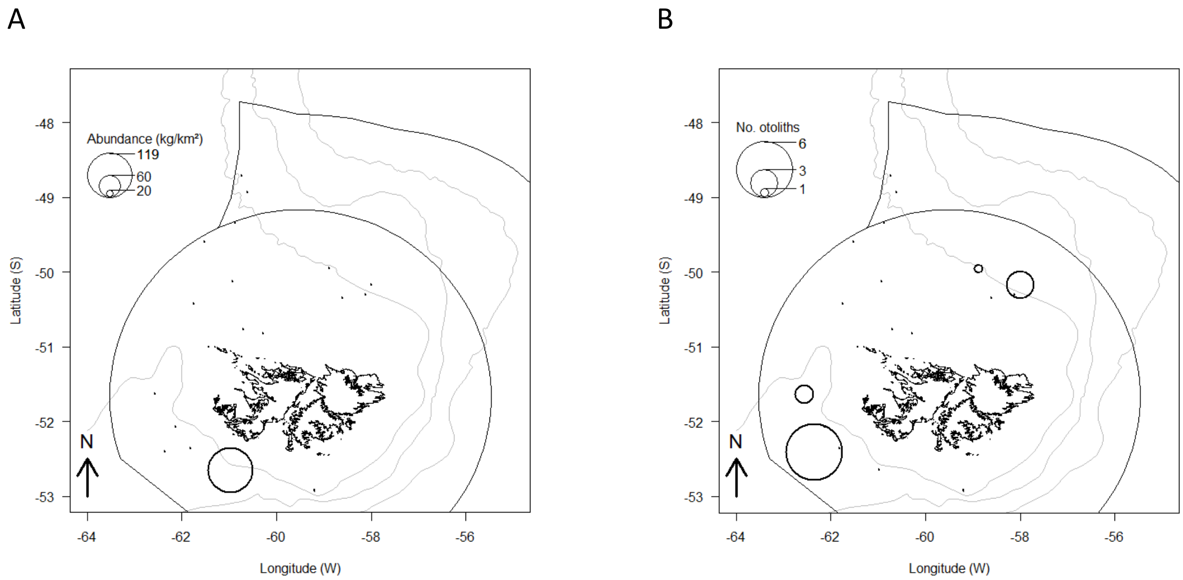


Fig 7. Distribution of (A) densities and (B) otolith samples of *Micromesistius australis australis*.

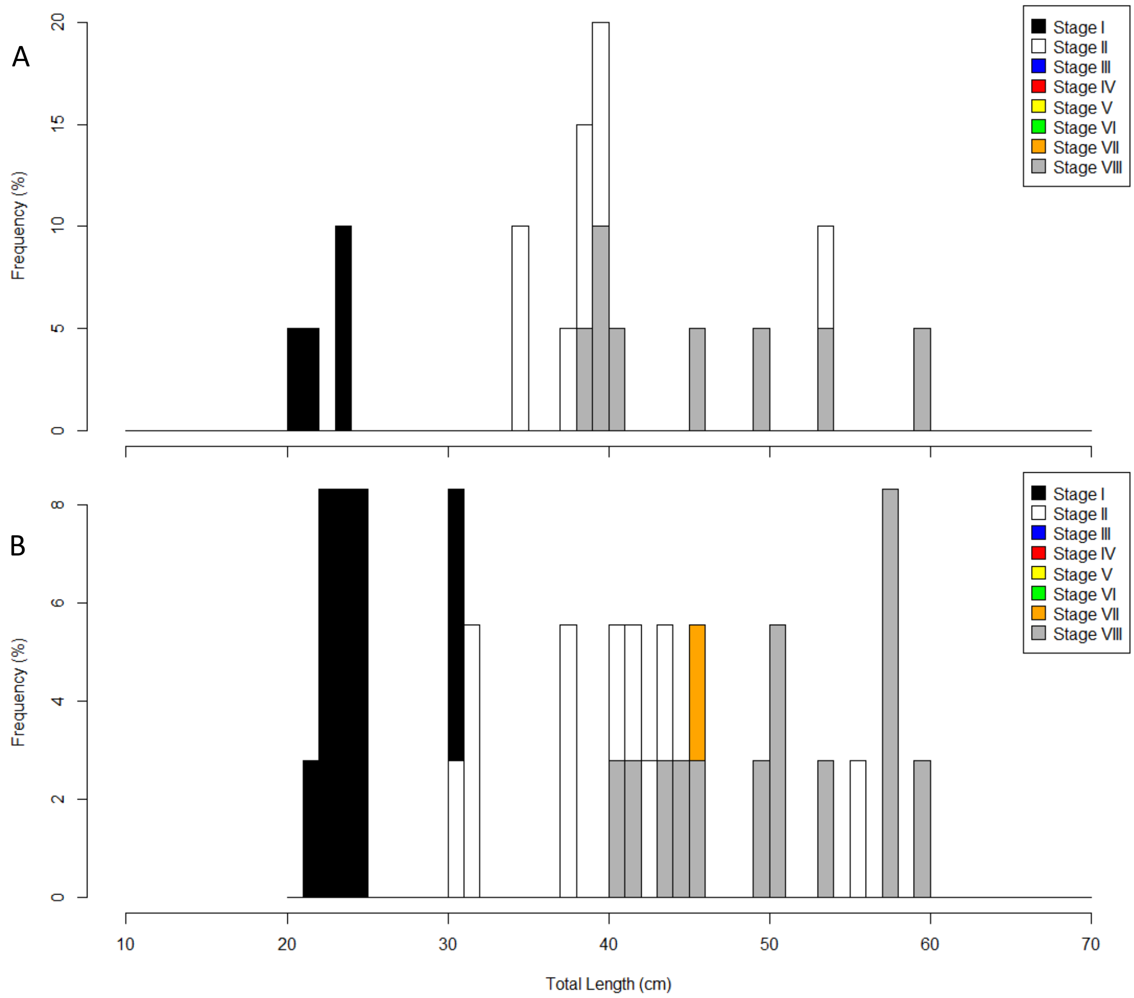


Fig 8. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Micromesistius australis australis* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 20) and (B) males (N = 36).

3.2.3 *Merluccius hubbsi* – Common hake

The total catch of *M. hubbsi* was 714 kg (Table 2). It was caught at 51 of the 80 stations sampled during this cruise (63.8%) (Fig 9a). Catches ranged from 0.46 to 44.88 kg. Of the 51 stations 28 yielded > 10kg (54.9%), eight > 25 kg (15.7%), and none > 100 kg. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 2.14 to 205.73 kg/km^2 (Fig 9a) whereas CPUE ranged from 0.46 to 44.88 kg/hr. Catches of *M. hubbsi* occurred throughout the northwest of the survey area, but primarily in the area known as the “Hake Box” (area delimited north of 51°S and west of 60°W (Fig 9a). The number of *M. hubbsi* sampled for otoliths was 320 (range = 1 to 19 per station) (Fig 9b) and covered the entire length frequency for both males and females. Overall, otoliths were collected from 253 females (T_L = 31 to 77 cm) and 67 males (T_L = 30 to 49 cm) (Fig 10). The number of fish sampled for length frequency was 1,299 (1,106 females and 193 males). Female T_L ranged from 31 to 77 cm (mean of 43.12 cm) (Fig 11a), whereas males measured between 30 and 60 cm (mean of 39.11 cm) (Fig 11b). The histograms show a single mode at 42 cm for females and 39 cm for males (Figs 11). Females were observed Stage II (8%), Stage III (< 1%), Stage VII (1%), and Stage VIII (91%) (Fig 11a). Males were observed Stage II (2%), Stage III (< 1%), Stage IV (< 1%), Stage V (2%), Stage VII (92%), and Stage VIII (4%) (Fig 11b). Most small individuals, smaller or equal to the median T_L of 42 cm for females (N = 636) and 39 cm for males (N = 115), were found in shallower waters of the sampling area (Fig 12a), whereas larger individuals (470 females and 78 males) were caught mostly in deeper waters of the sampling area (Fig 12b).

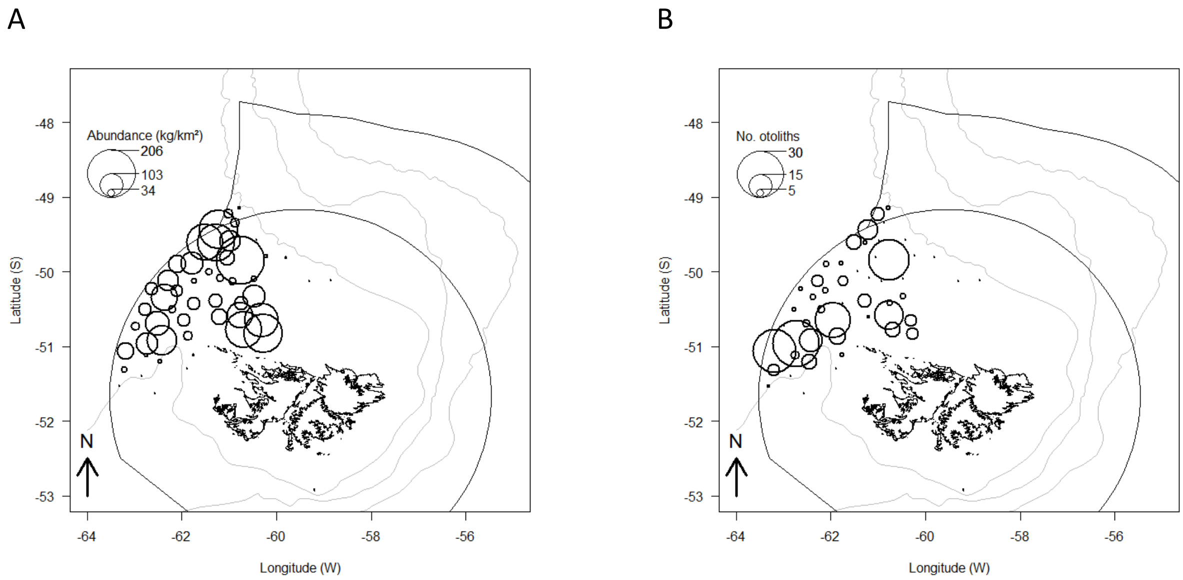


Fig 9. Distribution of (A) densities and (B) otolith samples (N = 320) of *Merluccius hubbsi*.

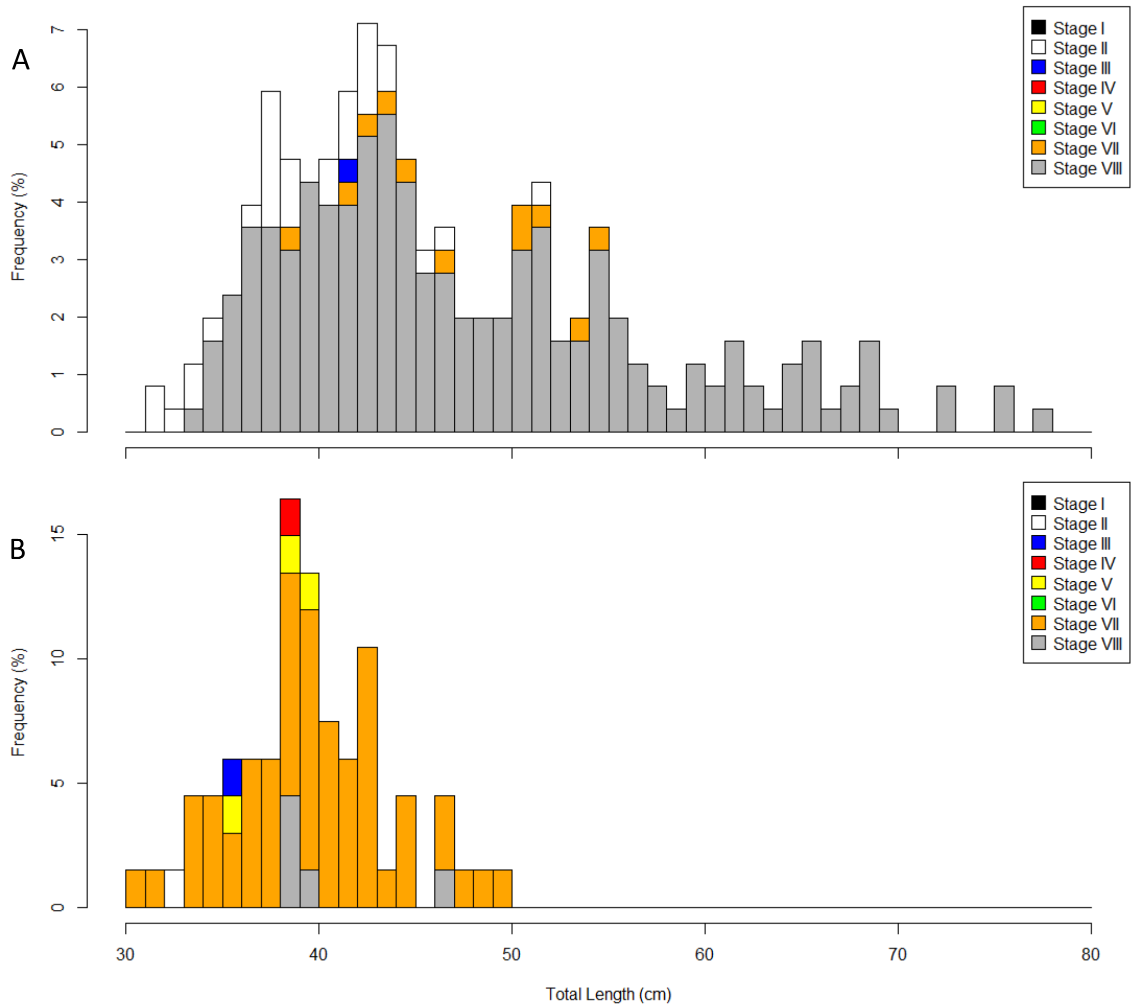


Fig 10. Length frequency (percentage of the total sample collected) of *Merluccius hubbsi* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 253) and (B) males (N = 67).

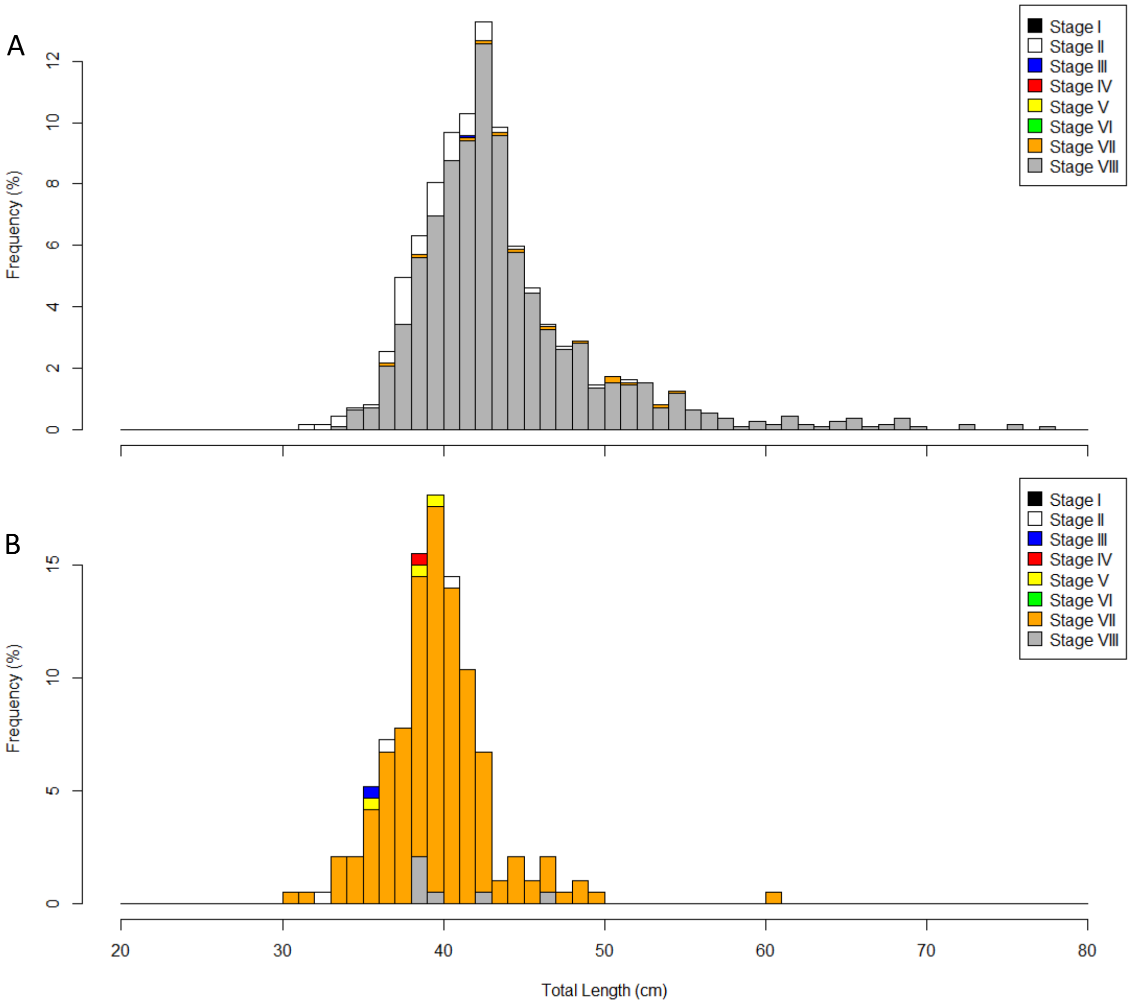


Fig 11. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Merluccius hubbsi* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 1,106) and (B) males (N = 193).

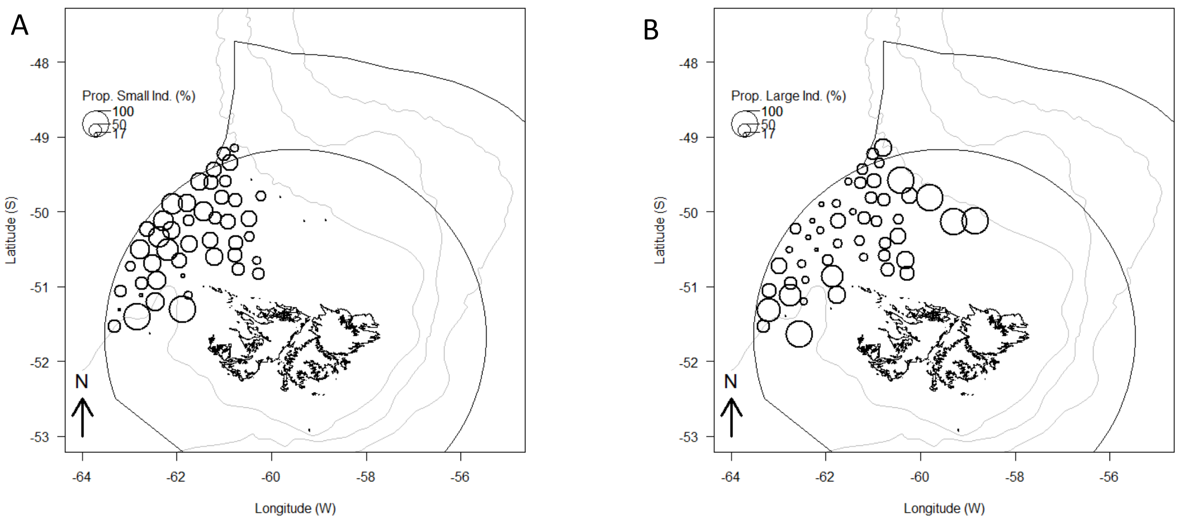


Fig 12. Distribution of the proportion (%) of (A) small (N = 751) and (B) large (N = 548) *Merluccius hubbsi* individuals.

3.2.4 *Genypterus blacodes* – Kingclip

The total catch of *G. blacodes* was 3,398 kg (Table 2). It was caught at 75 of the 80 stations sampled during this cruise (93.8%) (Fig 13a). Catches ranged from 0.52 to 755.86 kg. Of the 75 stations 54 yielded > 10kg (72.0%), seven > 100 kg (9.3%), and none > 1 t. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 2.47 to 3,636.89 kg/km^2 (Fig 13a) whereas CPUE ranged from 0.52 to 755.86 kg/hr. Catches of *G. blacodes* occurred throughout the survey area, but primarily in the southwest (Fig 13a). The number of *G. blacodes* sampled for otoliths was 681 (range = 1 to 42 per station) (Fig 13b) and covered the entire length frequency for both males and females. Overall, otoliths were collected from 397 females (T_L = 36 to 126 cm), 283 males (T_L = 37 to 122 cm), and one unsexed individual of 126 cm T_L (Fig 14). The number of fish sampled for length frequency was 2,392 (1,320 females and 1,072 males). Female T_L ranged from 36 to 126 cm (mean of 62.66 cm) (Fig 15a), whereas males measured between 37 and 122 cm (mean of 57.24 cm) (Fig 15b). The histograms show a single obvious cohort at 53 cm for females and 51 cm for males with additional cohorts likely to be present, but are difficult to distinguish due to overlap between them (Figs 15). Females were observed Stage I (2%), Stage II (95%), Stage III (< 1%), Stage IV (< 1%), Stage VII (< 1%), and Stage VIII (2%) (Fig 15a). Males were observed Stage I (4%), Stage II (88%), Stage III (4%), Stage IV (< 1%), Stage VII (< 1%), and Stage VIII (3%) (Fig 15b). Most small individuals, smaller or equal to the median T_L of 59 cm for females (N = 680) and 55 cm for males (N = 573), were found in the northwest and north of the sampling area (Fig 16a), whereas larger individuals (640 females and 499 males) were caught mostly in deeper waters in the southwest of the sampling area (Fig 16b).

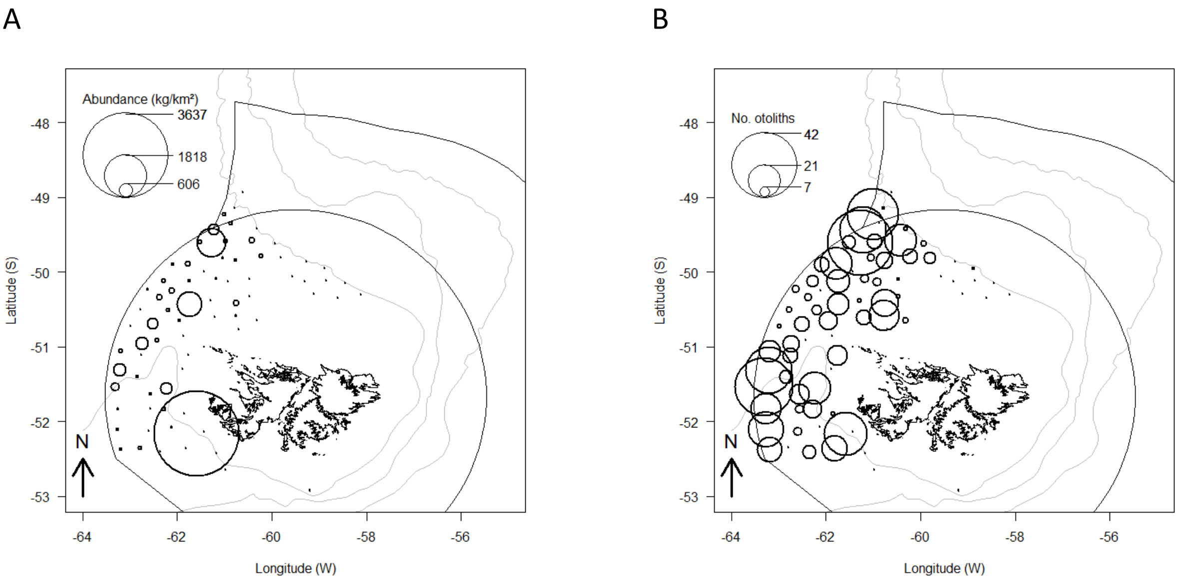


Fig 13. Distribution of (A) densities and (B) otolith samples (N = 681) of *Genypterus blacodes*.

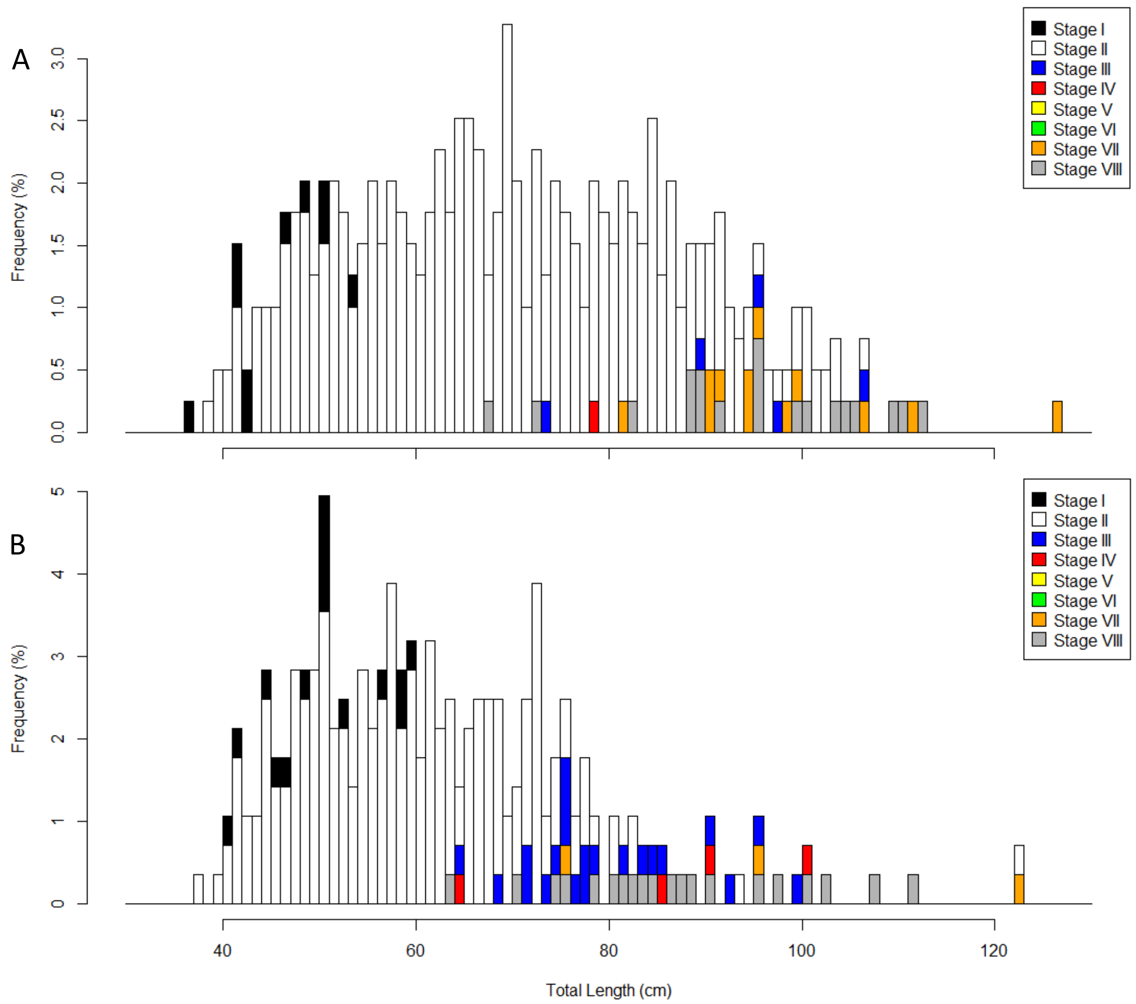


Fig 14. Length frequency (percentage of the total sample collected) of *Genypterus blacodes* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 397) and (B) males (N = 283).

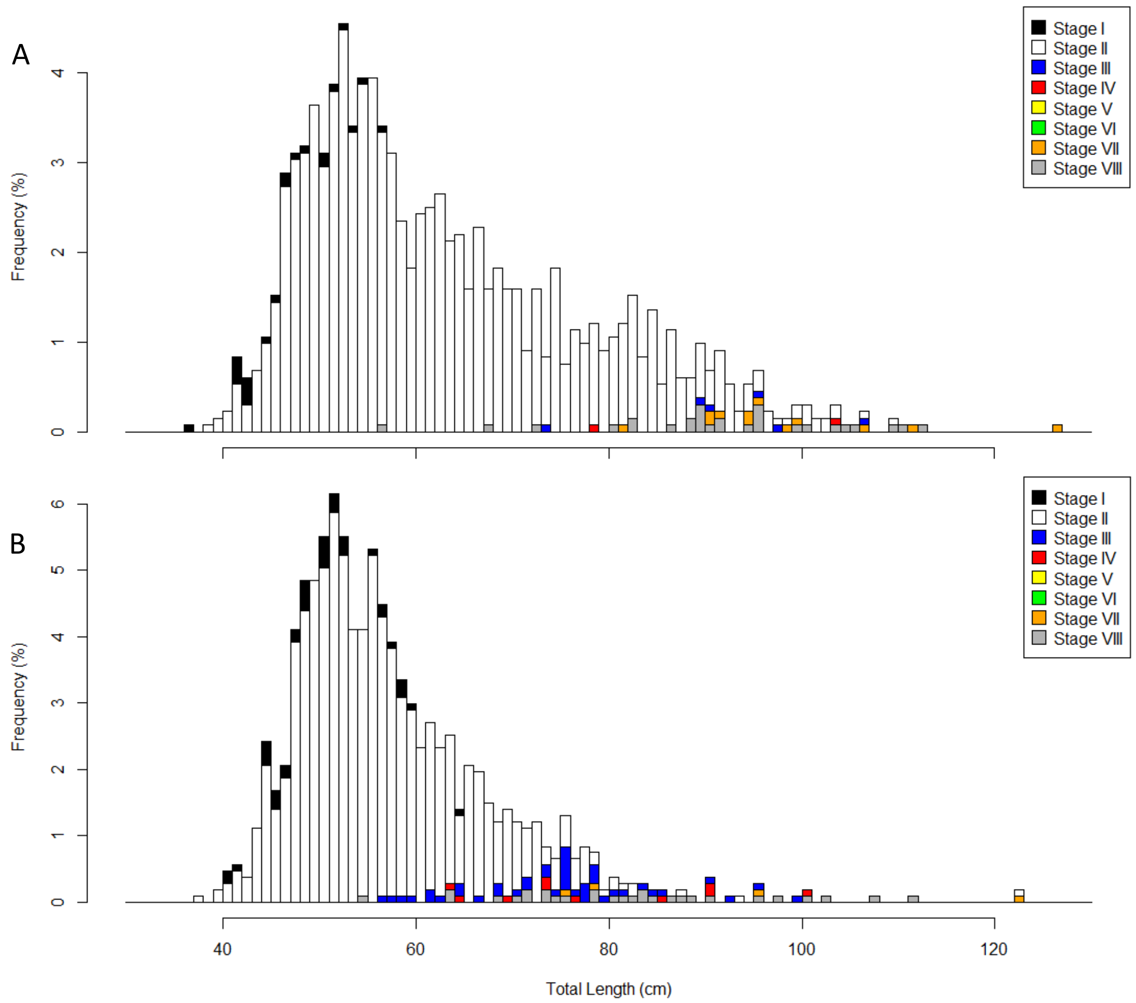


Fig 15. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Genypterus blacodes* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 1,320) and (B) males (N = 1,072).

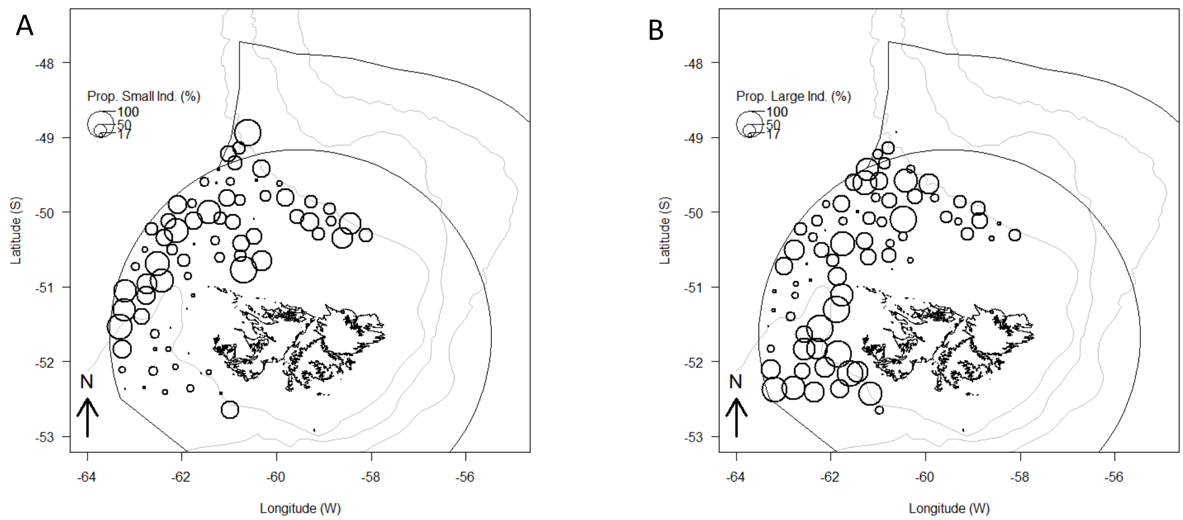


Fig 16. Distribution of the proportion (%) of (A) small (N = 1,253) and (B) large (N = 1,139) *Genypterus blacodes* individuals.

3.2.5 *Patagonotothen ramsayi* – Common rock cod

The total catch of *P. ramsayi* was 1,774 kg (Table 2). It was caught at all 80 stations sampled during this cruise; the only species caught at all stations (Fig 17a). Catches ranged from 0.23 to 369.60 kg. Of the 80 stations 25 yielded > 10kg (31.3%), four > 100 kg (5.0%), and none > 1 t. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 0.96 to 2,071.18 kg/km^2 (Fig 17a) whereas CPUE ranged from 0.23 to 369.60 kg/hr. Catches of *P. ramsayi* occurred throughout the survey area, but primarily in the southwest (Fig 17a). In fact, few stations outside of this area allowed us to process a full sample of 100 *P. ramsayi.* The number of *P. ramsayi* sampled for otoliths was 539 (range = 1 to 53 per station) (Fig 17b) and covered the entire length frequency for both males and females. Overall, including the non-random samples, otoliths were collected from 271 females (T_L = 11 to 41 cm), 250 males (T_L = 11 to 37 cm), and 18 juvenile individuals (T_L = 4.5 to 6.0 cm) (Fig 18). The number of fish sampled for length frequency (as subsample of the random sample) was 5,401 (2,638 females, 2,736 males, ten juveniles, and 17 unsexed individuals). Female T_L ranged from 11 to 37 cm (mean of 19.07 cm) (Fig 19a), whereas males measured between 11 and 36 cm (mean of 18.83 cm) (Fig 19b). Otoliths were collected from five non-random female *P. ramsayi* (T_L = 34 to 41 cm) and four non-random males *P. ramsayi* (T_L = 32 to 37 cm) which were not included in the length frequency histograms. The histograms show a single obvious cohort at 15 cm for females and 15 cm for males with additional cohorts likely to be present, but are difficult to distinguish due to overlap between them (Figs 19). Females were observed Stage I (14%), Stage II (80%), Stage III (2%), Stage IV (< 1%), Stage V (< 1%), Stage VII (< 1%), and Stage VIII (3%) (19a). Males were observed Stage I (21%), Stage II (75%), Stage III (3%), and Stage VIII (< 1%) (Fig 19b). Most small individuals, smaller or equal to the median T_L of 17 cm for females (N = 1,331) and 17 cm for males (N = 1,471), were found in the west, northwest, and north of the sampling area (Fig 20a), whereas larger individuals (1,307 females and 1,265 males) were caught primarily in deeper waters in the southwest of the sampling area (Fig 20b).

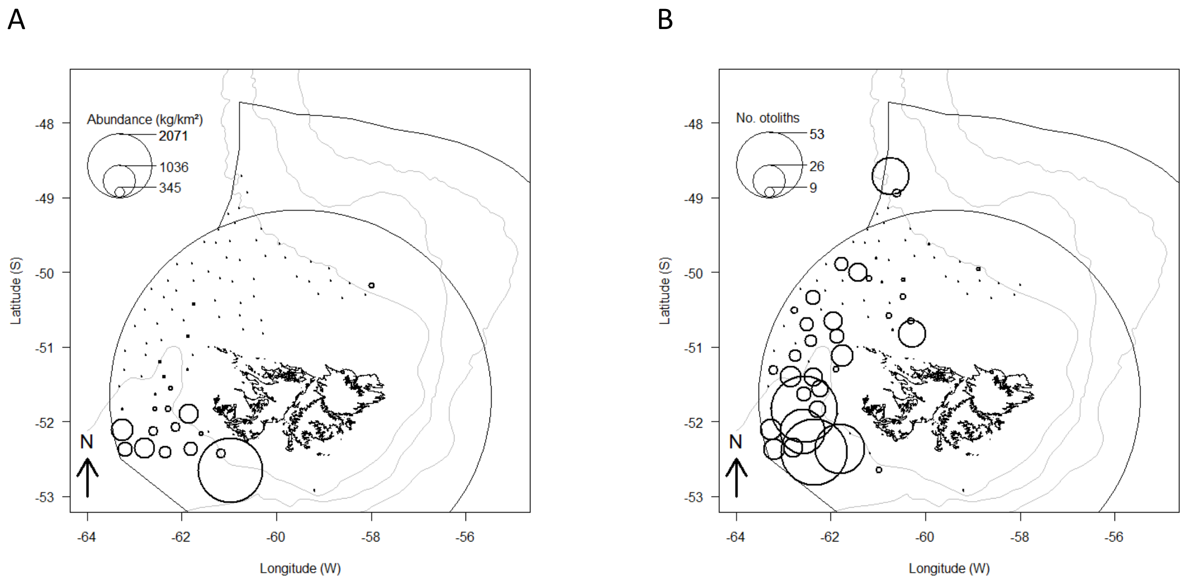


Fig 17. Distribution of (A) densities and (B) otolith samples (N = 539) of *Patagonotothen ramsayi*.

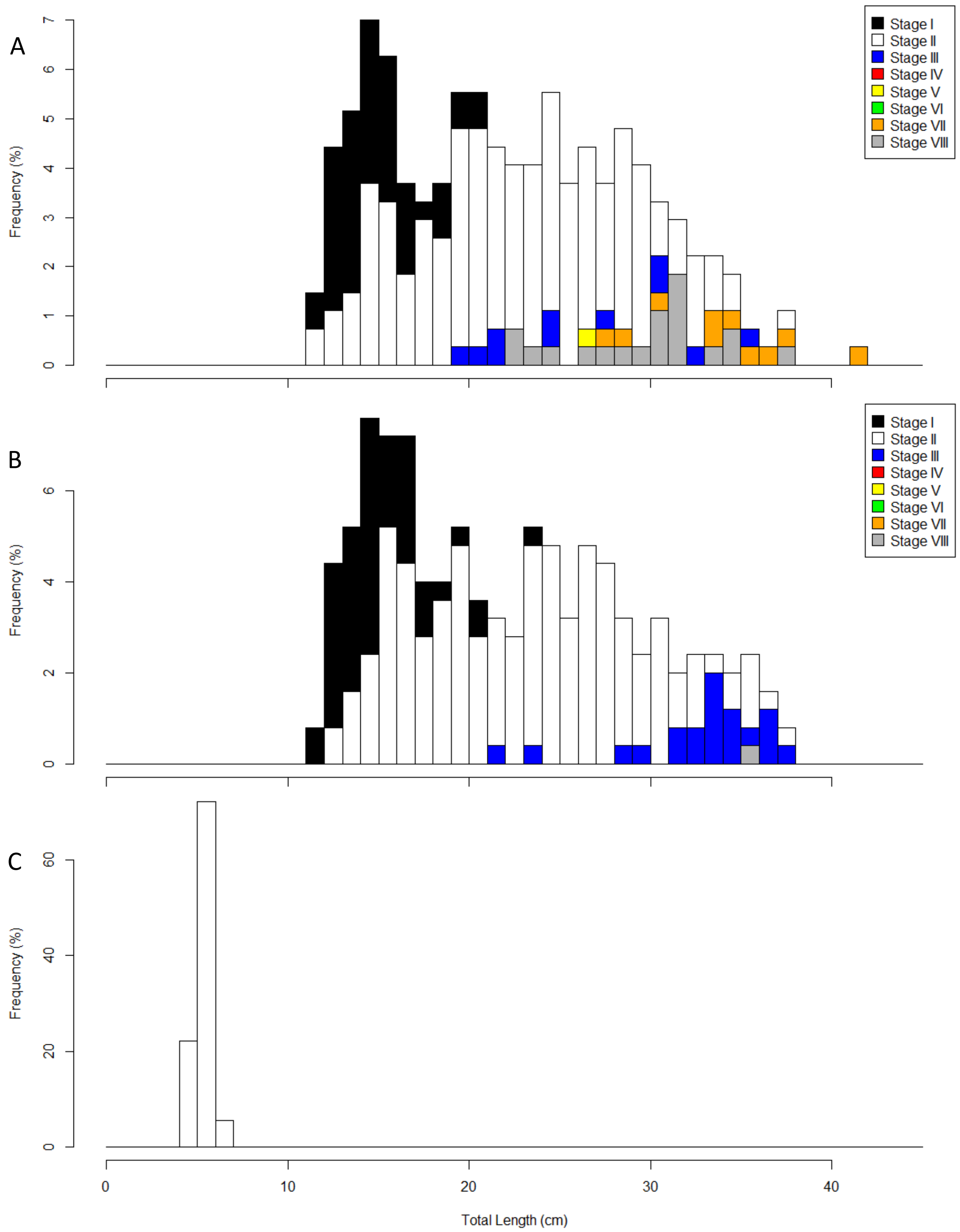


Fig 18. Length frequency (percentage of the total sample collected) of *Patagonotothen ramsayi* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 271), (B) males (N = 250), and (C) juveniles (N = 18).

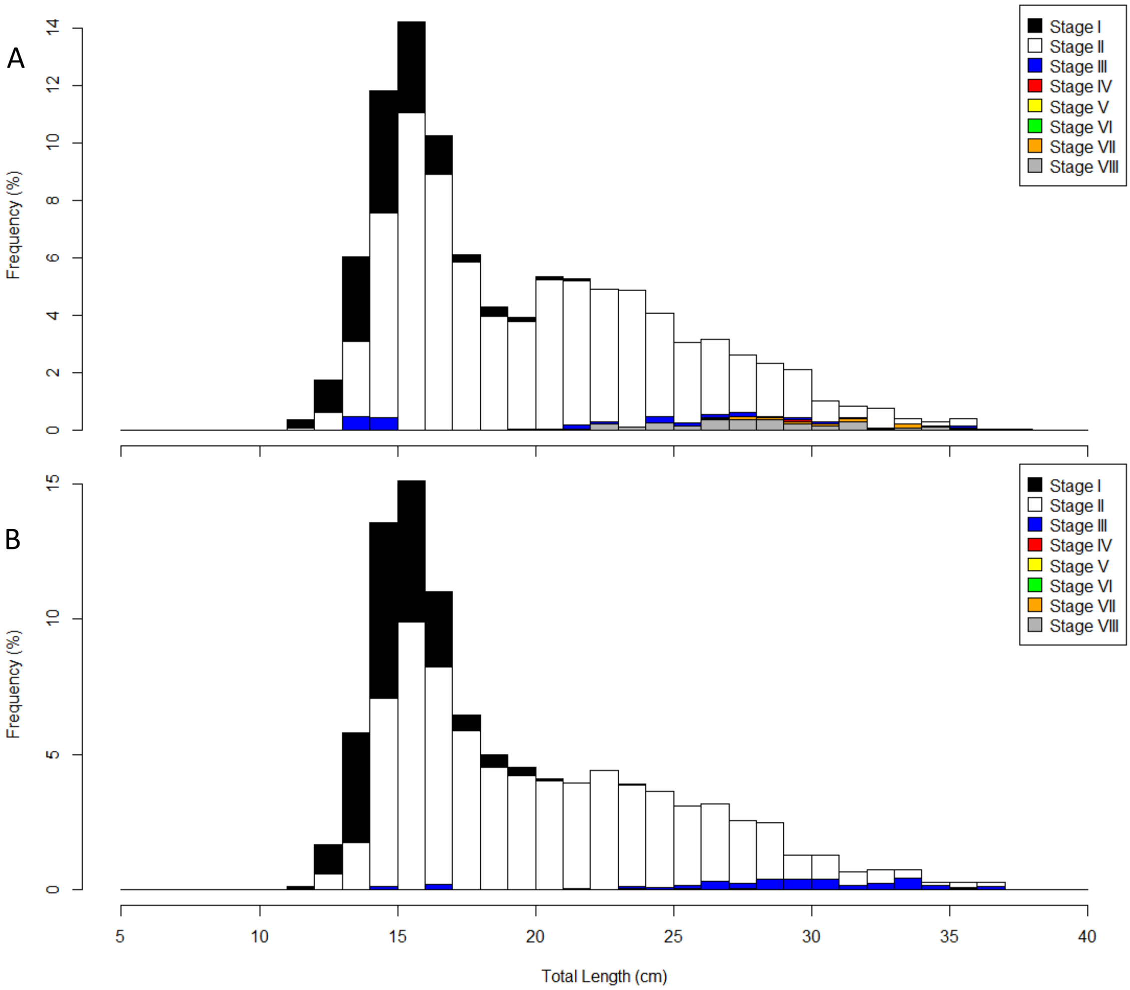


Fig 19. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Patagonotothen ramsayi* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 2,638) and (B) males (N = 2,736).

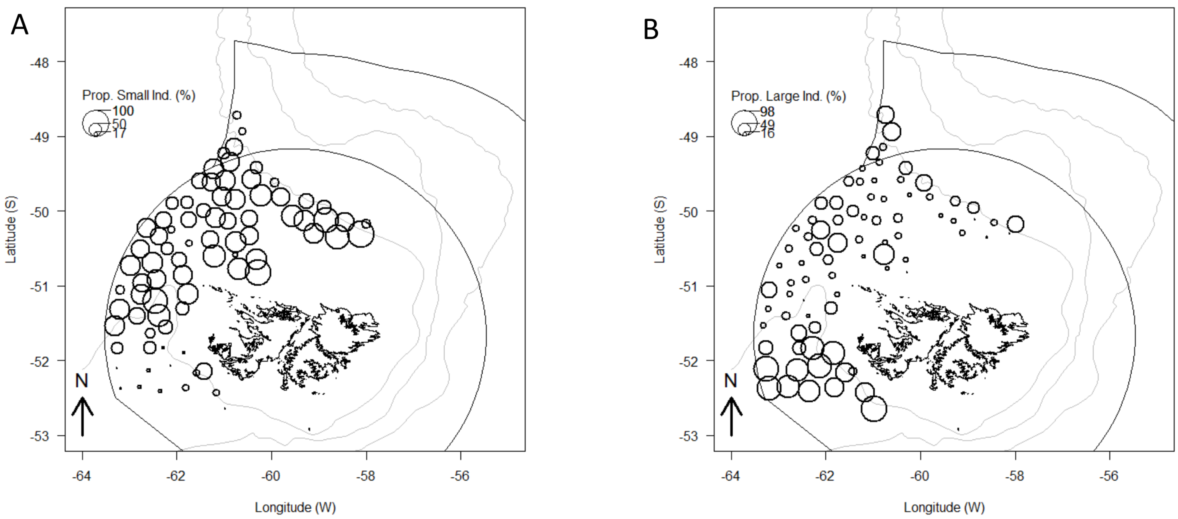


Fig 20. Distribution of the proportion (%) of (A) small (N = 2,802) and (B) large (N = 2,572) *Patagonotothen ramsayi* individuals.

3.2.6 *Merluccius australis* – Patagonian hake

The total catch of *Merluccius australis* was 89 kg (Table 2). It was caught at ten of the 80 stations sampled during this cruise (12.5%) (Fig 21a). Catches ranged from 1.24 to 32.07 kg. Of the ten stations three yielded > 10kg (30.0%), one > 25 kg (10.0%), and none > 100 kg. Densities ranged from 5.86 to 164.56 kg/km^2 (Fig 21a) whereas CPUE ranged from 1.24 to 32.07 kg/hr. Catches of *Merluccius australis* occurred primarily in the southwest (Fig 21a). All 30 *Merluccius australis* individuals caught were sampled for otoliths (range = 1 to 11 per station) (Fig 21b). Overall, otoliths were collected from 23 females (T_L = 45 to 86 cm) and seven males (T_L = 54 to 76 cm). The number of fish sampled for length frequency was 30 (23 females and seven males). Female T_L ranged from 45 to 86 cm (mean of 65.22 cm) (Fig 22a), whereas males measured between 54 and 76 cm (mean of 63.29 cm) (Fig 22b). Females were observed Stage II (65%), Stage III (22%), and Stage VIII (13%) (Fig 22a). Males were observed Stage II (29%), Stage III (43%), Stage VII (14%), and Stage VIII (14%) (Fig 22b).

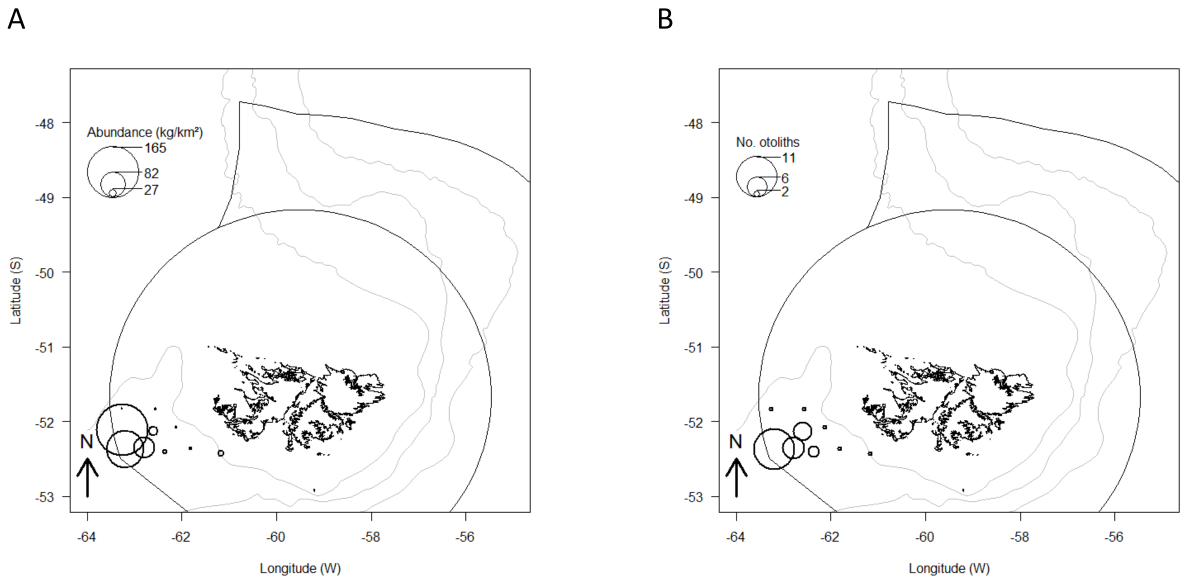


Fig 21. Distribution of (A) densities and (B) otolith samples (N = 30) from *Merluccius australis*.

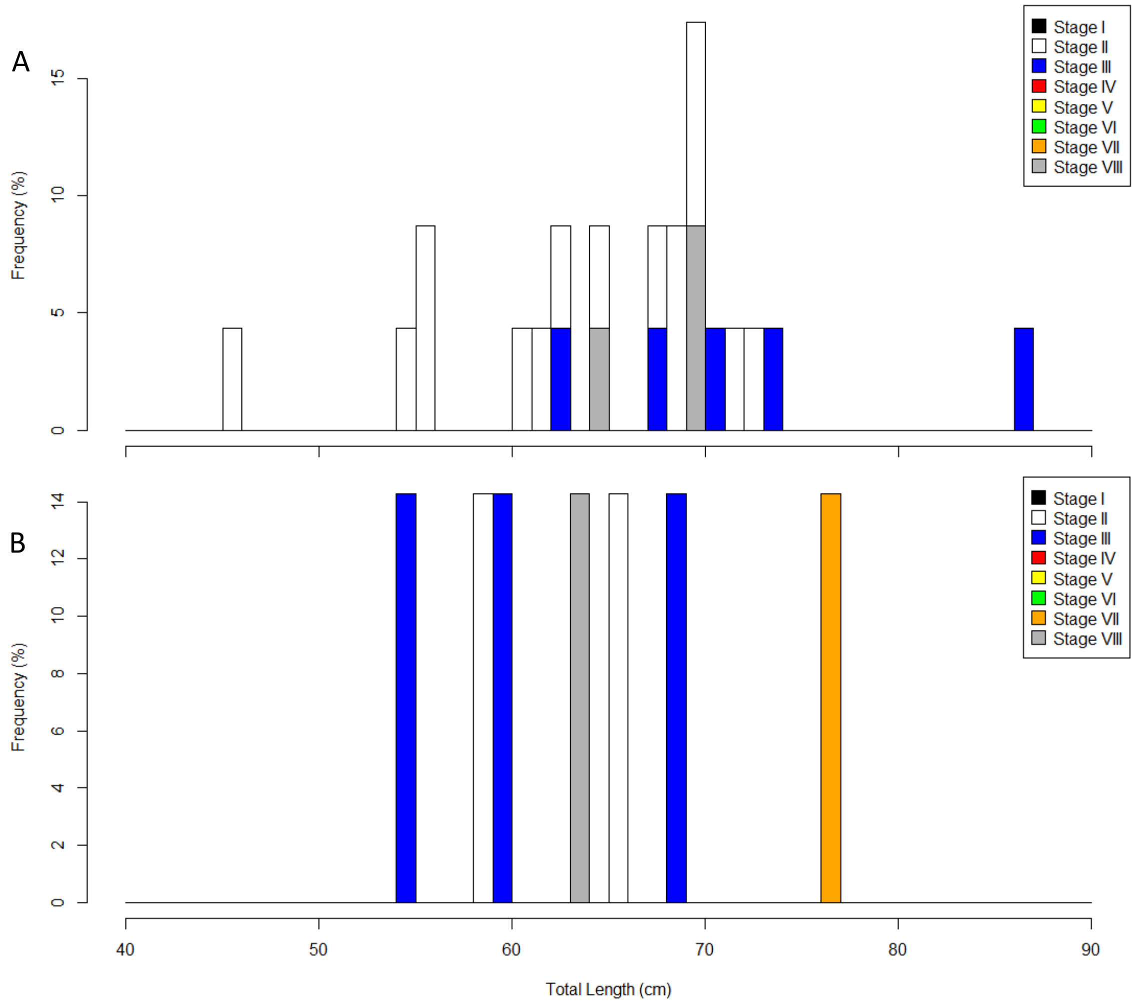


Fig 22. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Merluccius australis* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 23) and (B) males (N = 7).

3.2.7 *Dissostichus eleginoides* – Patagonian toothfish

The total catch of *D. eleginoides* was 263 kg (Table 2). It was caught at 27 of the 80 stations sampled during this cruise (33.8%) (Fig 23a). Catches ranged from < 0.01 to 33.68 kg. Of the 27 stations eight yielded > 10kg (29.6%), four > 25 kg (14.8%), and none > 100 kg. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from < 0.01 to 173.54 kg/km^2 (Fig 23a) whereas CPUE ranged from < 0.01 to 33.68 kg/hr. Catches of *D. eleginoides* occurred primarily in the southwest of the survey area (Fig 23a). The number of *D. eleginoides* sampled for otoliths was 166 (range = 1 to 22 per station) (Fig 23b) and covered the entire length frequency for trawl caught males and females. Overall, otoliths were collected from 109 females (T_L = 29 to 83 cm), 56 males (T_L = 32 to 83 cm), and one juvenile individual of 5 cm T_L (Fig 24). The number of fish sampled for length frequency was 190 (119 females and 71 males). Female T_L ranged from 29 to 83 cm (mean of 51.81 cm) (Fig 25a), whereas males measured between 32 and 83 cm (mean of 47.99 cm) (Fig 25b). The histograms do not show obvious cohorts due to overlap between them, but there seem to be two potential cohorts for females at 45 and 56-61 cm and for males at 42-44 and 57 cm (Figs 25). Females were observed Stage I (31%) and Stage II (69%) (Fig 25a). Males were observed Stage I (37%) and Stage II (63%) (Fig 25b).

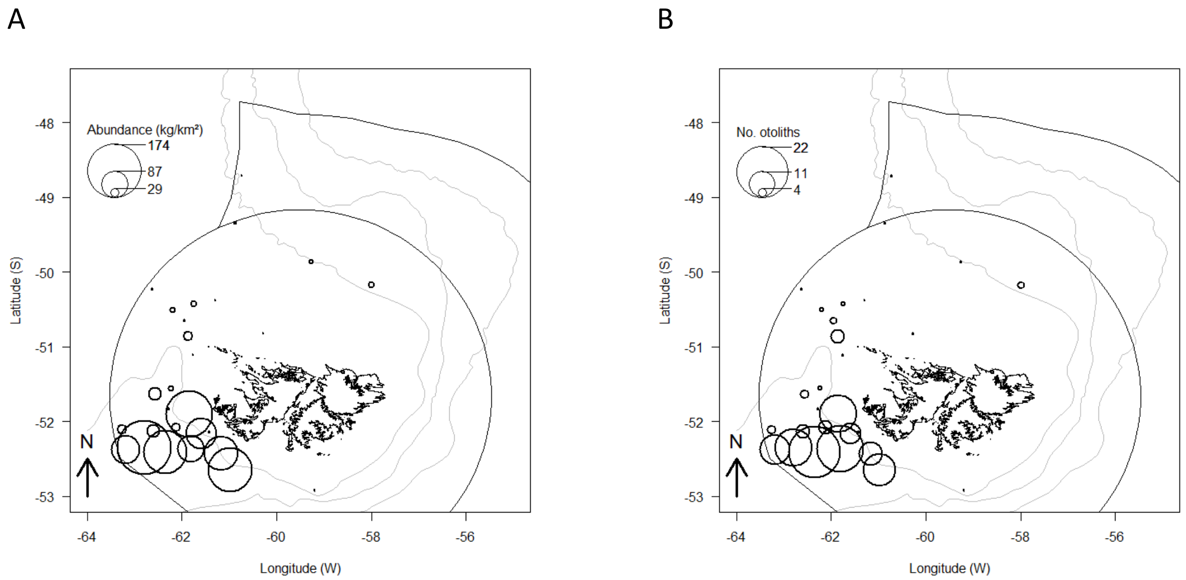


Fig 23. Distribution of (A) densities and (B) otolith samples (N = 166) of *Dissostichus eleginoides*.

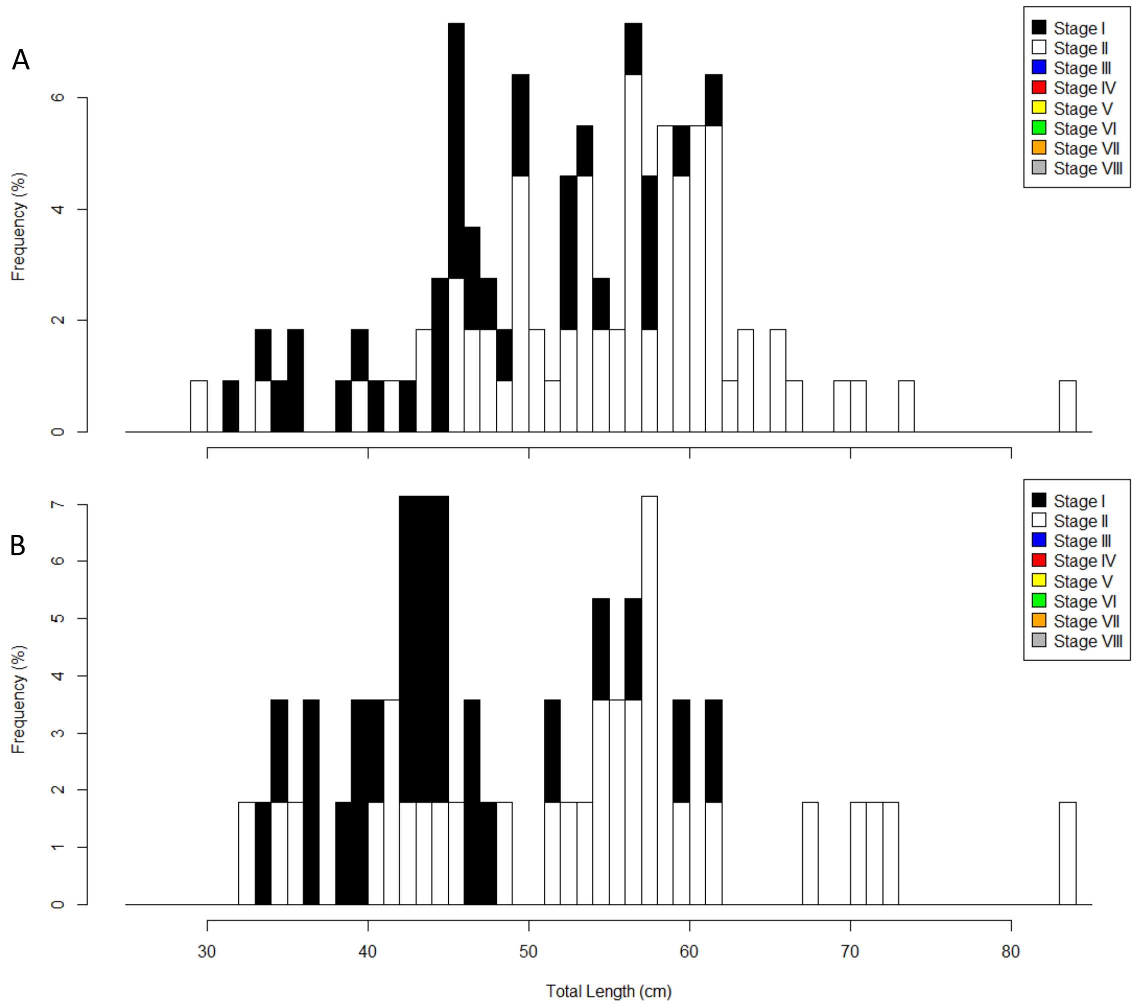


Fig 24. Length frequency (percentage of the total sample collected) of *Dissostichus eleginoides* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 109), (B) and males (N = 56).

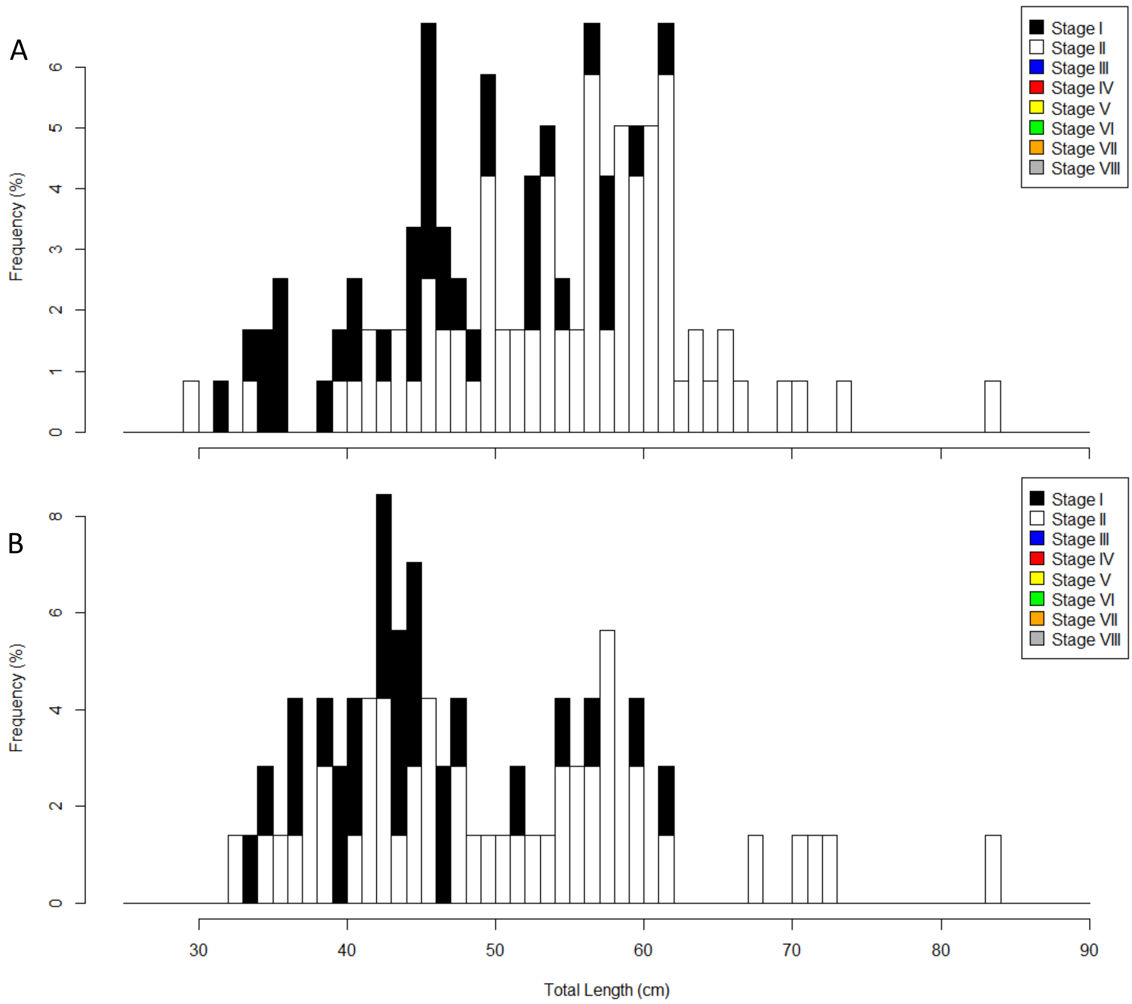


Fig 25. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Dissostichus eleginoides* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 119) and (B) males (N = 71).

3.2.8 *Macruronus magellanicus* – Hoki

The total catch of *M. magellanicus* was 14,323 kg (Table 2). It was caught at 28 of the 80 stations sampled during this cruise (35.0%) (Fig 26a). Catches ranged from 0.14 to 4,585.28 kg. Of the 28 stations 13 yielded > 10kg (46.4%), seven > 100 kg (25.0%), and four > 1 t (14.3%). Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 0.69 to 22,975.21 kg/km^2 (Fig 26a), whereas CPUE ranged from 0.14 to 4,585.28 kg/hr. Catches of *M. magellanicus* occurred primarily in the southwest of the area sampled (Fig 26a). Including non-random samples, the number of *M. magellanicus* sampled for otoliths was 123 (range = 1 to 43 per station) (Fig 26b) and covered the entire length frequency for both males and females. Overall, otoliths were collected from 64 females (pre-anal length = 12 to 41 cm) and 59 males (pre-anal length = 13 to 35 cm) (Fig 27). The number of fish sampled for length frequency (as subsample of the random sample) was 1,157 (687 females and 470 males). Female pre-anal length ranged from 12 to 41 cm (mean of 21.12 cm) (Fig 28a), whereas males measured between 14 and 33 cm (mean of 20.85 cm) (Fig 28b). Otoliths were collected from 21 non-random female *M. magellanicus* (pre-anal length = 14 to 38 cm) and 16 non-random males *M. magellanicus* (pre-anal length = 13 to 35 cm) which were not included in the length frequency histograms. The histograms show two obvious cohorts at 17-18 and 23 cm for females and 17-18 and 22-23 cm for males (Figs 28). Females were observed Stage I (3%), Stage II (92%), Stage III (< 1%), Stage V (< 1%), Stage VII (< 1%), and Stage VIII (4%) (Fig 28a). Males were observed Stage I (8%), Stage II (74%), Stage III (12%), Stage IV (< 1%), Stage VII (1%), and Stage VIII (4%) (Fig 28b). Most small individuals, smaller or equal to the median pre-anal length of 22 cm for females (N = 427) and 21 cm for males (N = 240), were found in shallower waters of the southwest of the sampling area (Fig 29a), whereas larger individuals (260 females and 230 males) were caught mostly in deeper waters in the southwest and in the north of the sampling area (Fig 29b).

A B

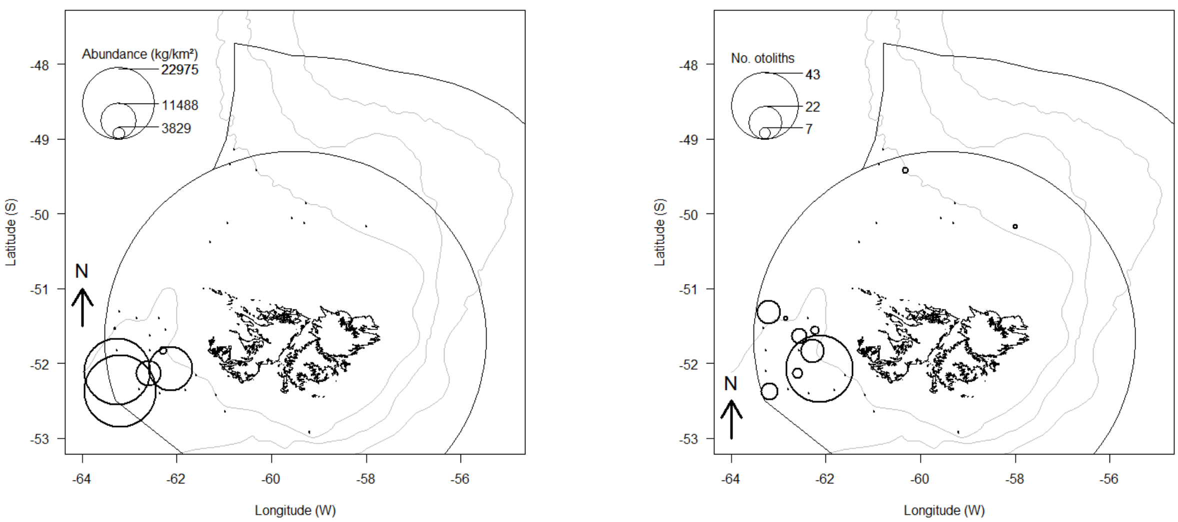


Fig 26. Distribution of (A) densities and (B) otolith samples (N = 123) of *Macruronus magellanicus*.

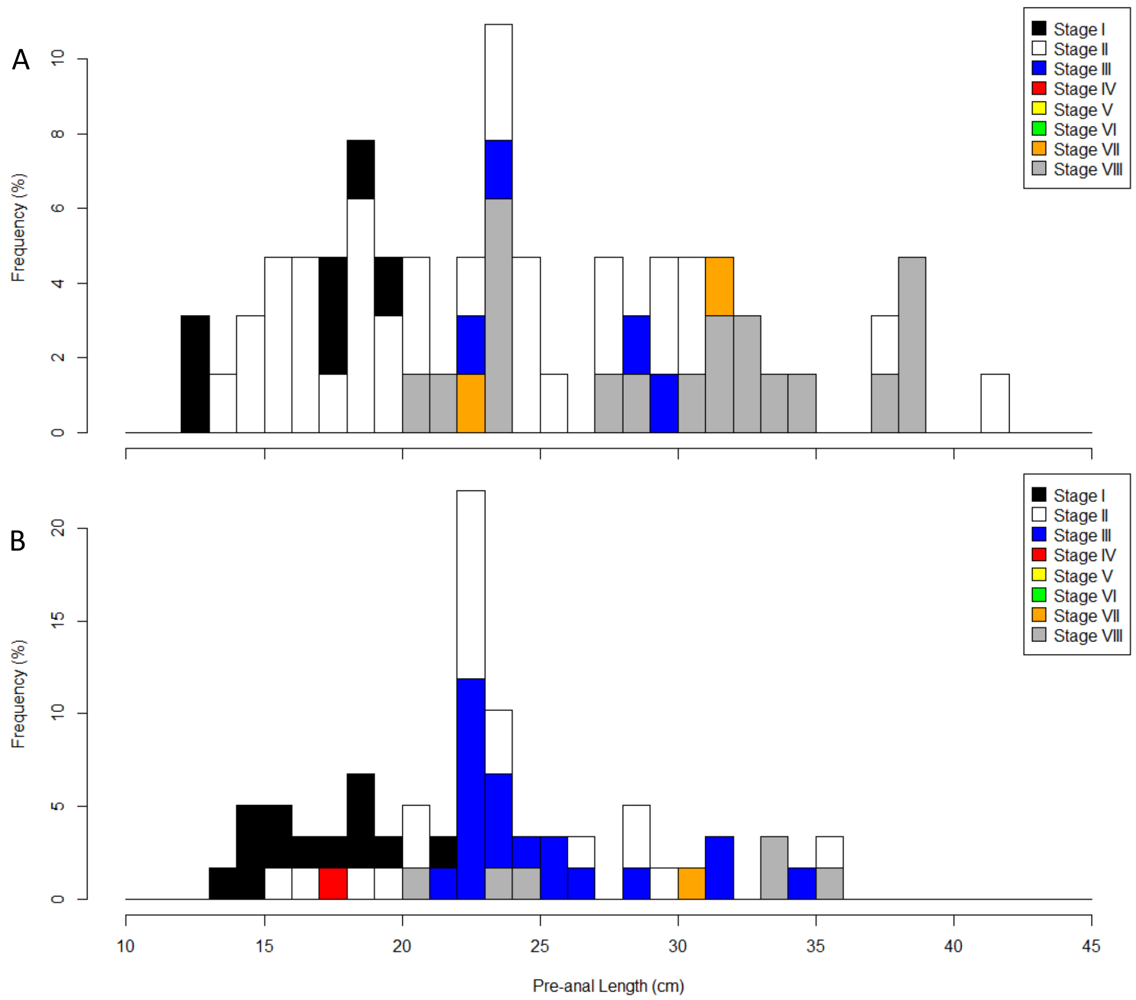


Fig 27. Length frequency (percentage of the total sample collected) of *Macruronus magellanicus* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 64) and (B) males (N = 59).

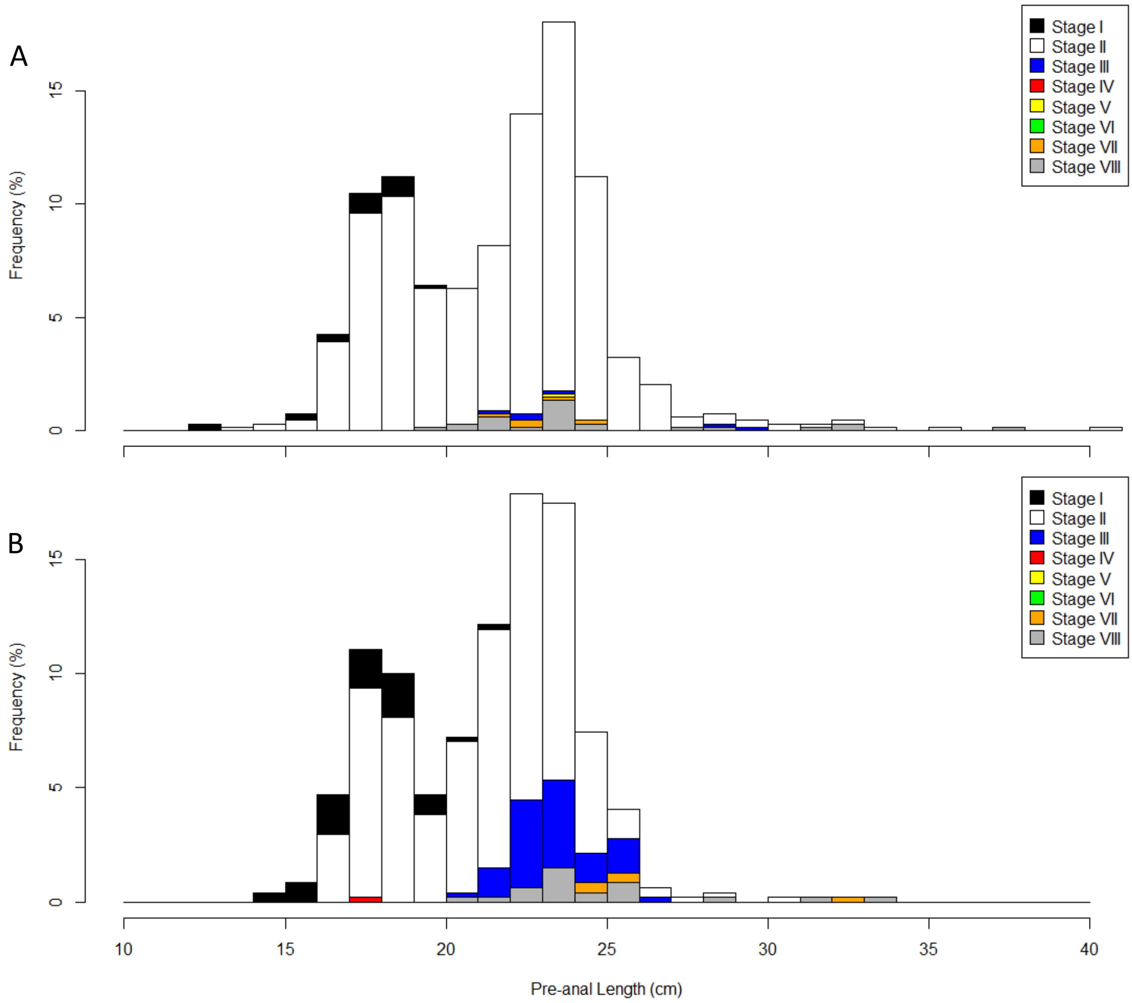


Fig 28. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Macruronus magellanicus* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 687) and (B) males (N = 470).

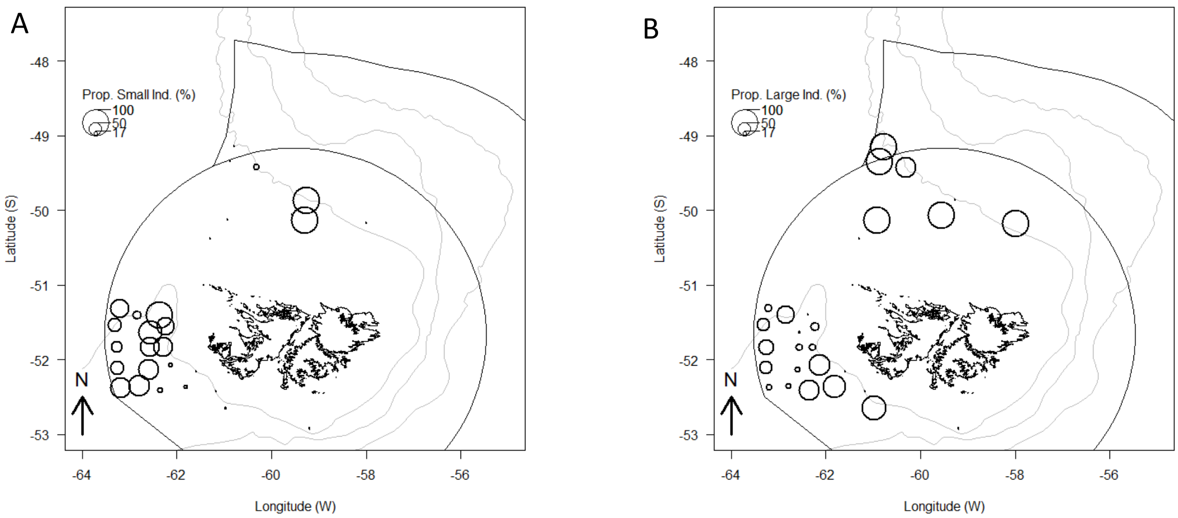


Fig 29. Distribution of the proportion (%) of (A) small (N = 667) and (B) large (N = 490) *Macruronus magellanicus* individuals.

3.2.9 *Stromateus brasiliensis* – Butterfish

The total catch of *S. brasiliensis* was 1,353 kg (Table 2). It was caught at 64 stations of the 80 stations sampled during this cruise (80.0%) (Fig 30a). Catches ranged from 0.21 to 119.32 kg. Of the 64 stations 34 yielded > 10kg (53.1%), two > 100 kg (3.1%), and none > 1 t. Densities for the survey area ranged from 0.98 to 484.08 kg/km^2 (Fig 30a) whereas CPUE ranged from 0.21 to 119.32 kg/hr. Catches of *S. brasiliensis* occurred throughout the survey area, but primarily to the west and northwest of the sampling area along the Argentine EEZ (Fig 30a). The number of *S. brasiliensis* sampled for otoliths was 218 (range = 1 to 19 per station) (Fig 30b) and covered the entire length frequency for both males and females. Overall, including the non-random samples, otoliths were collected from 130 females (T_L = 18 to 40 cm) and 88 males (T_L = 18 to 36 cm) (Fig 31). The number of fish sampled for length frequency (as subsample of the random sample) was 3,523 (2,253 females and 1,270 males). Female T_L ranged from 18 to 40 cm (mean of 24.89 cm) (Fig 32a), whereas males measured between 18 and 39 cm (mean of 22.54 cm) (Fig 32b). Otoliths were collected from two non-random female *S. brasiliensis* (T_L = 38 and 39 cm, respectively) and a single non-random male *S. brasiliensis* (T_L = 36 cm) which were not included in the length frequency histograms. The histograms show three obvious cohorts at 21, 27, and 33-34 cm for females and 21, 26, and 31 cm for males (Figs 32). Females were observed Stage I (< 1%), Stage II (85%), Stage III (14%), Stage IV (< 1%), Stage V (< 1%), and Stage VIII (< 1%) (Fig 32a). Males were observed Stage I (24%), Stage II (63%), Stage III (7%), Stage IV (2%), Stage V (< 1%), Stage VII (< 1%), and Stage VIII (2%) (Fig 32b). Most small individuals, smaller or equal to the median T_L of 23 cm for females (N = 1,191) and 21 cm for males (N = 648), were found in the shallower water across the sampling area (Fig 33a), whereas larger individuals (1,062 females and 622 males) were caught primarily in deeper waters of the sampling area (Fig 33b).

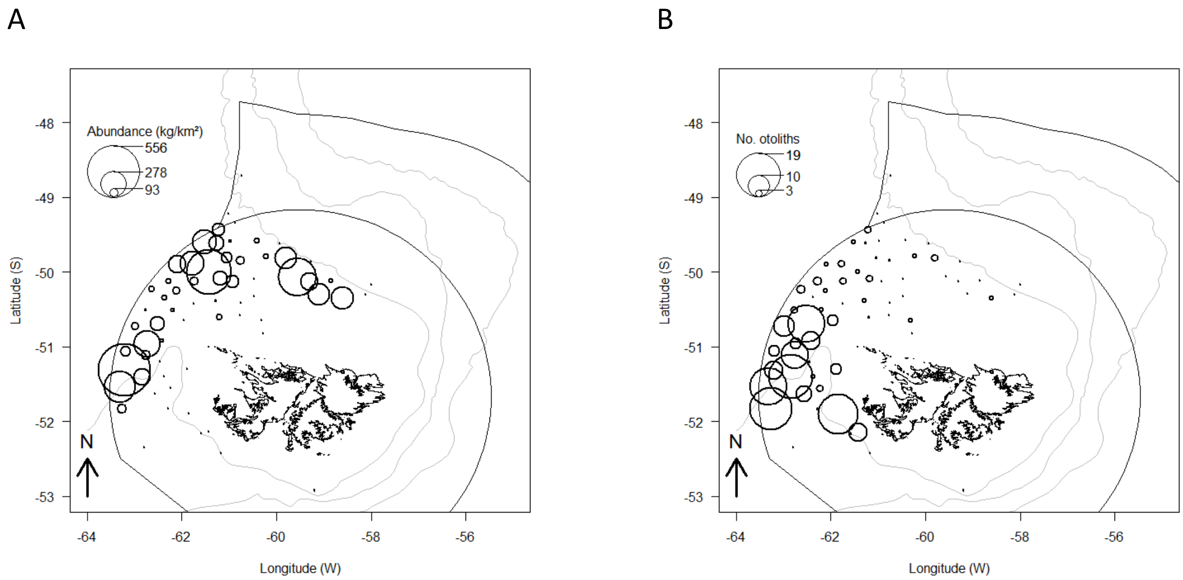


Fig 30. Distribution of (A) densities and (B) otolith samples (N = 218) of *Stromateus brasiliensis*.

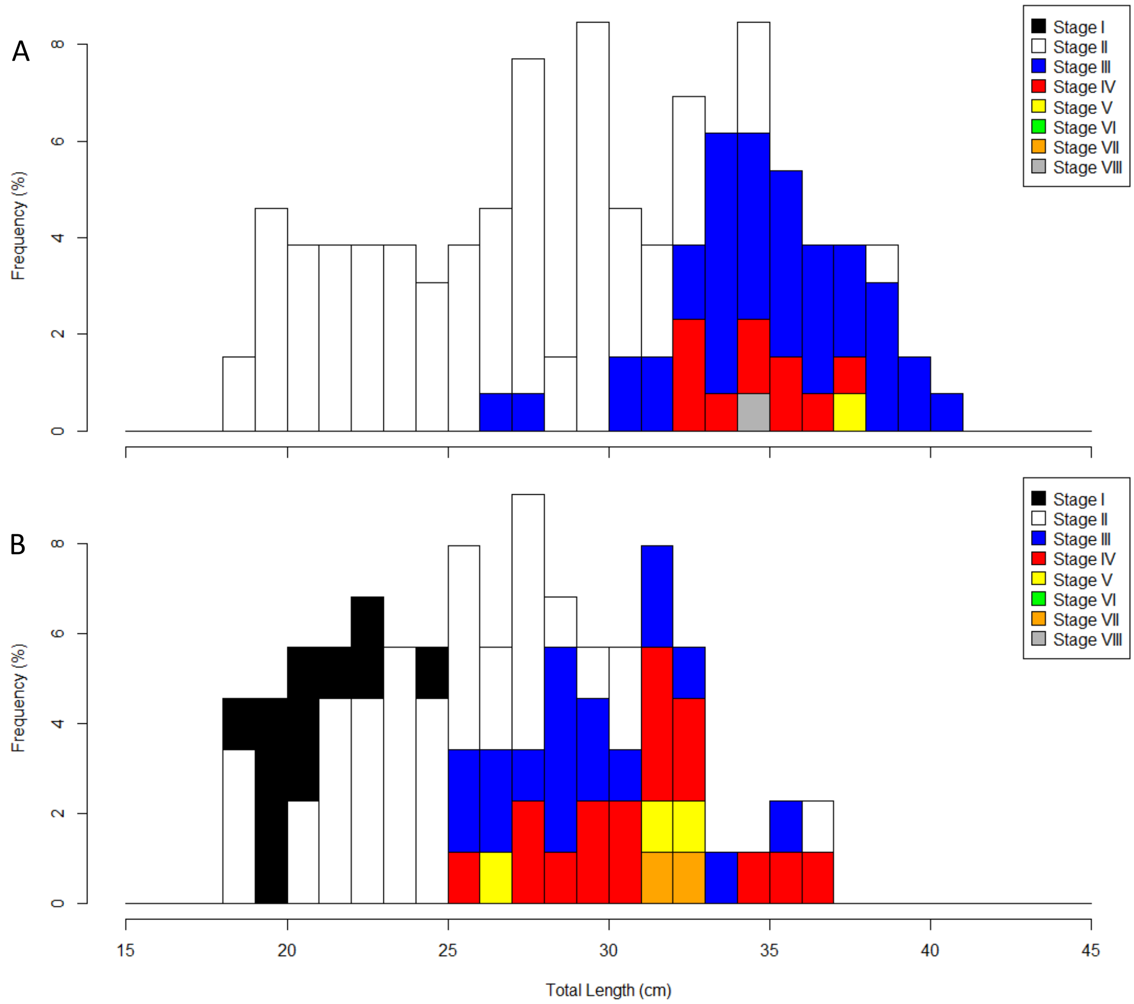


Fig 31. Length frequency (percentage of the total sample collected) of *Stromateus brasiliensis* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 130) and (B) males (N = 88).

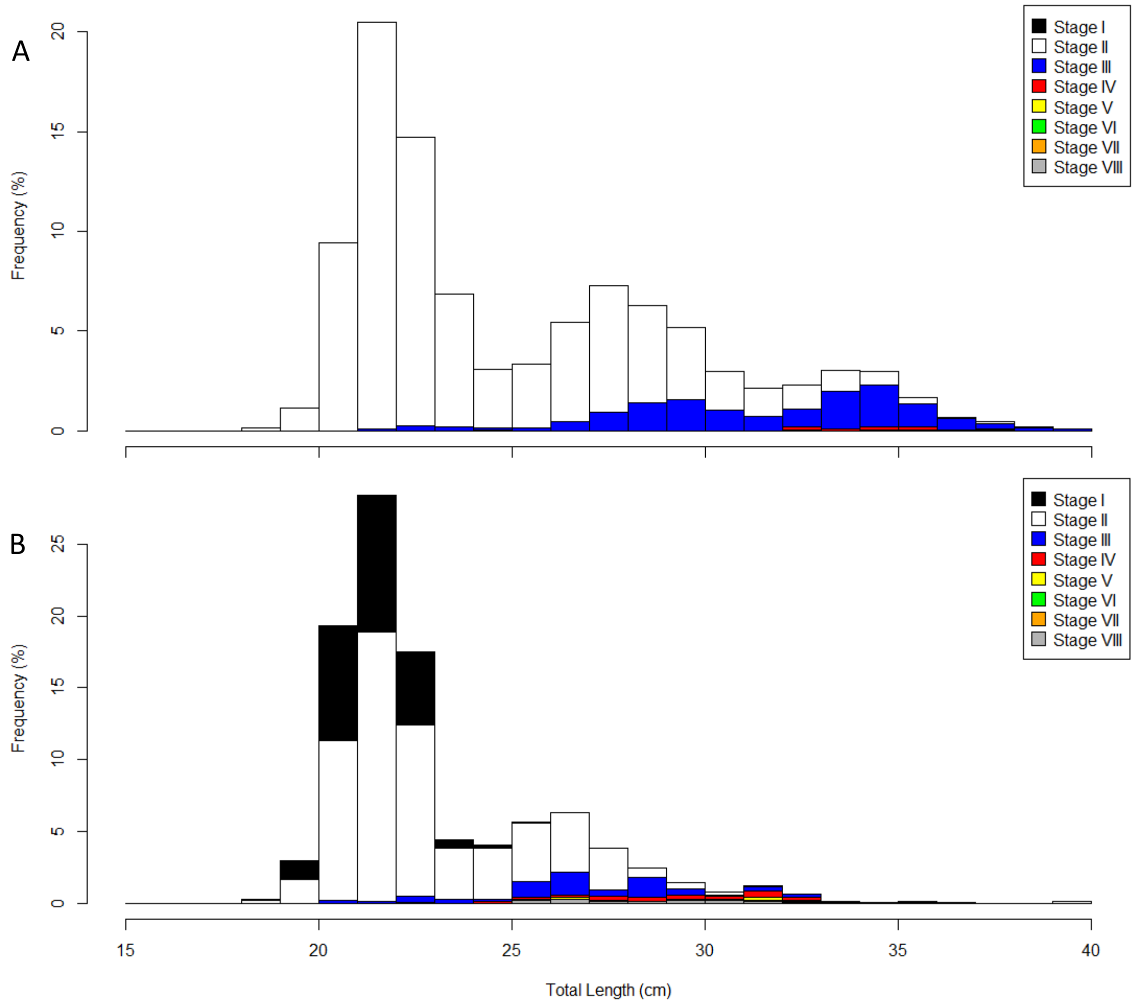


Fig 32. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Stromateus brasiliensis* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 2,253) and (B) males (N = 1,270).

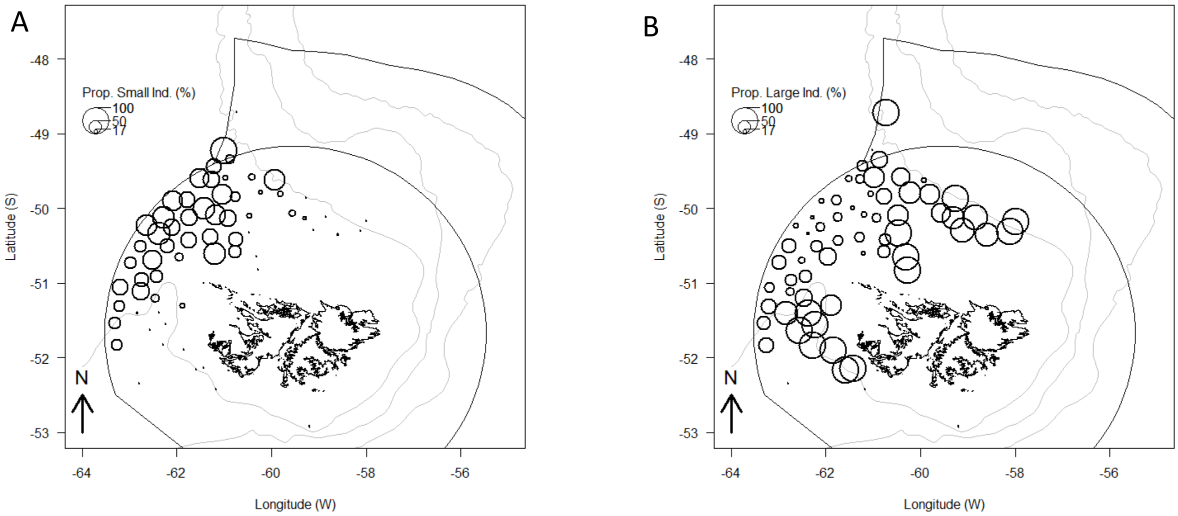


Fig 33. Distribution of the proportion (%) of (A) small (N = 1,839) and (B) large (N = 1,684) *Stromateus brasiliensis* individuals.

3.2.10 *Macrourus carinatus* – Ridge-scaled grenadier

The total catch of *M. carinatus* was 168 kg (Table 2). It was caught at four of the 80 stations sampled during this cruise (5.0%) (Fig 34a). Catches ranged from 1.56 to 152.74 kg. Of the four stations two yielded > 10kg (50.0%), one > 100 kg (25.0%), and none > 1 t. Densities ranged from 8.84 to 855.93 kg/km^2 (Fig 34a) whereas CPUE ranged from 1.56 to 152.74 kg/hr. Catches of *M. carinatus* occurred only in the deeper waters to the southwest of the survey area (Fig 34a). Otoliths were collected from six individuals (range = 1 to 4 per station) (Fig 34b). Overall, otoliths were collected from females only (pre-anal length = 23 to 35 cm). The number of fish sampled for length frequency (as subsample of the random sample) was 91 (87 females and four males). Female pre-anal length ranged from 16 to 35 cm (mean of 24.76 cm) (Fig 35a), whereas males measured between 17 and 21 cm (mean of 19.00 cm) (Fig 35b). Females were observed Stage II (14%), Stage III (25%), Stage IV (1%), Stage VII (7%), and Stage VIII (53%) (Fig 35a). Males were observed Stage II (50%) and Stage IV (50%) (Fig 35b).

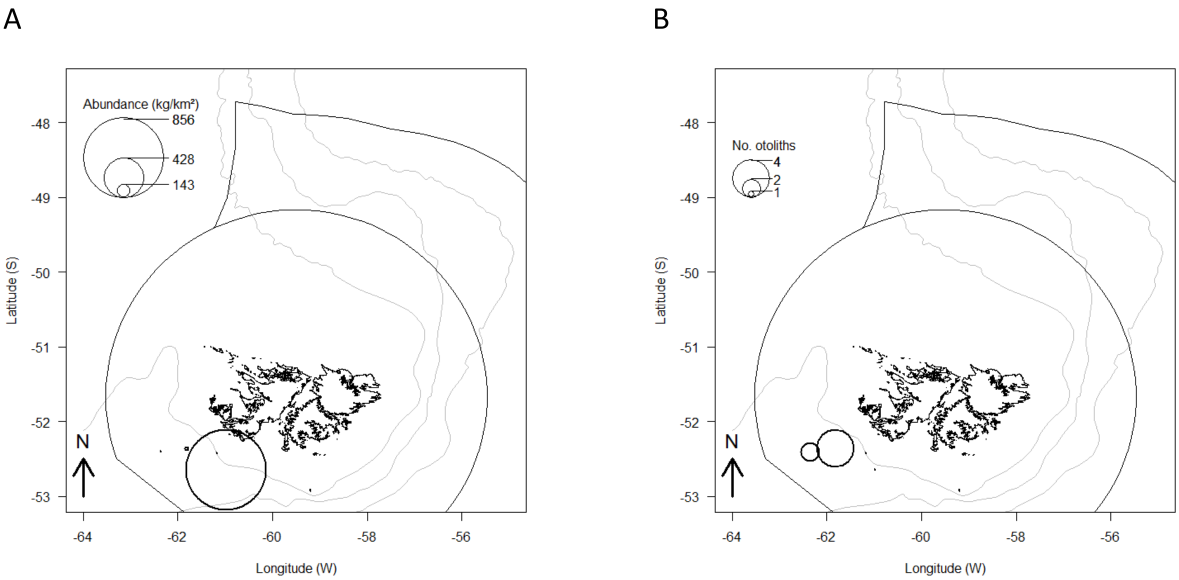


Fig 34. Distribution of (A) densities and (B) otolith samples (N = 6) of *Macrourus carinatus*.

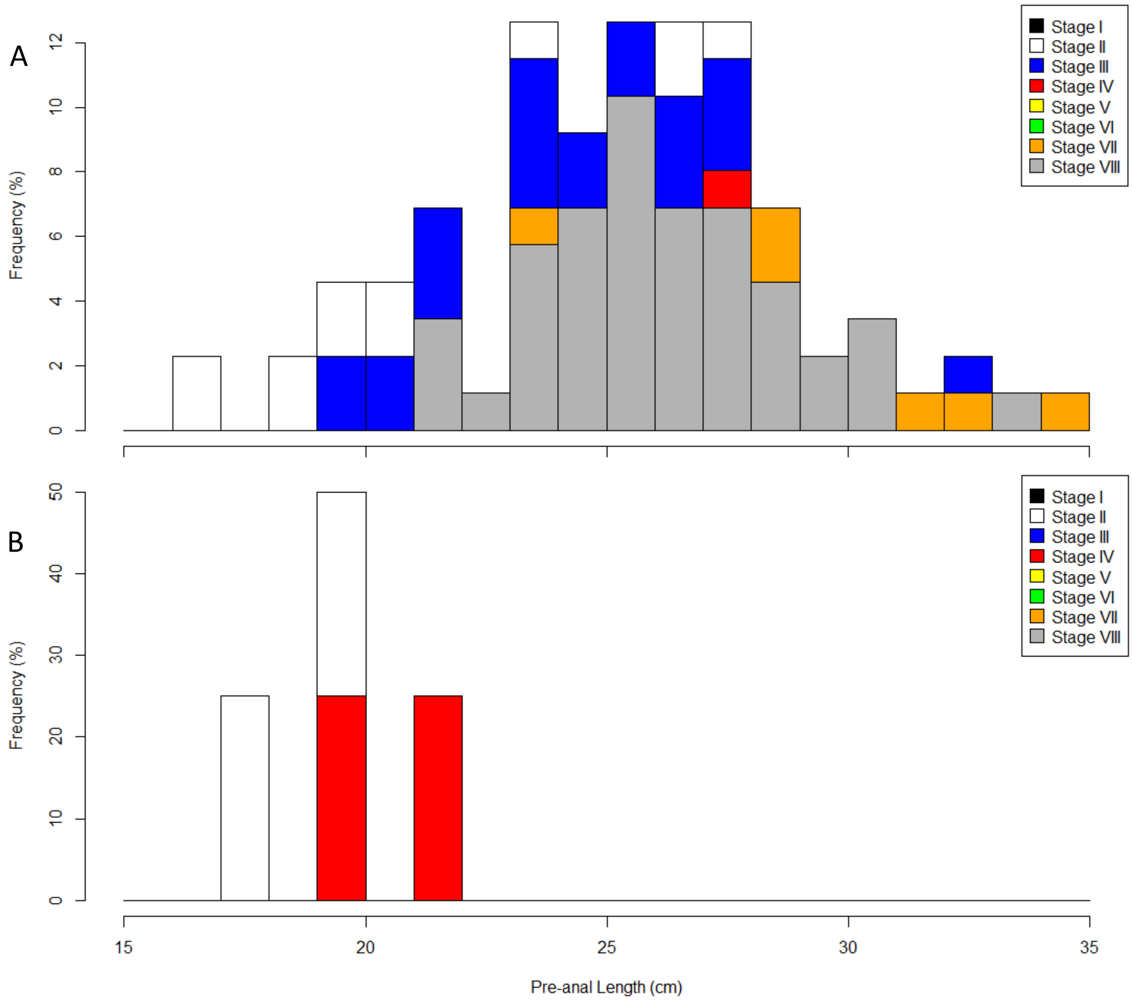


Fig 35. Length frequency (percentage of the total sample collected) of *Macrourus carinatus* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 87) and (B) males (N = 4).

3.2.11 *Coelorinchus fasciatus* – Banded whiptail grenadier

The total catch of *C. fasciatus* was 2,419 kg (Table 2). It was caught at 17 of the 80 stations sampled during this cruise (21.3%) (Fig 36a). Catches ranged from 0.34 to 676.38 kg. Of the 17 stations 13 yielded > 10kg (76.5%), six > 100 kg (35.3%), and none > 1 t. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 1.66 to 3,790.32 kg/km^2 (Fig 36a) whereas CPUE ranged from 0.35 to 676.38 kg/hr. Catches of *C. fasciatus* occurred only in the deeper waters to the southwest of the survey area (Fig 36a). Including non-random samples, the number of *C. fasciatus* sampled for otoliths was 110 (range = 1 to 42 per station) (Fig 36b) and covered the entire length frequency for both males and females. Overall, otoliths were collected from 73 females (pre-anal length = 4 to 13 cm) and 37 males (pre-anal length = 3 to 12 cm) (Fig 37). The number of fish sampled for length frequency (as subsample of the random sample) was 1,254 (1,067 females and 187 males). Female pre-anal length ranged from 5 to 13 cm (mean of 10.12 cm) (Fig 38a), whereas males measured between 4 and 12 cm (mean of 8.88 cm) (Fig 38b). Otoliths were collected from 22 non-random female *C. fasciatus* (pre-anal length = 4 to 6 cm) and 13 non-random males *C. fasciatus* (pre-anal length = 3 to 6 cm) which were not included in the length frequency histograms. The histograms show a single obvious cohort at 10 cm for females and 9 cm for males (Fig 38). Females were observed Stage I (< 1%), Stage II (59%), Stage III (14%), Stage IV (1%), Stage V (< 1%), Stage VII (7%), and Stage VIII (17%) (Fig 38a). Males were observed Stage I (9%), Stage II (59%), Stage III (31%), and Stage IV (1%) (Fig 38b). Most small individuals, smaller or equal to the median pre-anal length of 10 cm for females (N = 654) and 9 cm for males (N = 122), were found in shallower waters (Fig 39a), whereas larger individuals (413 females and 65 males) were caught mostly in deeper waters in the southwest of the sampling area, along the Argentine EEZ (Fig 39b).

A B

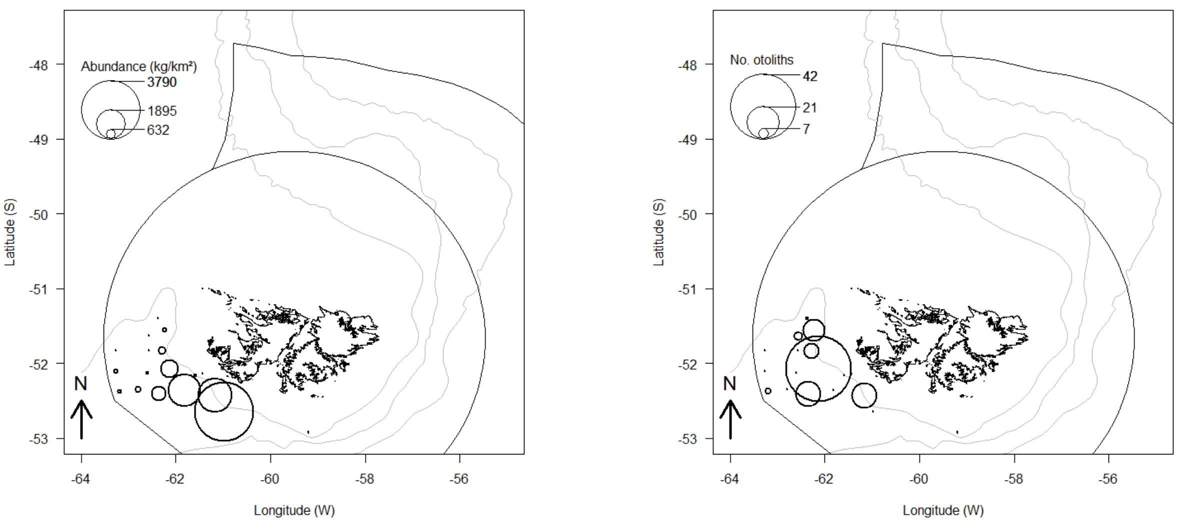


Fig 36. Distribution of (A) densities and (B) otolith samples (N = 110) of *Coelorinchus fasciatus*.

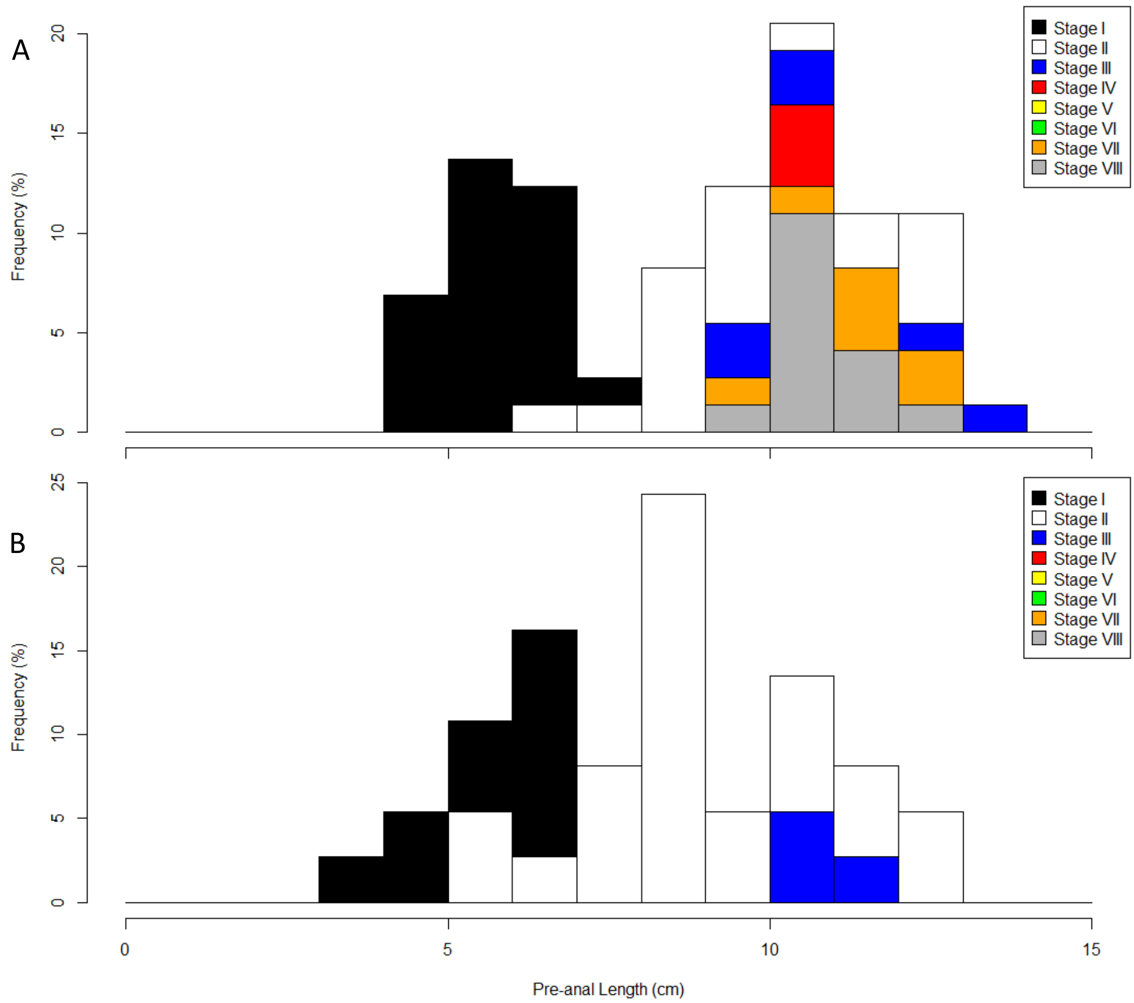


Fig 37. Length frequency (percentage of the total sample collected) of *Coelorinchus fasciatus* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 73) and (B) males (N = 37).

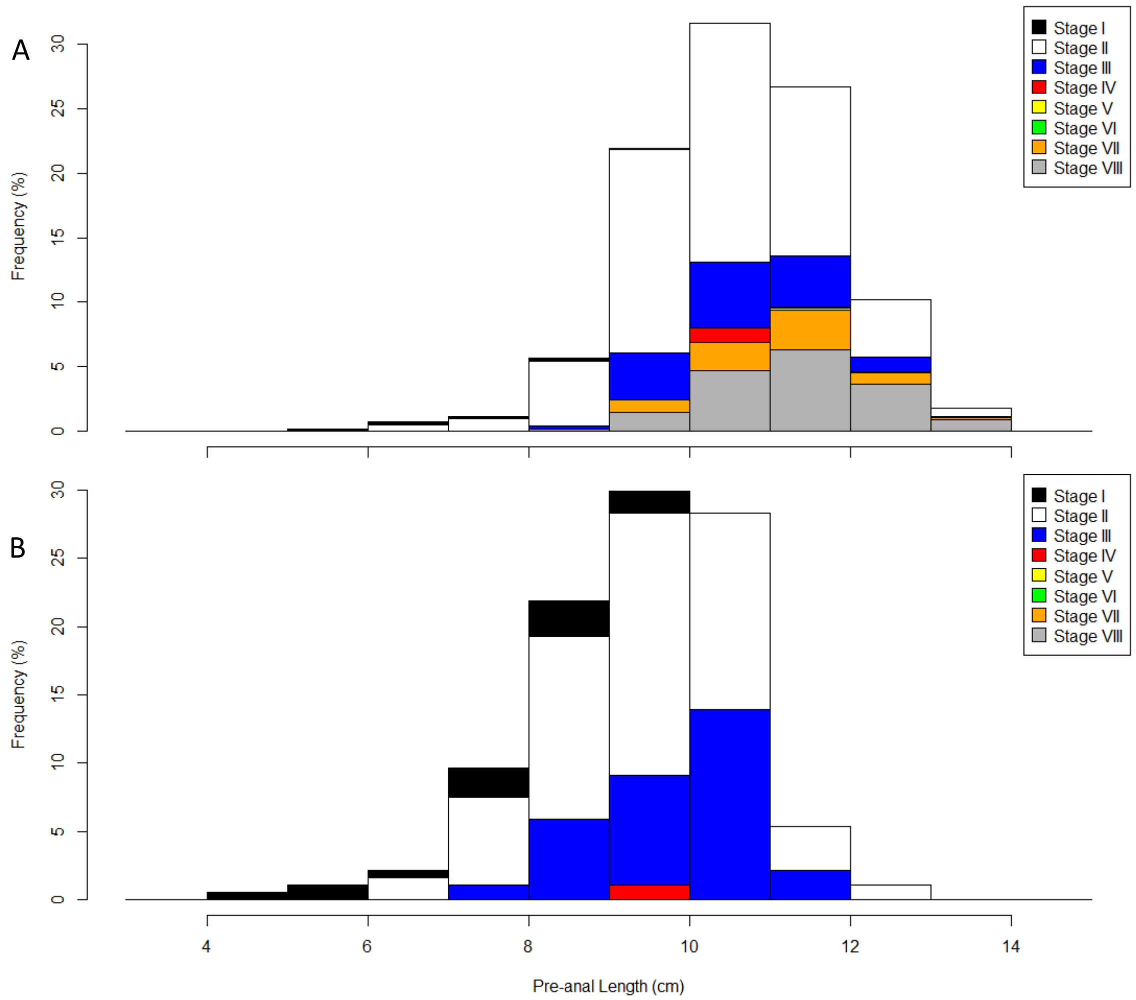


Fig 38. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Coelorinchus fasciatus* with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 1,067) and (B) males (N = 187).

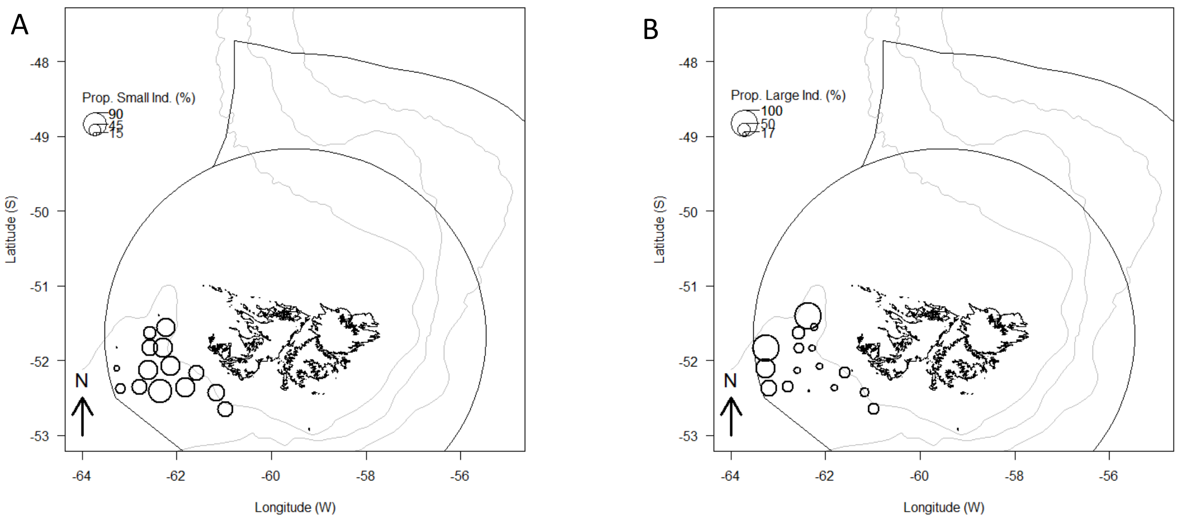


Fig 39. Distribution of the proportion (%) of (A) small (N = 776) and (B) large (N = 478) *Coelorinchus fasciatus* individuals.

3.2.12 *Sebastes oculatus* – Redfish

The total catch of *S. oculatus* was 15 kg (Table 2). It was caught at six stations of the 80 stations sampled during this cruise (7.5%) (Fig 40a). Catches ranged from 0.03 to 5.76 kg. Of the six stations four yielded > 1kg (66.7%) and none > 10 kg. Densities ranged from 0.12 to 25.77 kg/km^2 (Fig 40a), whereas CPUE ranged from 0.03 to 5.76 kg/hr. Catches of *S. oculatus* occurred primarily to the north of the survey area (Fig 40a). All *S. oculatus* caught were sampled for otoliths (N = 26; range = 1 to 10 per station) (Fig 40b). Overall, otoliths were collected from 12 females (T_L = 20 to 38 cm) and 14 males (T_L = 27 to 38 cm). The number of fish sampled for length frequency was 26 (12 females and 14 males). Female T_L ranged from 20 to 38 cm (mean of 30.58 cm) (Fig 41a), whereas males measured between 27 and 38 cm (mean of 33.79 cm) (Fig 41b). Females were observed Stage II (25%), Stage VI (25%), Stage VII (8%), and Stage VIII (42%) (Fig 41a). Males were observed Stage II (14%), Stage III (7%), Stage VII (7%), and Stage VIII (71%) (Fig 41b).

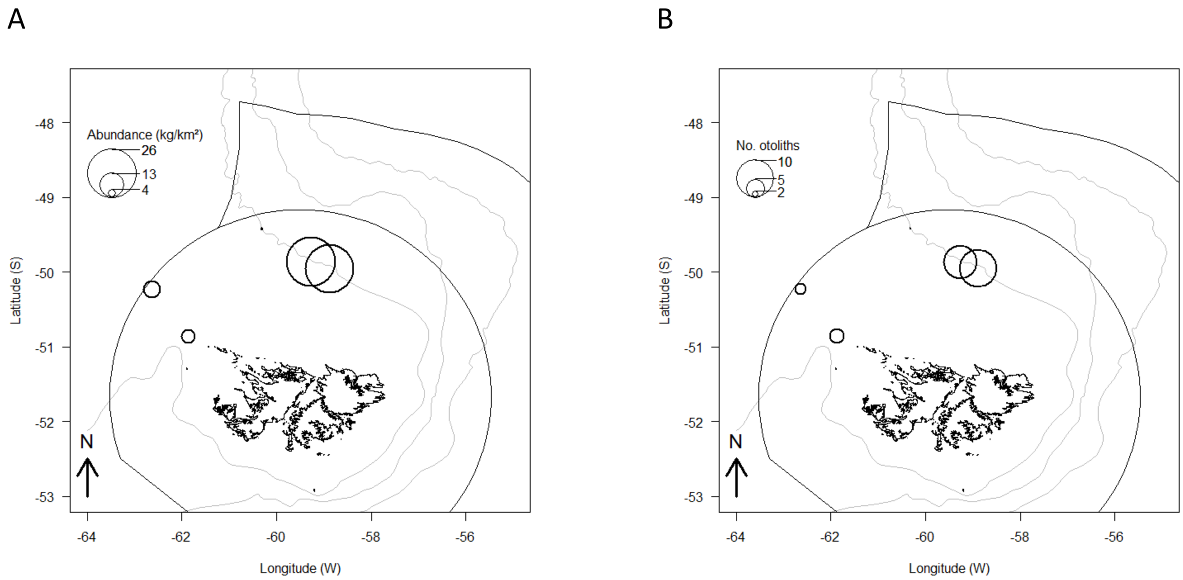


Fig 40. Distribution of (A) densities and (B) otolith samples (N = 26) of *Sebastes oculatus*.

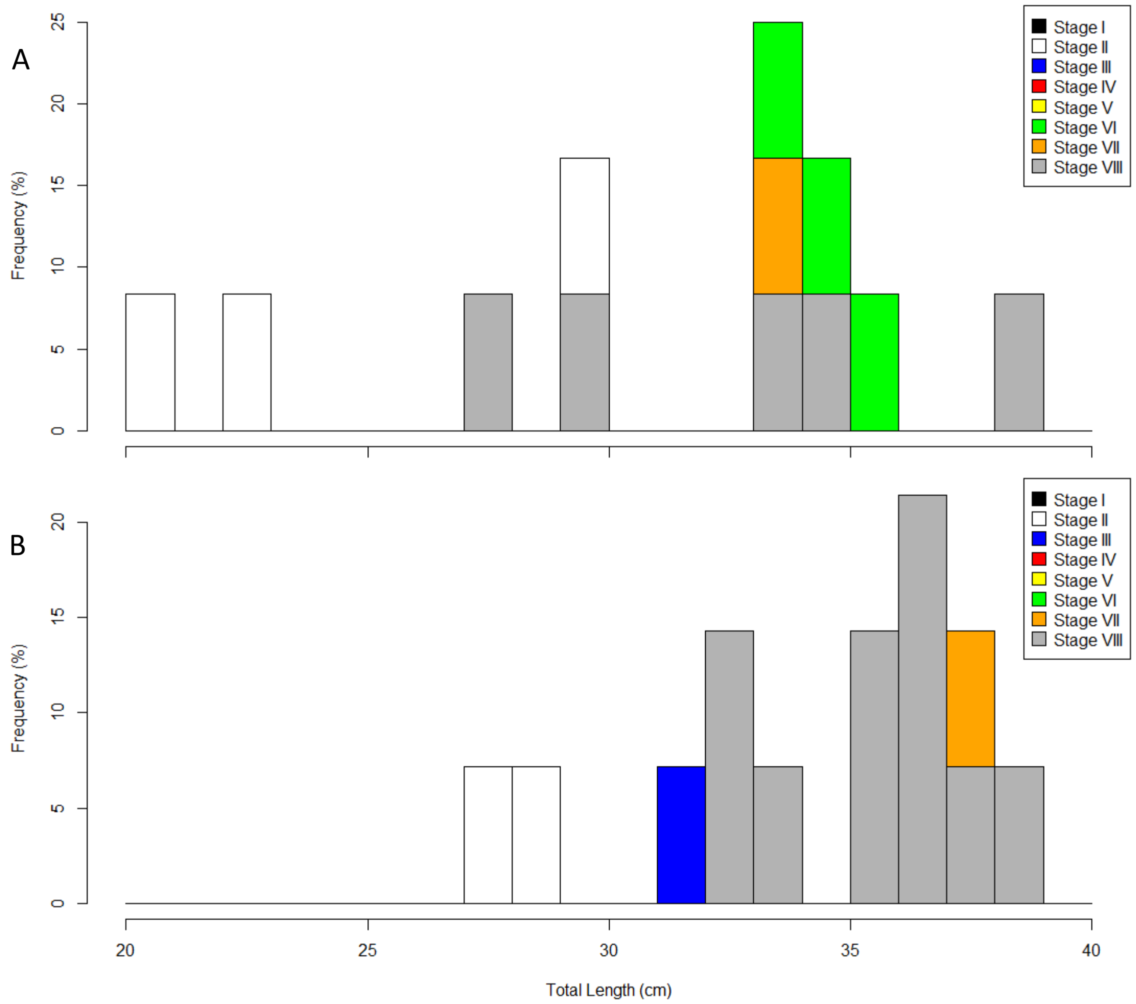


Fig 41. Length frequency (percentage of the total sample collected) of *Sebastes oculatus* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 12) and (B) males (N = 14).

3.3 Biological information on squid species

3.3.1 *Illex argentinus* – Argentine shortfin squid

The total catch of *I. argentinus* was 17,853 kg (Table 2). It was caught at 72 of the 80 stations sampled during this cruise (90.0%) (Fig 42). Catches ranged from 0.05 to 3,027.54 kg. Of the 72 stations 44 yielded > 10kg (61.1%), 30 > 100 kg (41.7%), and three > 1 t (4.2%). Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 0.23 to 14,744.80 kg/km^2 (Fig 42) whereas CPUE ranged from 0.05 to 3,027.54 kg/hr. Catches of *I. argentinus* occurred throughout the survey area, but primarily in the north of the survey area (Fig 42). The number of squid sampled for length frequency was 4,537 (2,536 females and 2,001 males). Female dorsal mantle length ranged from 8.0 to 31.5 cm (mean of 23.28 cm) (Fig 43a), whereas males measured between 8.5 and 27.5 cm (mean of 22.14 cm) (Fig 43b). The histograms show two obvious cohorts at 12 and 23 cm for females and 12 and 22 cm for males (Fig 43). Females were observed Stage I (1%), Stage II (79%), Stage III (13%), Stage IV (4%), and Stage V (2%) (Fig 43a). Males were observed Stage I (1%), Stage II (4%), Stage III (8%), Stage IV (35%), and Stage V (51%) (Fig 43b). Most small individuals, smaller or equal to the median dorsal mantle length of 23.5 cm for females (N = 1,405) and 22.5 cm for males (N = 1,176), were found mostly in the west of the sampling area (Fig 44a), whereas larger individuals (1,131 females and 825 males) were caught mostly in the north of the sampling area (Fig 44b).

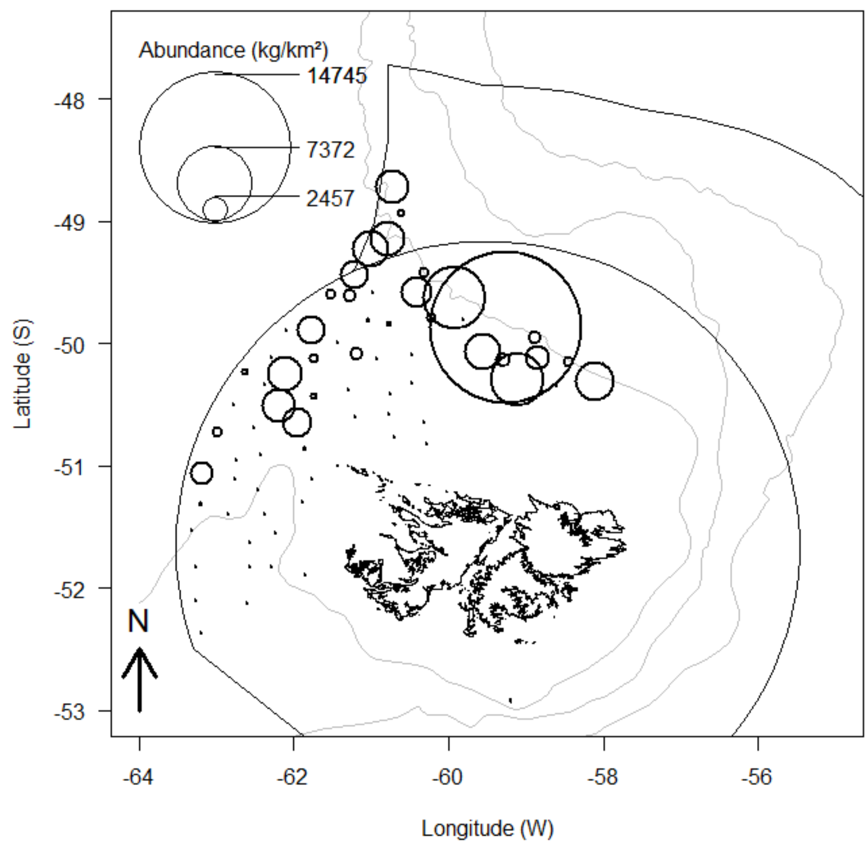


Fig 42. Distribution of densities of *Illex argentinus*.

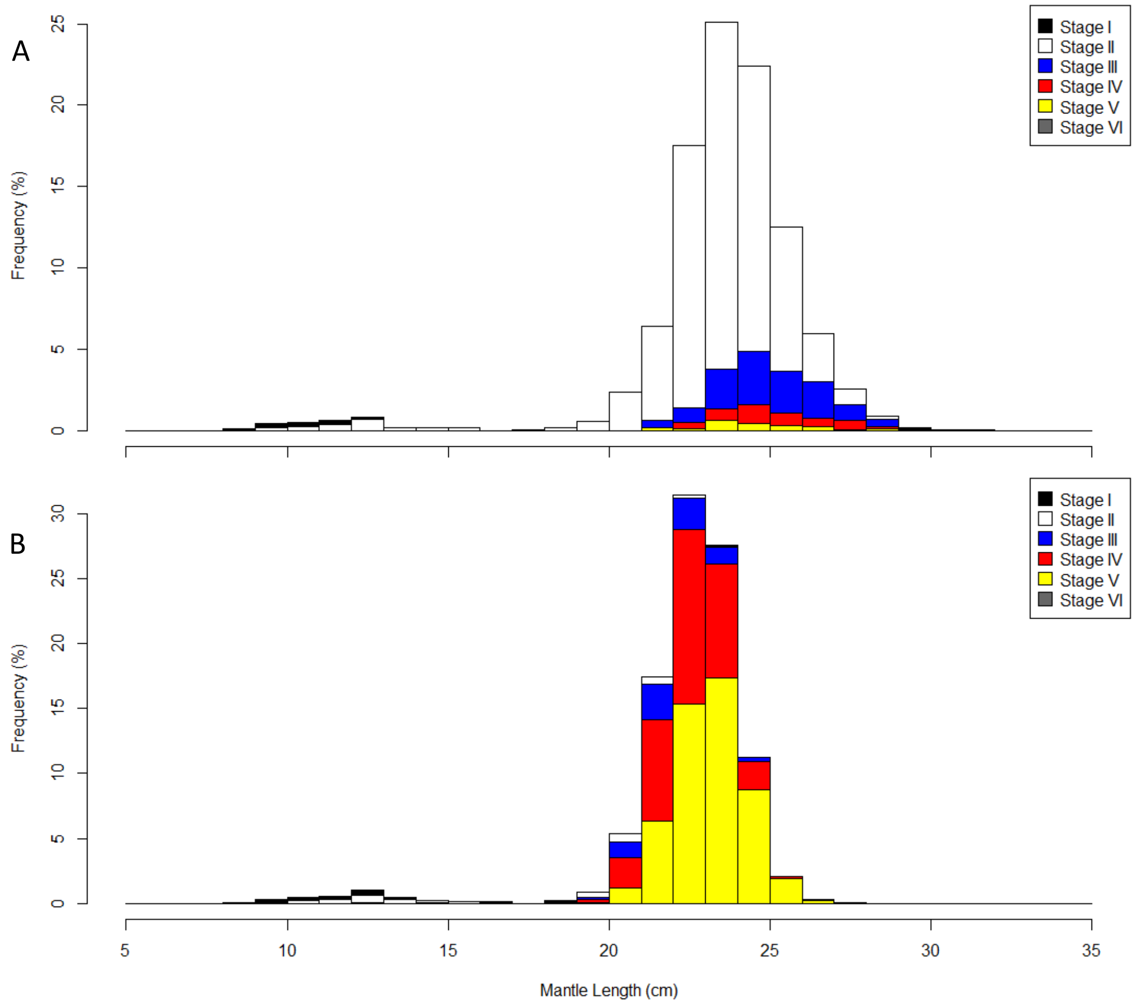


Fig 43. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Illex argentinus* with associated maturity stages (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent) for (A) females (N = 2,536) and (B) males (N = 2,001).

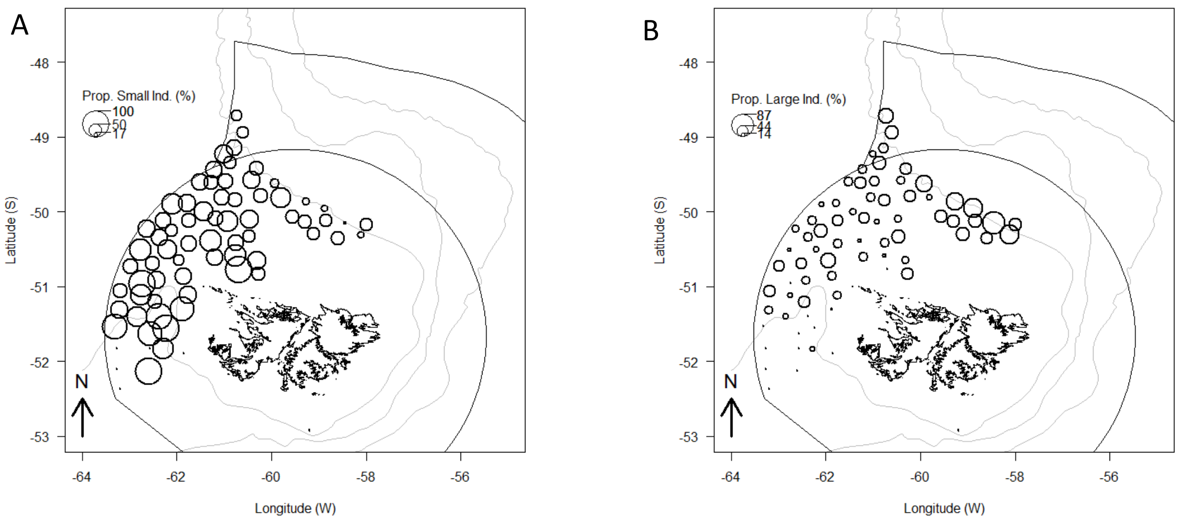


Fig 44. Distribution of the proportion (%) of (A) small (N = 2,581) and (B) large (N = 1,956) *Illex argentinus* individuals.

3.3.2 *Doryteuthis gahi* – Patagonian longfin squid

The total catch of *D. gahi* was 3,694 kg (Table 2). It was caught at 78 of the 80 stations sampled during this cruise (97.5%) (Fig 45). Catches ranged from 0.20 to 202.51 kg. Of the 78 stations 67 yielded > 10kg (85.9%), nine > 100 kg (11.5%), and none > 1 t. Densities for the survey area, as presented in Ramos & Winter (2020), ranged from 0.92 to 948.64 kg/km^2 (Fig 45) whereas CPUE ranged from 0.20 to 202.51 kg/hr. Catches of *D. gahi* occurred throughout the survey area, but primarily in the west of the survey area south of 50.5°S (Fig 45). The number of squid sampled for length frequency was 7,962 (4,608 females and 3,354 males). Female dorsal mantle length ranged from 5.0 to 17.0 cm (mean of 9.39 cm) (Fig 46a), whereas males measured between 5.0 and 16.5 cm (mean of 9.72 cm) (Fig 46b). The histograms show one obvious cohort at 9 cm for females and 9 cm for males (Fig 46). Females were observed Stage I (1%), Stage II (93%), Stage III (5%), Stage IV (1%), and Stage V (< 1%) (Fig 46a). Males were observed Stage I (3%), Stage II (82%), Stage III (9%), Stage IV (5%), and Stage V (2%) (Fig 46b). Most small individuals, smaller or equal to the median dorsal mantle length of 9.0 cm for females (N = 2,349) and 9.5 cm for males (N = 1,877), were found mostly in the west of the sampling area (Fig 47a), whereas larger individuals (2,259 females and 1,477 males) were caught mostly in the north of the sampling area (Fig 47b).

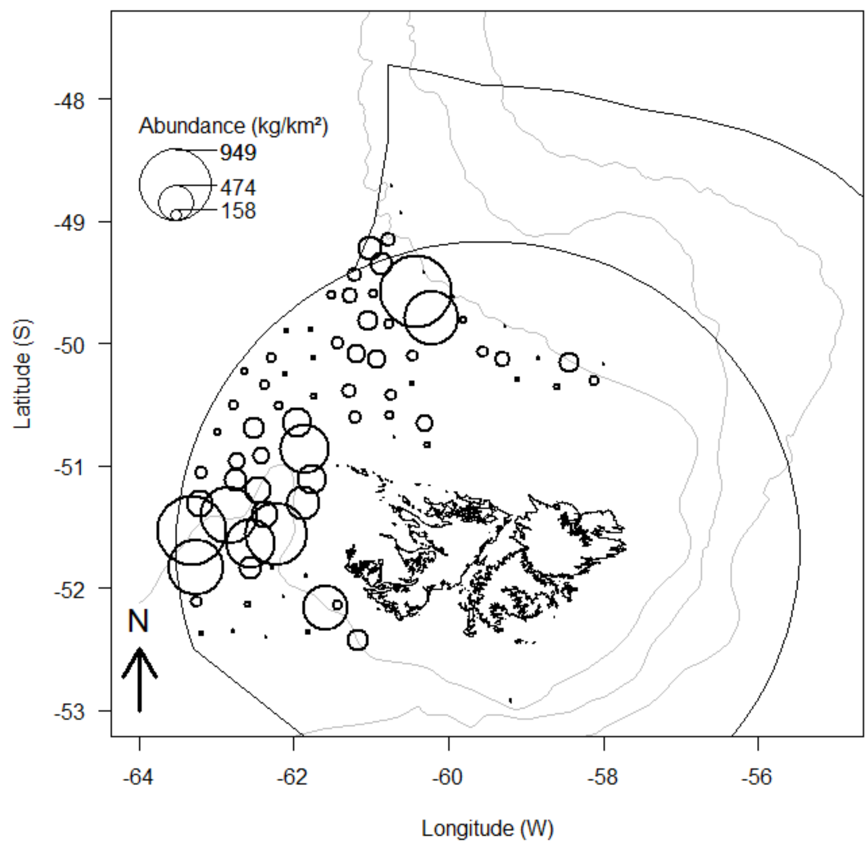


Fig 45. Distribution of densities of *Doryteuthis gahi*.

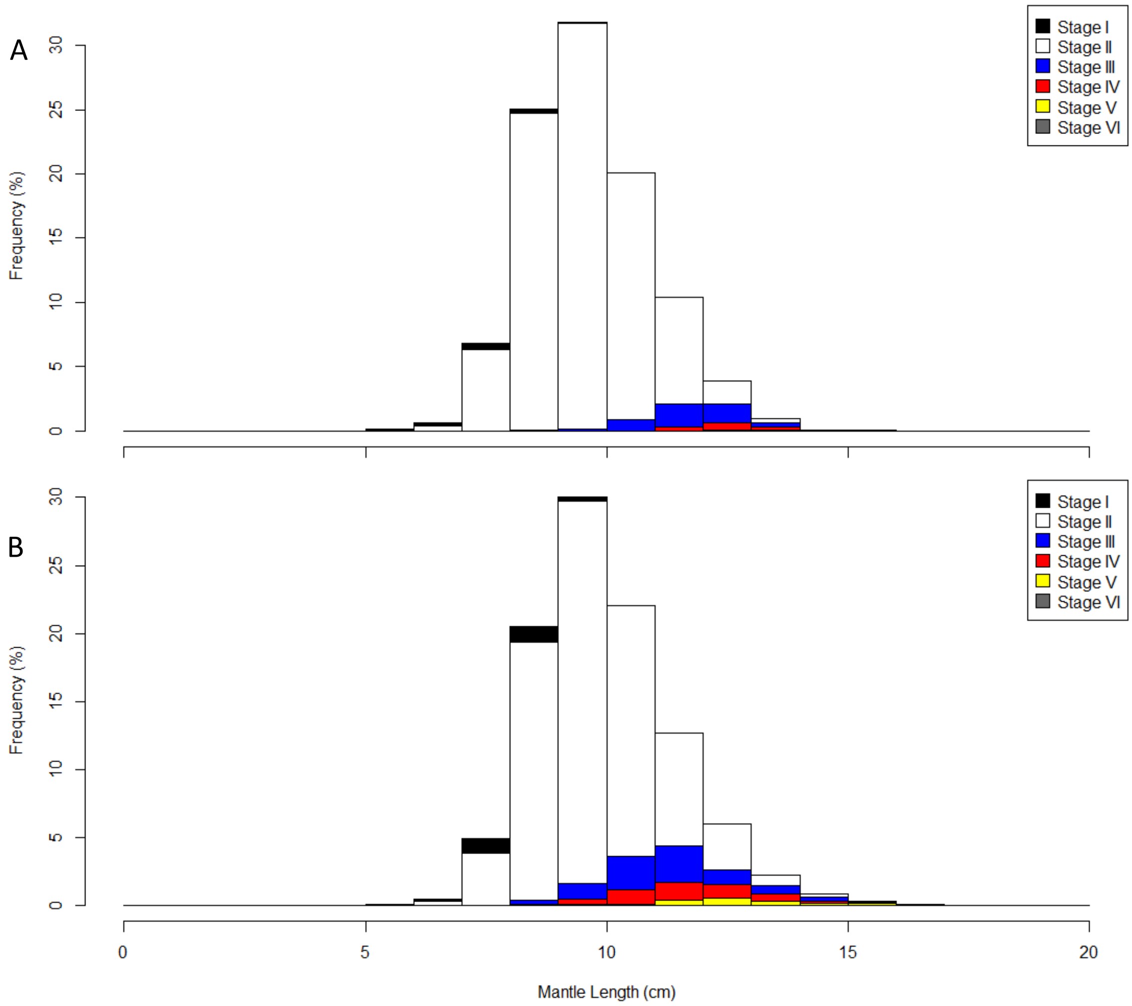


Fig 46. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Doryteuthis gahi* with associated maturity stages (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent) for (A) females (N = 4,608) and (B) males (N = 3,354).

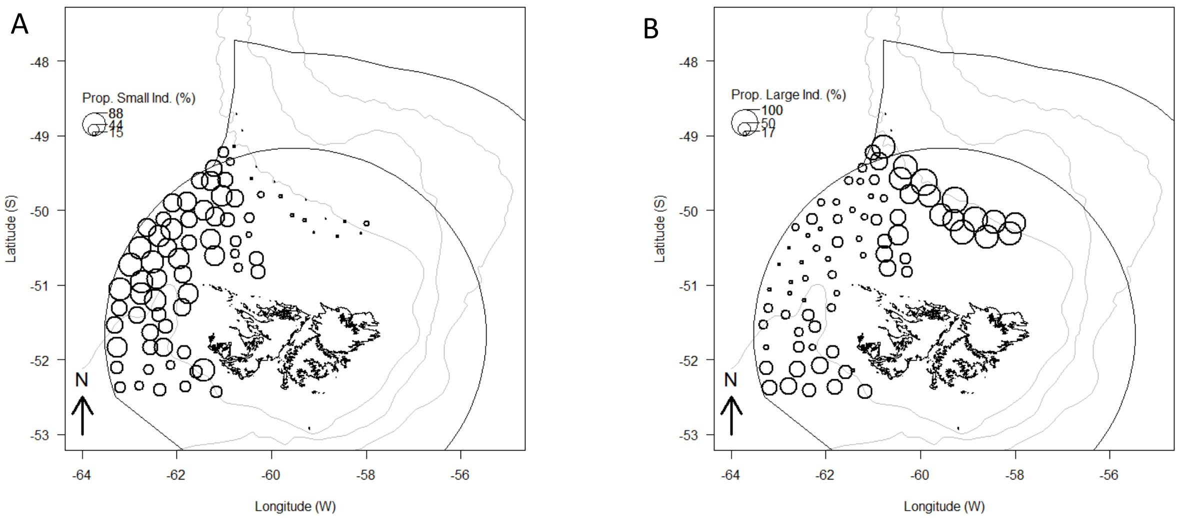


Fig 47. Distribution of the proportion (%) of (A) small (N = 4,226) and (B) large (N = 3,736) *Doryteuthis gahi* individuals.

3.4 Biological information on skate species

3.4.1 *Bathyraja albomaculata* – White spotted skate

The total catch of *B. albomaculata* was 26 kg (Table 2). It was caught at 14 of the 80 stations sampled during this cruise (17.5%) (Fig 48). Catches ranged from 0.10 to 6.30 kg. Of the 14 stations ten yielded > 1 kg (71.4%), one > 5 kg (7.1%), and none > 10 kg. Densities for the survey area ranged from 0.45 to 29.49 kg/km^2 (Fig 48), whereas CPUE ranged from 0.10 to 6.20 kg/hr. Catches of *B. albomaculata* occurred primarily along the 200 m isobath to the north of the survey area (Fig 48). The number of skates sampled for disc width frequency was 19 (9 females and 10 males). Female disc width ranged from 11 to 44 cm (mean of 35.22 cm) (Fig 49a), whereas males measured between 16 and 45 cm (mean of 37.00 cm) (Fig 49b). Females were observed Stage I (11%), Stage II (44%), Stage IV (30%), and Stage VI (11%) (Fig 49a). Males were observed Stage I (10%), Stage II (10%), Stage III (30%), Stage IV (10%), and Stage V (40%) (Fig 49b).

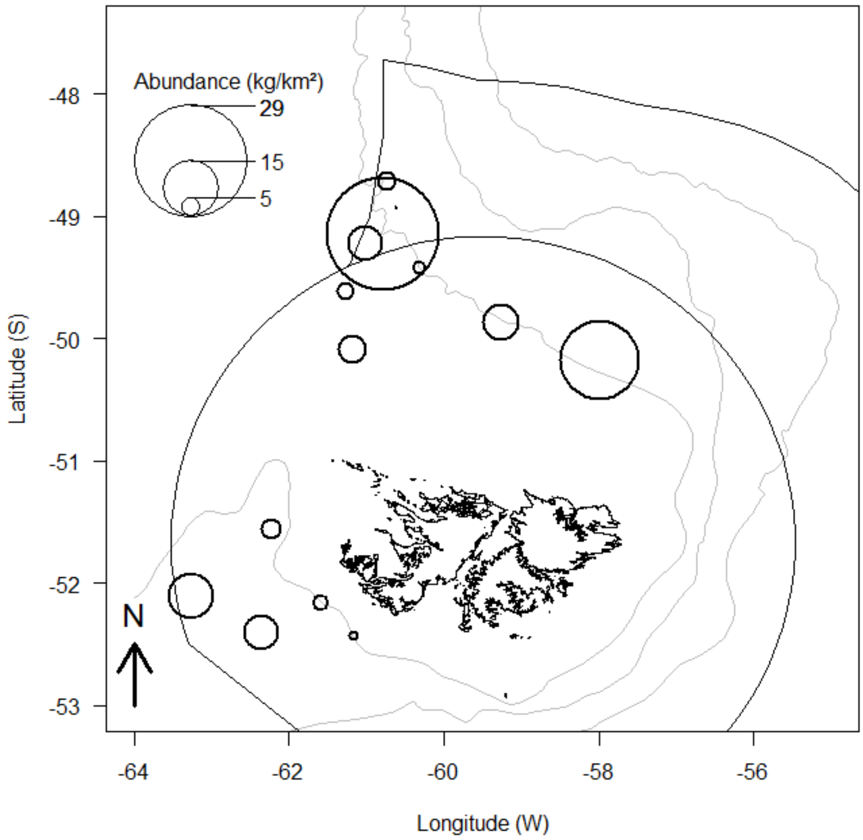


Fig 48. Distribution of densities of *Bathyraja albomaculata*.

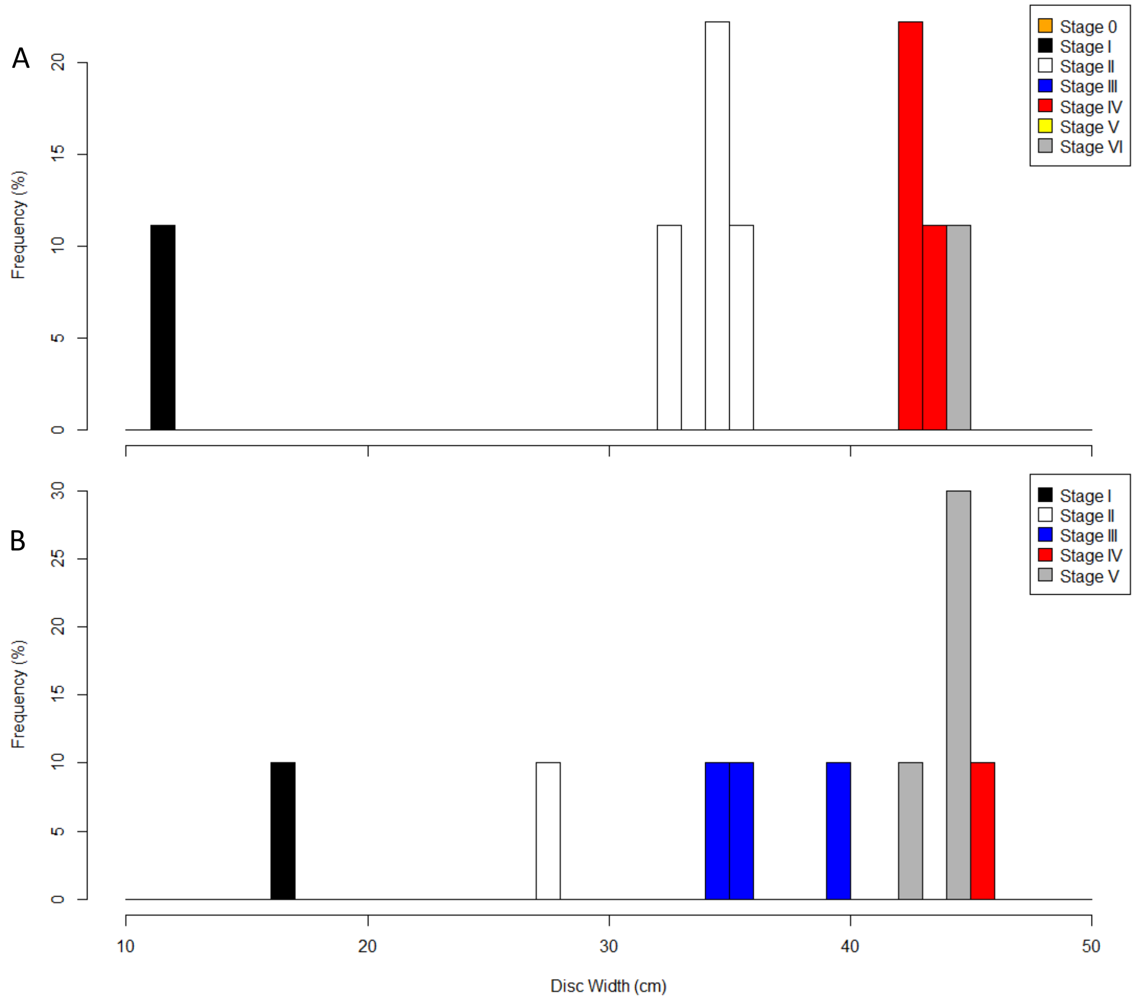


Fig 49. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja albomaculata* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 9) and (B) males (N = 10).

3.4.2 *Bathyraja brachyurops* – blonde skate

The total catch of *B. brachyurops* was 405 kg (Table 2). It was caught at 49 of the 80 stations sampled during this cruise (61.3%) (Fig 50). Catches ranged from 0.22 to 81.54 kg. Of the 49 stations 42 yielded > 1 kg (85.7%), seven > 10 kg (14.3%), and two > 50 kg (4.1%). Densities for the survey area ranged from 1.00 to 361.14 kg/km^2 (Fig 50), whereas CPUE ranged from 0.22 to 81.54 kg/hr. Catches of *B. brachyurops* occurred primarily to the north of the survey area (Fig 50). The number of skates sampled for disc width frequency was 531 (254 females and 277 males). Female disc width ranged from 5 to 64 cm (mean of 29.21 cm) (Fig 51a), whereas males measured between 12 and 63 cm (mean of 29.51 cm) (Fig 51b). Females were observed Stage I (42%), Stage II (49%), Stage III (4%), Stage IV (2%), Stage V (< 1%), and Stage VI (4%) (Fig 51a). Males were observed Stage I (50%), Stage II (33%), Stage III (8%), Stage IV (3%), and Stage V (6%) (Fig 51b). Most small individuals, smaller or equal to the median disc width of 27 cm for females (N = 129) and 28 cm for males (N = 152), were found mostly in the north of the sampling area (Fig 52a), whereas larger individuals (125 females and 125 males) were caught mostly in the west and northwest of the sampling area (Fig 52b).

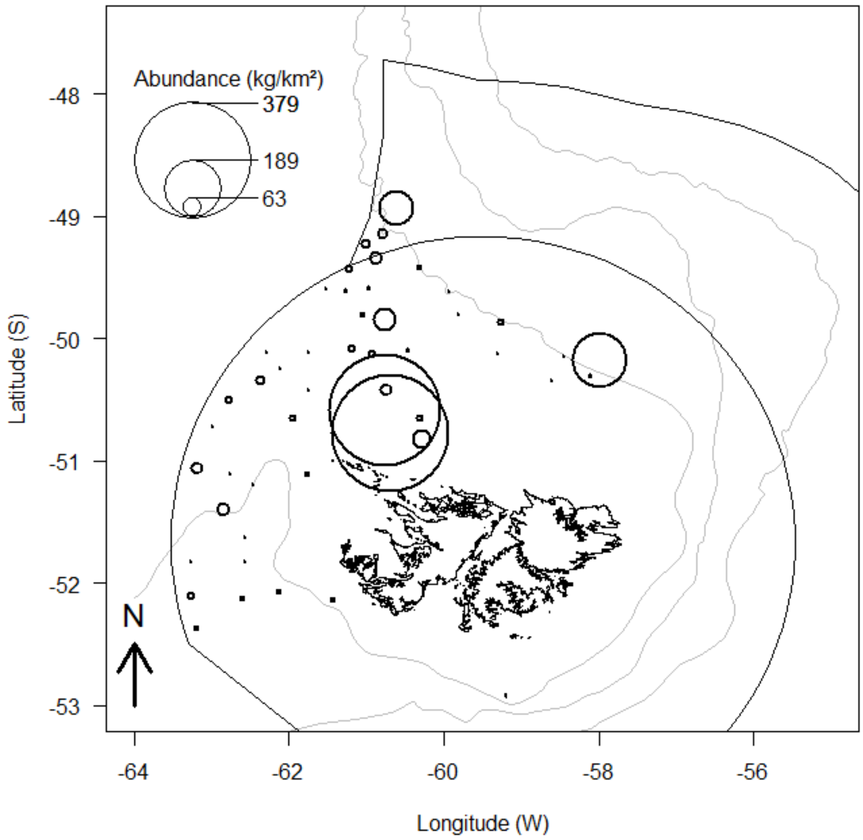


Fig 50. Distribution of densities of *Bathyraja brachyurops*.

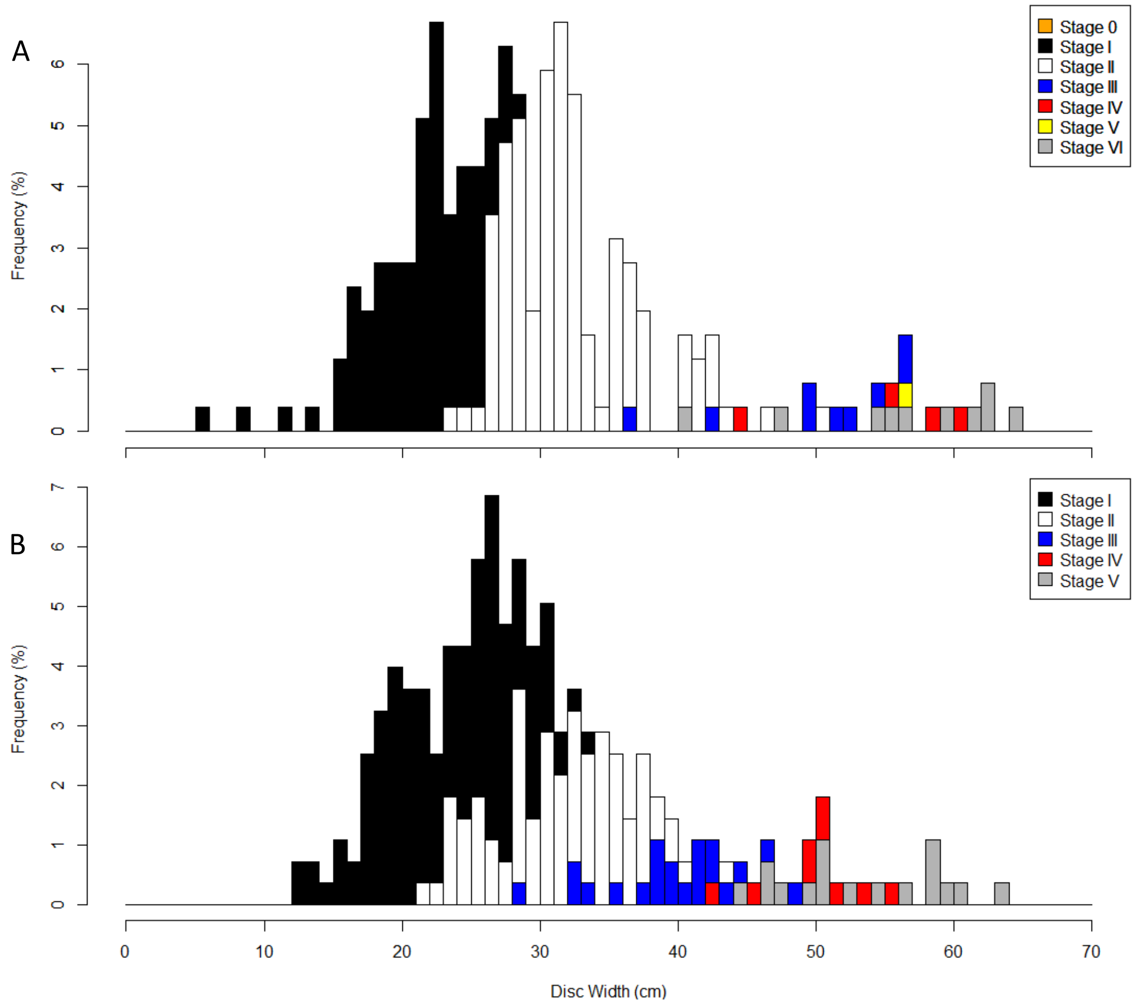


Fig 51. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja brachyurops* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 254) and (B) males (N = 277).

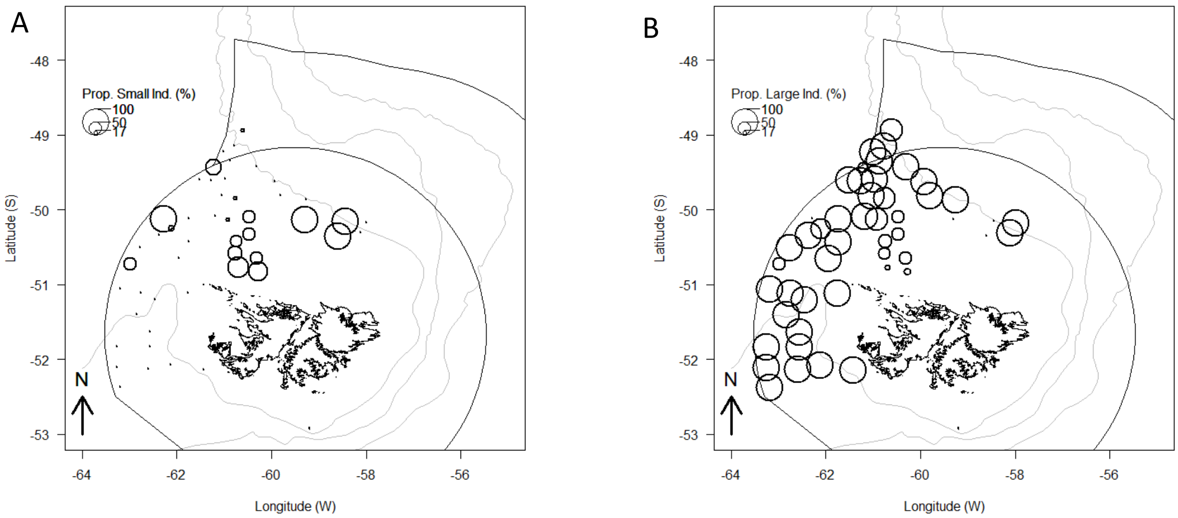


Fig 52. Distribution of the proportion (%) of (A) small (N = 281) and (B) large (N = 250) *Bathyraja brachyurops* individuals.

3.4.3 *Bathyraja cousseauae* – Joined-fin skate

The total catch of *B. cousseauae* was 26 kg (Table 2). It was caught at four of the 80 stations sampled during this cruise (5.0%) (Fig 53). Catches ranged from 0.86 to 19.52 kg. Of the four stations three yielded > 1 kg (75.0%), one > 10 kg (25.0%), and none > 50 kg. Densities for the survey area ranged from 3.94 to 92.48 kg/km^2 (Fig 53), whereas CPUE ranged from 0.86 to 19.52 kg/hr. Catches of *B. cousseauae* occurred primarily to the northeast of the survey area (Fig 53). The number of skates sampled for disc width frequency was 8 (3 females and 5 males). Female disc width ranged from 37 to 75 cm (mean of 50.33 cm) (Fig 54a), whereas males measured between 36 and 70 cm (mean of 54.40 cm) (Fig 54b). Females were observed Stage II (67%) and Stage VI (33%) (Fig 54a). Males were observed Stage I (40%), Stage II (40%) and Stage V (20%) (Fig 54b).

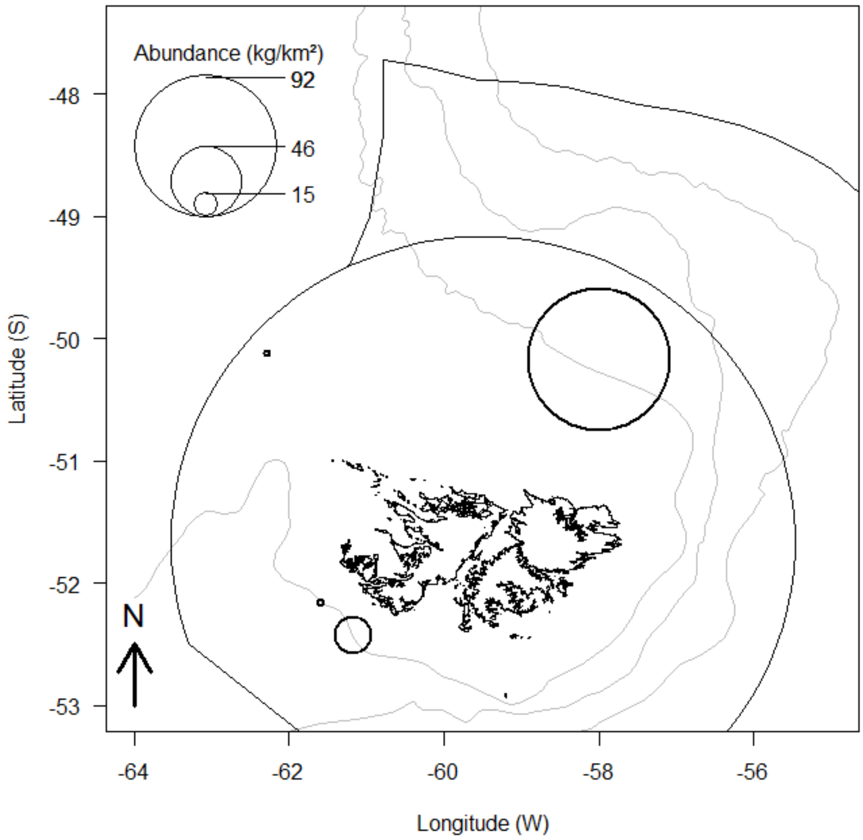


Fig 53. Distribution of densities of *Bathyraja cousseauae*.

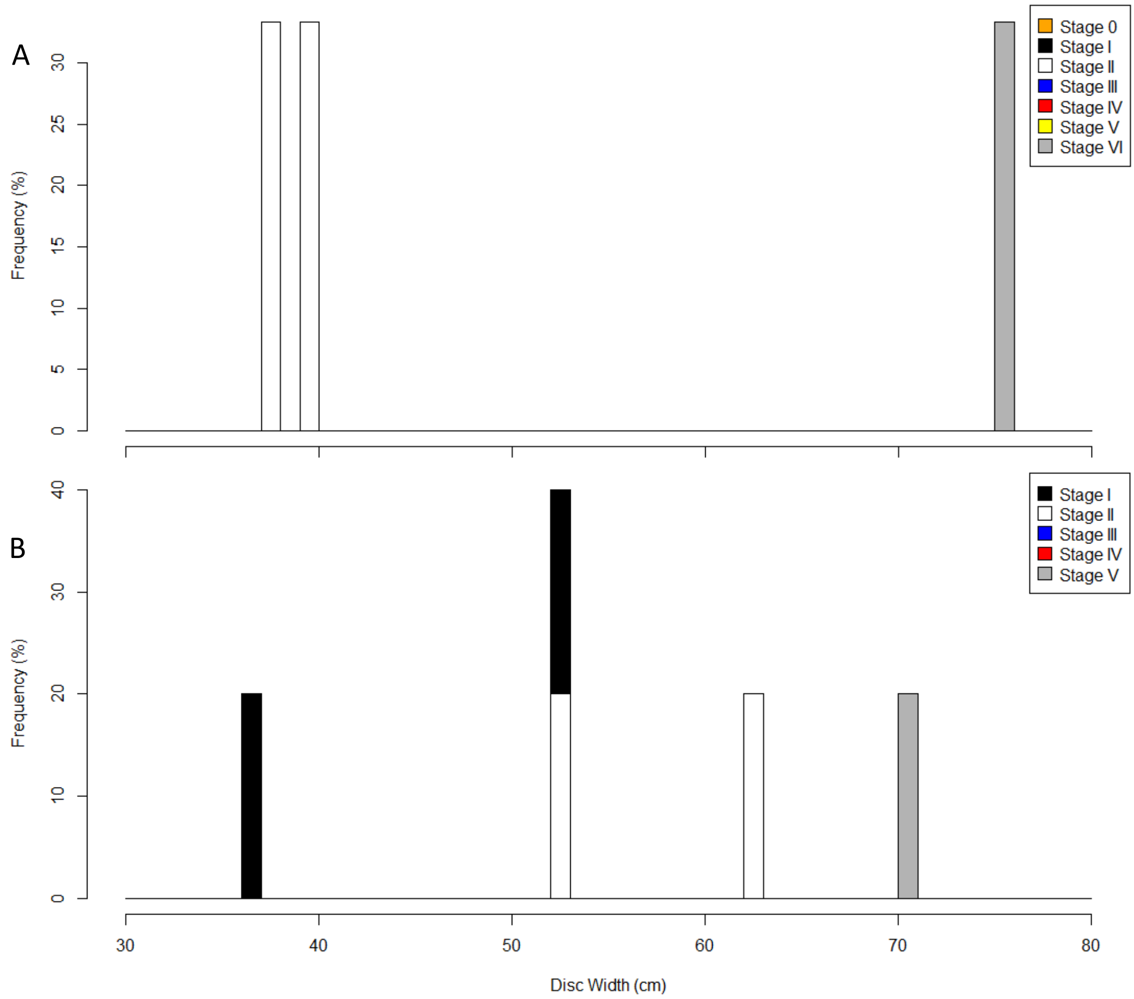


Fig 54. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja cousseauae* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 3) and (B) males (N = 5).

3.4.4 *Amblyraja doellojuradoi* – Starry skate

The total catch of *A. doellojuradoi* was 11 kg (Table 2). It was caught at 11 of the 80 stations sampled during this cruise (13.8%) (Fig 55). Catches ranged from 0.36 to 1.68 kg. Of the 11 stations four yielded > 1 kg (36.4%) and none > 10 kg. Densities for the survey area ranged from 1.59 to 8.62 kg/km^2 (Fig 55), whereas CPUE ranged from 0.36 to 1.68 kg/hr. Catches of *A. doellojuradoi* occurred primarily to the southwest and north of the survey area (Fig 55). The number of skates sampled for disc width frequency was 15 (6 females and 9 males). Female disc width ranged from 8 to 34 cm (mean of 27.17 cm) (Fig 56a), whereas males measured between 9 and 39 cm (mean of 30.00 cm) (Fig 56b). Females were observed Stage I (17%), Stage II (17%), Stage IV (50.0%), and Stage V (17%) (Fig 56a). Males were observed Stage I (11%), Stage II (22%), Stage III (22%), Stage IV (22%), and Stage V (22%) (Fig 56b).

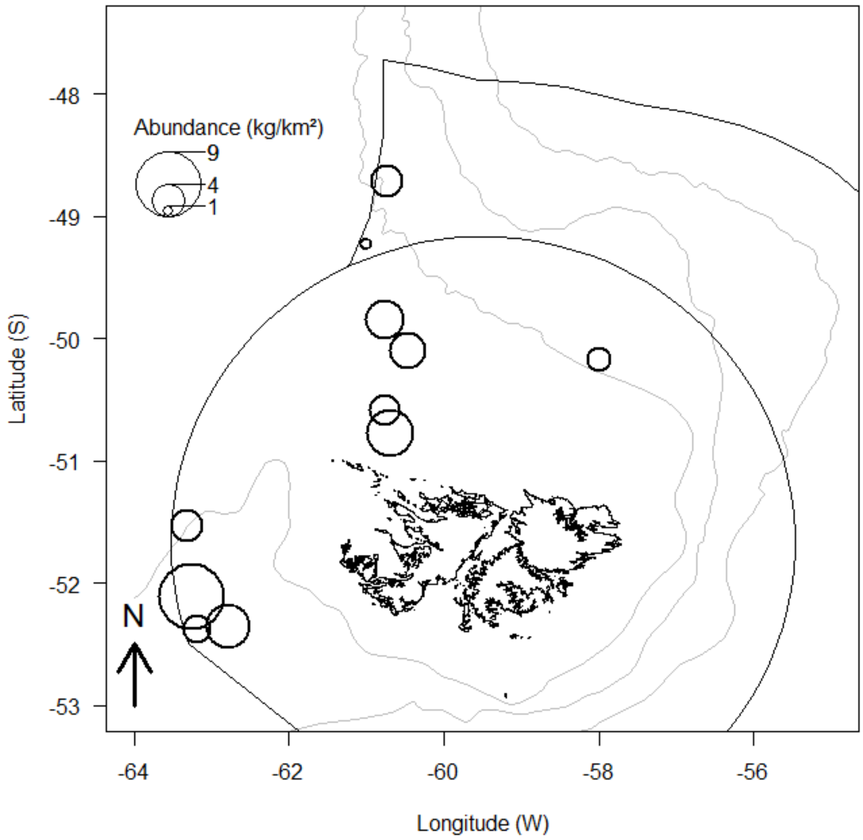


Fig 55. Distribution of densities of *Amblyraja doellojuradoi*.

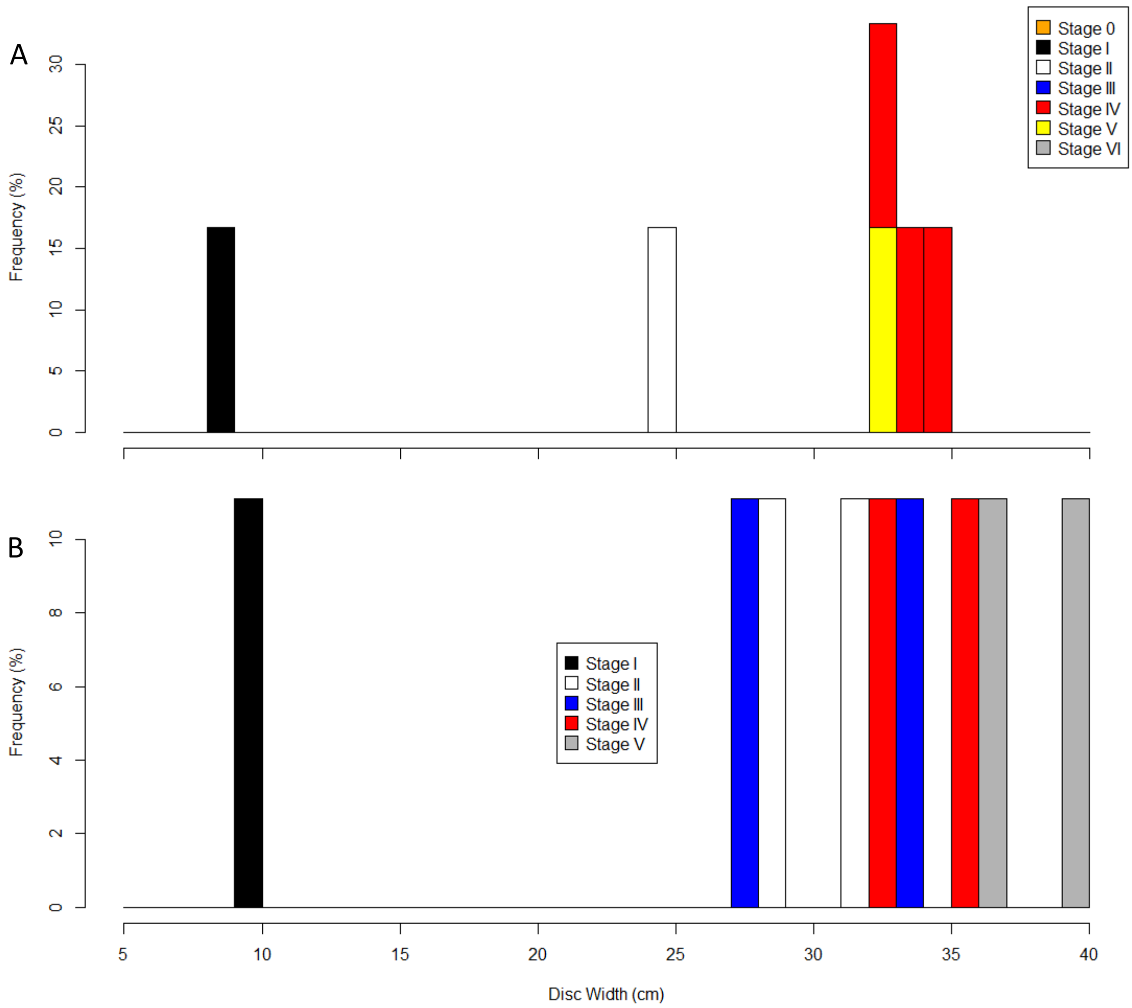


Fig 56. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Amblyraja doellojuradoi* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 6) and (B) males (N = 9).

3.4.5 *Zearaja chilensis* – Yellow nose skate

The total catch of *Z. chilensis* was 203 kg (Table 2). It was caught at 26 of the 80 stations sampled during this cruise (32.5%) (Fig 57). Catches ranged from 1.54 to 41.56 kg. Of the 26 stations 13 yielded > 5 kg (50.0%), two > 25 kg (7.7%), and none > 50 kg. Densities ranged from 6.28 to 196.86 kg/km^2 (Fig 57), whereas CPUE ranged from 1.54 to 41.56 kg/hr. Catches of *Z. chilensis* occurred primarily to the southwest and northeast of the survey area (Fig 57). The number of skates sampled for disc width frequency was 75 (65 females and 10 males). Female disc width ranged from 36 to 74 cm (mean of 55.78 cm) (Fig 58a), whereas males measured between 39 and 72 cm (mean of 49.20 cm) (Fig 58b). Females were observed Stage I (23%), Stage II (42%), Stage III (34%), and Stage VI (2%) (Fig 58a). Males were observed Stage I (20%), Stage II (30%), Stage III (40%), and Stage V (10%) (Fig 58b).

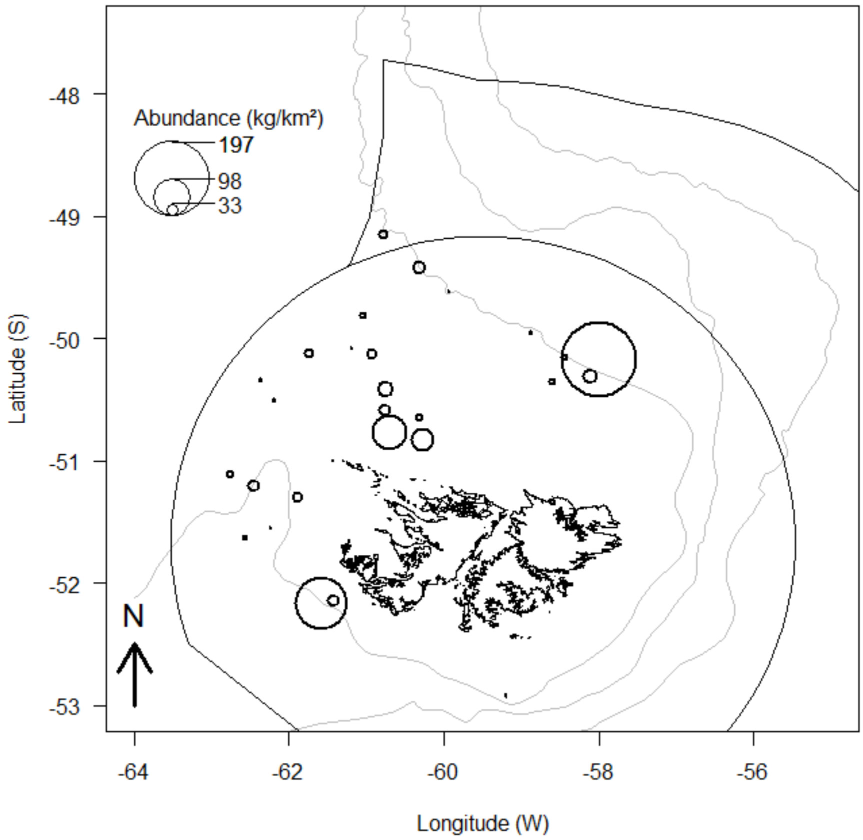


Fig 57. Distribution of densities of *Zearaja chilensis*.

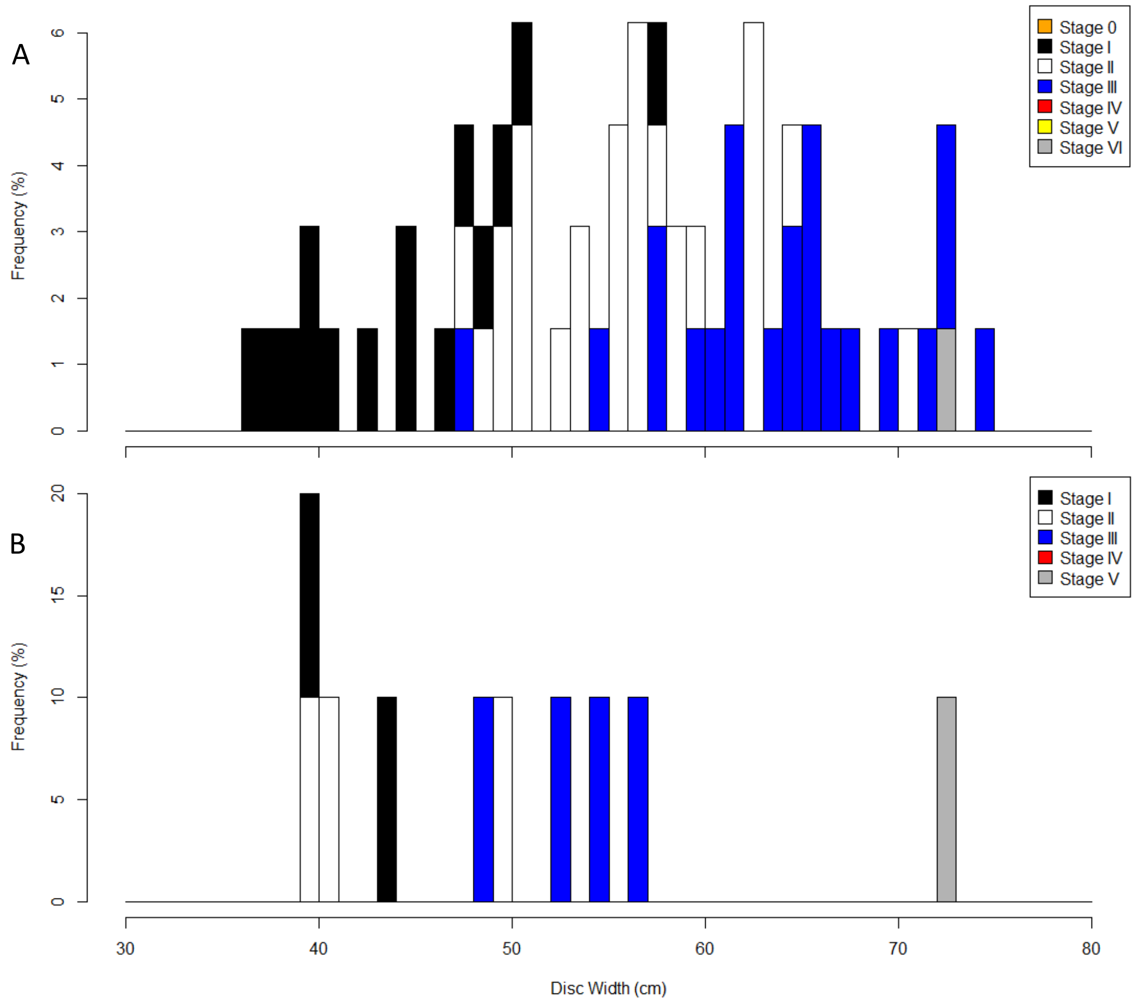


Fig 58. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Zearaja chilensis* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 65) and (B) males (N = 10).

3.4.6 *Bathyraja griseocauda* – Grey tailed skate

The total catch of *B. griseocauda* was 281 kg (Table 2). It was caught at 14 of the 80 stations sampled during this cruise (17.5%) (Fig 59). Catches ranged from 0.42 to 102.42 kg. Of the 14 stations 13 yielded > 1 kg (92.9%), nine > 10 kg (64.3%), and one > 100 kg (7.1%). Densities for the survey area ranged from 1.86 to 485.13 kg/km^2 (Fig 59) whereas CPUE ranged from 0.42 to 102.42 kg/hr. Catches of *B. griseocauda* occurred primarily to the northeast of the survey area (Fig 59). The number of skates sampled for disc width frequency was 44 (21 females and 23 males). Female disc width ranged from 17 to 99 cm (mean of 68.43 cm) (Fig 60a), whereas males measured between 19 and 87 cm (mean of 50.91 cm) (Fig 60b). Females were observed Stage I (29%), Stage II (19%), Stage III (19%), Stage IV (10%), Stage V (5%), and Stage VI (19%) (Fig 60a). Males were observed Stage I (48%), Stage II (22%), Stage IV (13%), and Stage V (17%) (Fig 60b).

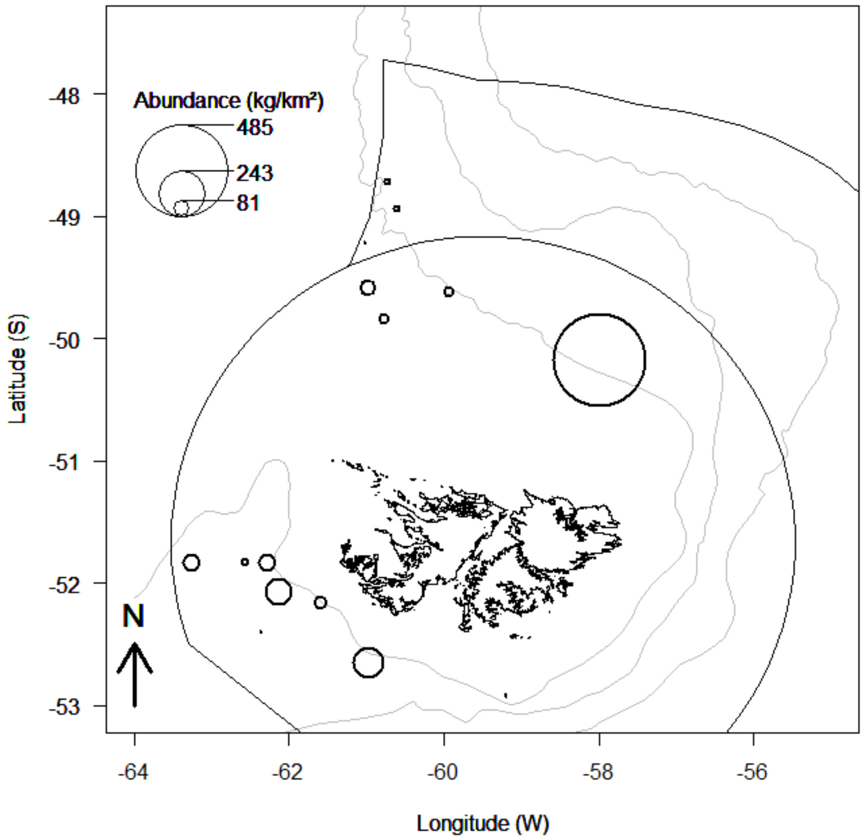


Fig 59. Distribution of densities of *Bathyraja griseocauda*.

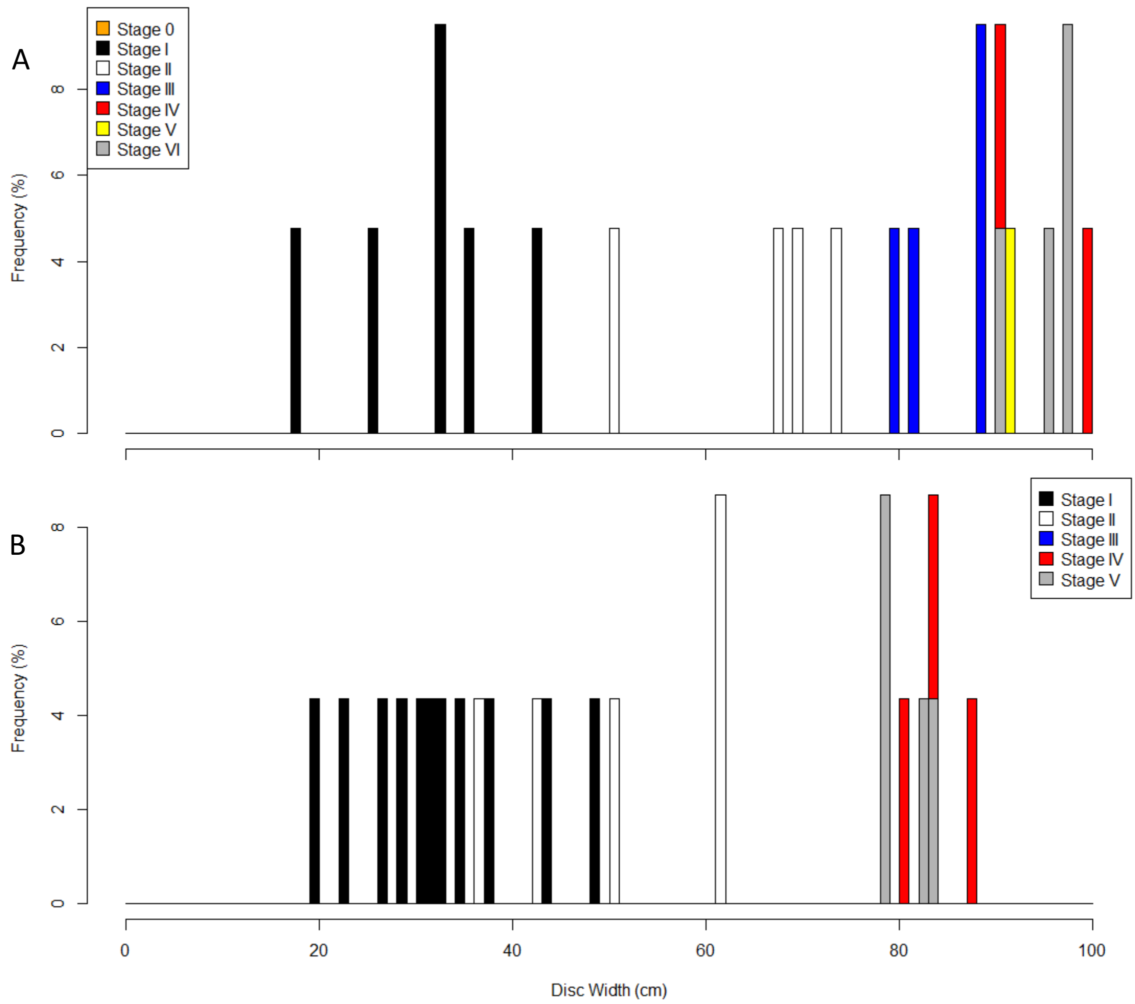


Fig 60. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja griseocauda* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 21) and (B) males (N = 23).

3.4.7 *Bathyraja macloviana* – Falkland skate

The total catch of *B. macloviana* was 34 kg (Table 2). It was caught at 24 of the 80 stations sampled during this cruise (30.0%) (Fig 61). Catches ranged from 0.04 to 4.08 kg. Of the 24 stations 15 yielded > 1 kg (62.5%) and none > 10 kg. Densities for the survey area ranged from 0.22 to 18.07 kg/km^2 (Fig 61) whereas CPUE ranged from 0.04 to 4.08 kg/hr. Catches of *B. macloviana* occurred primarily to the northwest of the survey area (Fig 61). The number of skates sampled for disc width frequency was 37 (19 females and 18 males). Female disc width ranged from 11 to 37 cm (mean of 30.47 cm) (Fig 62a), whereas males measured between 22 and 41 cm (mean of 32.72 cm) (Fig 62b). Females were observed Stage I (11%), Stage II (26%), Stage III (11%), Stage IV (26%), and Stage VI (26%) (Fig 62a). Males were observed Stage I (6%), Stage II (6%), Stage III (33%), Stage IV (6%), and Stage V (50%) (Fig 62b).

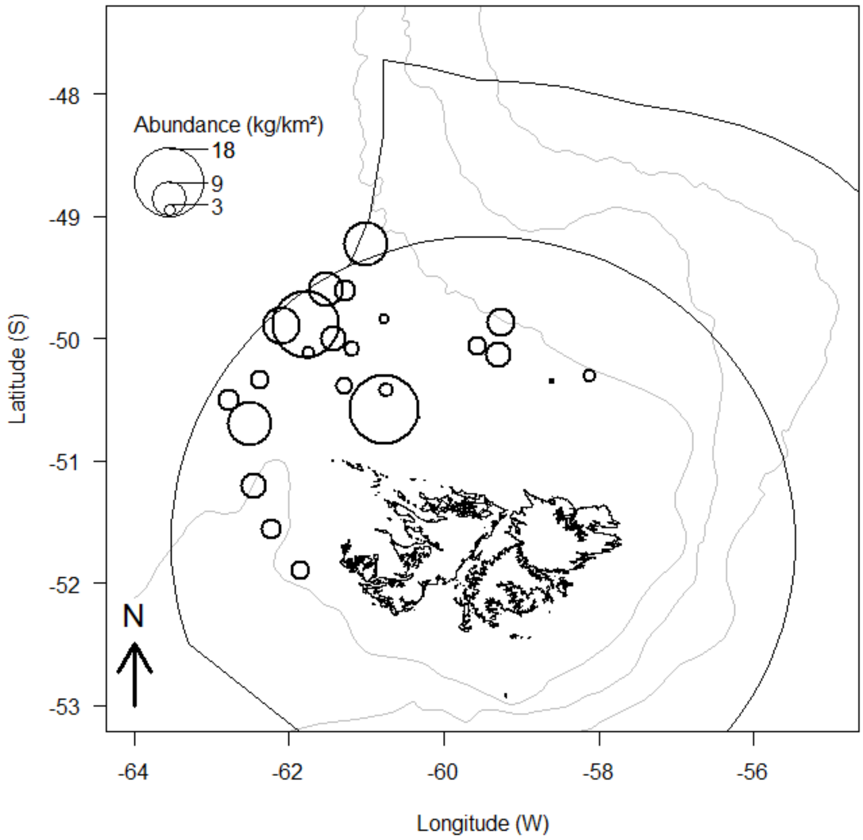


Fig 61. Distribution of densities of *Bathyraja macloviana*.

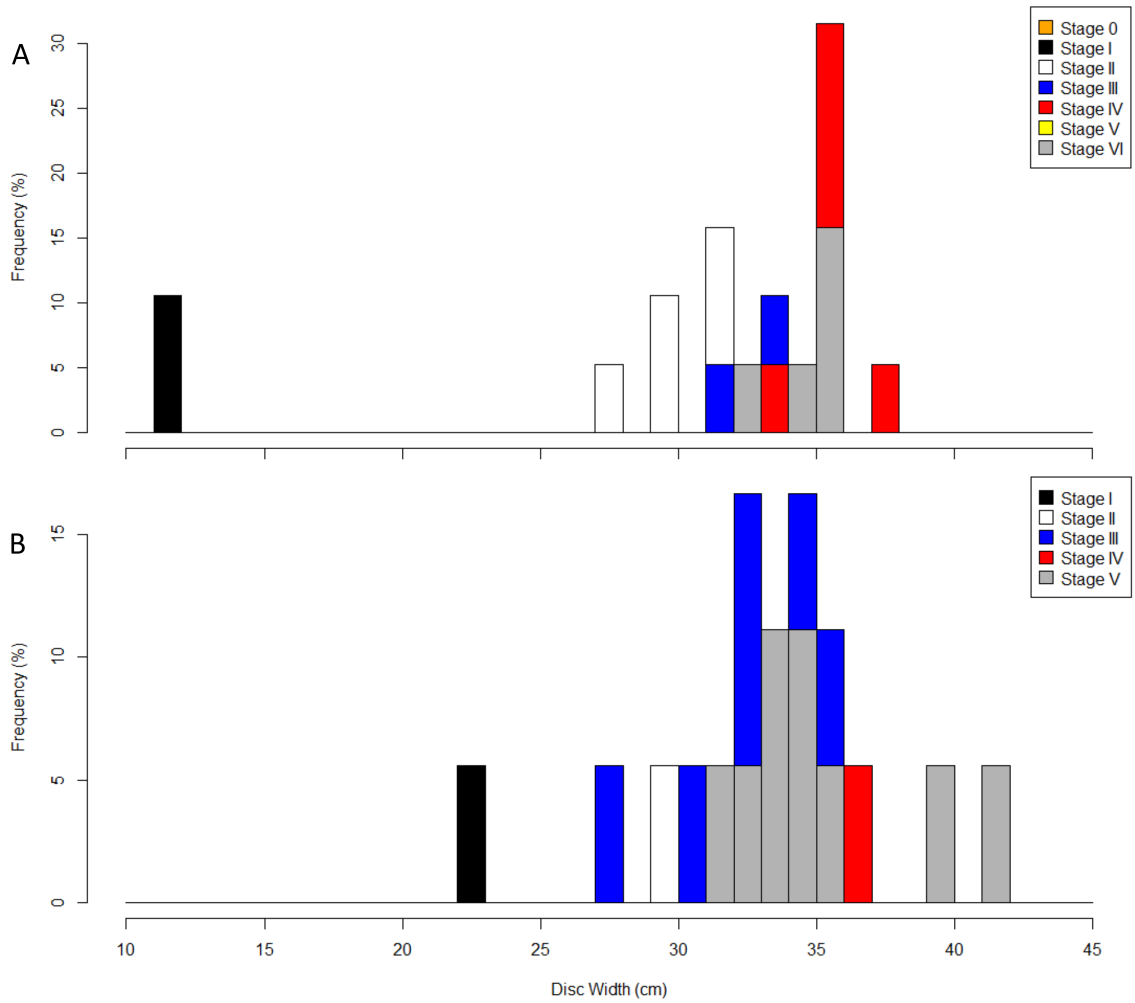


Fig 62. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja macloviana* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 19) and (B) males (N = 18).

3.4.8 *Bathyraja multispinis* – Multispined skate

The total catch of *B. multispinis* was 39 kg (Table 2). It was caught at three of the 80 stations sampled during this cruise (3.8%) (Fig 63). Catches ranged from 0.84 to 30.76 kg. Of the three stations two yielded > 1 kg (66.7%), one > 10 kg (33.3%), and none > 50 kg. Densities for the survey area ranged from 3.58 to 145.70 kg/km^2 (Fig 63) whereas CPUE ranged from 0.84 to 30.76 kg/hr. Catches of *B. multispinis* occurred primarily to the northeast of the survey area (Fig 63). The number of skates sampled for disc width frequency was 8 (3 females and 5 males). Female disc width ranged from 60 to 79 cm (mean of 71.00 cm) (Fig 64a), whereas males measured between 34 and 80 cm (mean of 61.80 cm) (Fig 64b). Females were observed Stage II (33%) and Stage III (67%) (Fig 64a). Males were observed Stage II (40%) and Stage V (60%) (Fig 64b).

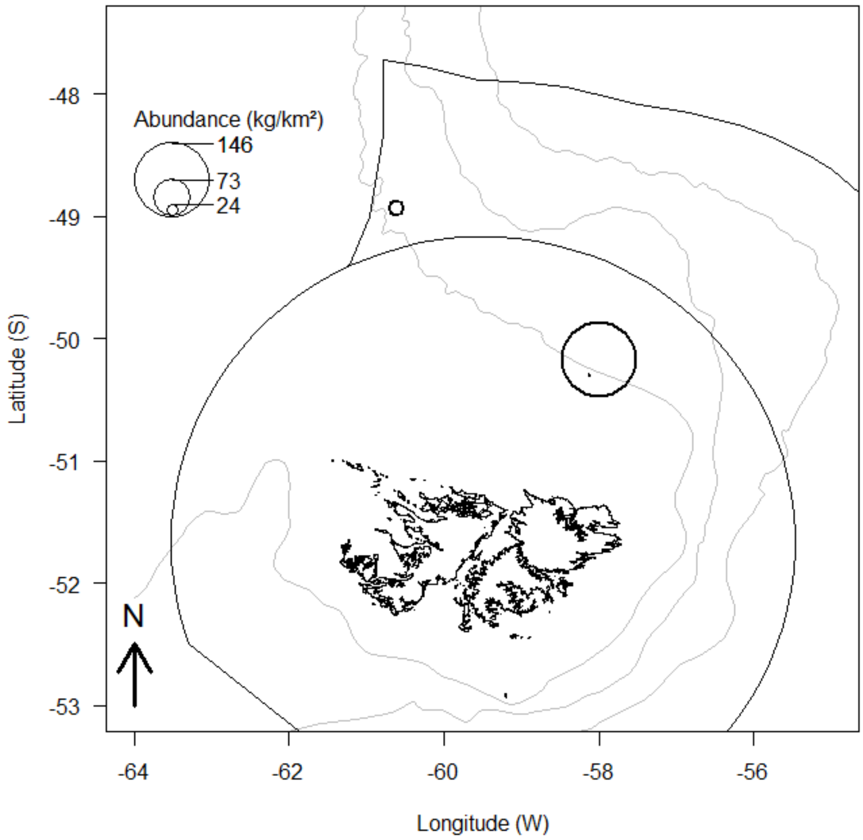


Fig 63. Distribution of densities of *Bathyraja multispinis*.

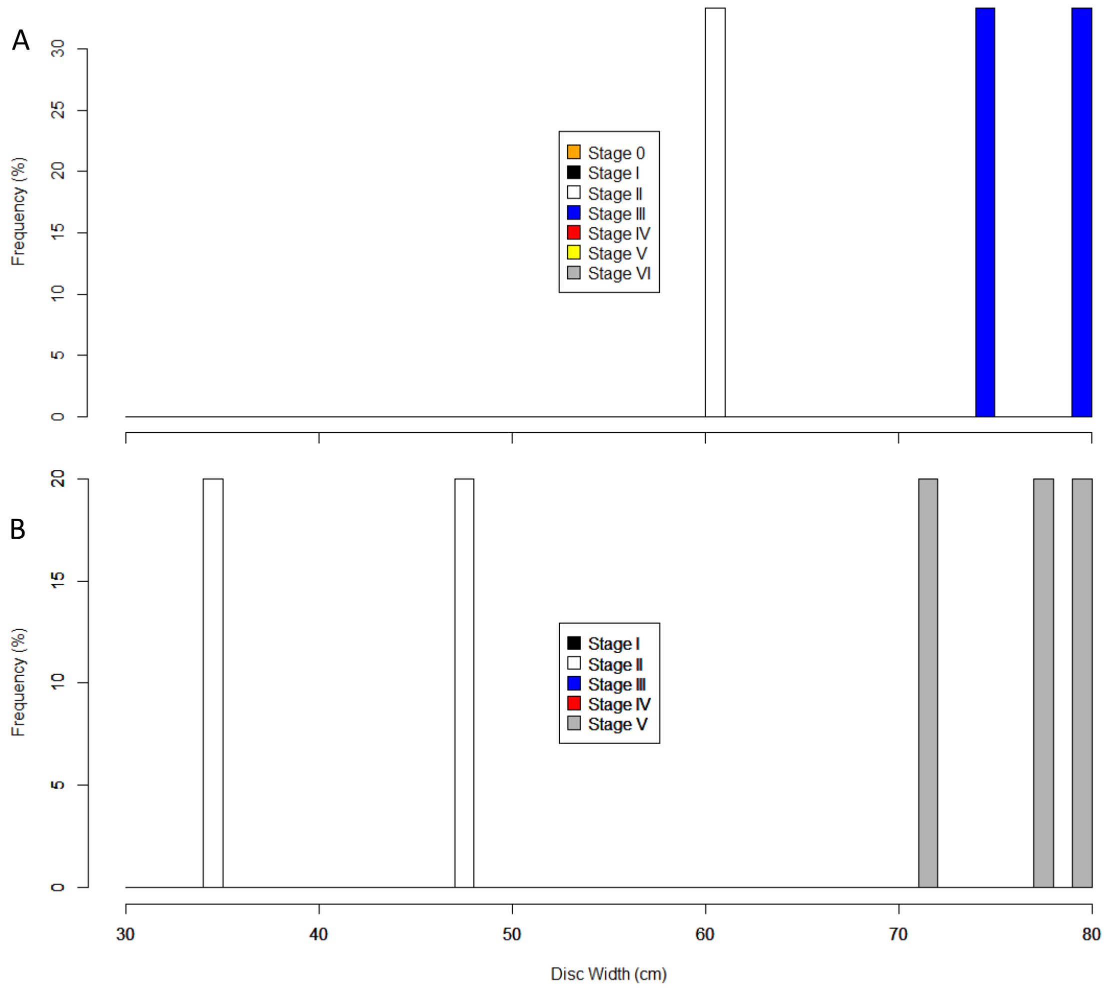


Fig 64. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja multispinis* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 3) and (B) males (N = 5).

3.4.9 *Psammobatis* spp. – Unidentified sandrays

Skates of the genus *Psammobatis* were not identified to species given the ongoing confusion with available identification guides. It is most likely that all specimens caught during this cruise are *P. normani* given that no station was shallower than 120 m. However, erring with caution, we refrain from identifying these to species. The total catch of *Psammobatis* spp. was 12 kg (Table 2). It was caught at 16 of the 80 stations sampled during this cruise (20.0%) (Fig 65). Catches ranged from < 0.01 to 3.62 kg. Of the 16 stations three yielded > 1 kg (18.8%) and none > 10 kg. Densities for the survey area ranged from 0.02 to 14.23 kg/km^2 (Fig 65) whereas CPUE ranged from < 0.01 to 3.62 kg/hr. Catches of *Psammobatis* spp. occurred primarily to the northwest of the survey area (Fig 65). The number of skates sampled for disc width frequency was 24 (13 females and 11 males). Female disc width ranged from 16 to 29 cm (mean of 24.15 cm) (Fig 66a), whereas males measured between 5 and 31 cm (mean of 23.18 cm) (Fig 66b). Females were observed Stage I (8%), Stage II (8%), Stage III (15%), Stage IV (23%), and Stage VI (46%) (Fig 66a). Males were observed Stage I (18%), Stage III (18%), Stage IV (9%), and Stage V (55%) (Fig 66b).

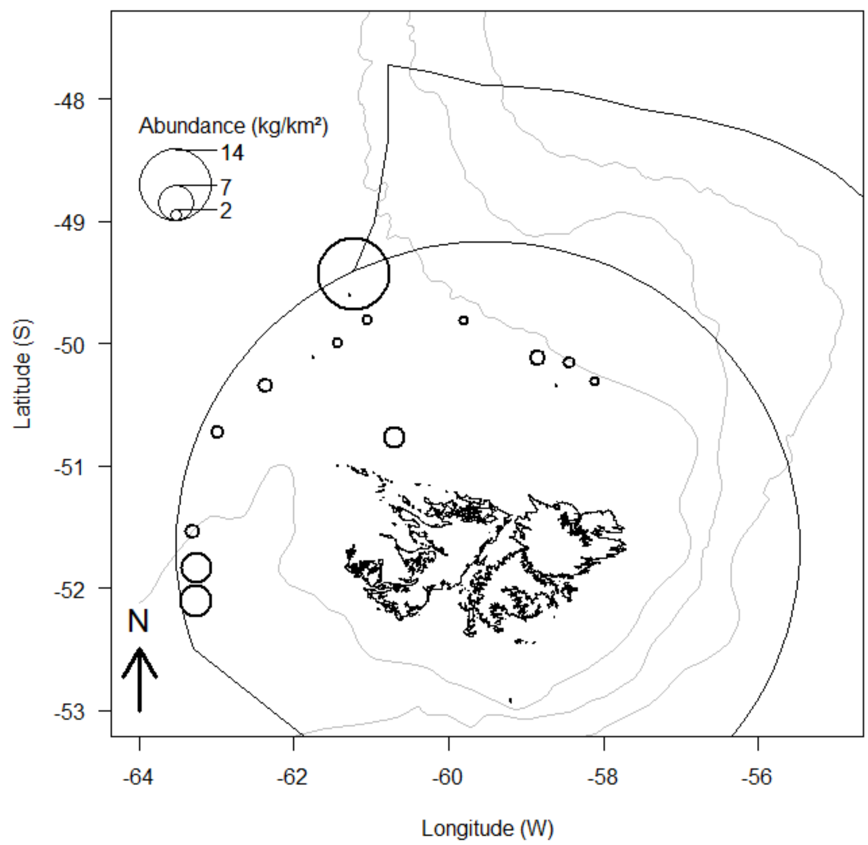


Fig 65. Distribution of densities of *Psammobatis* spp.

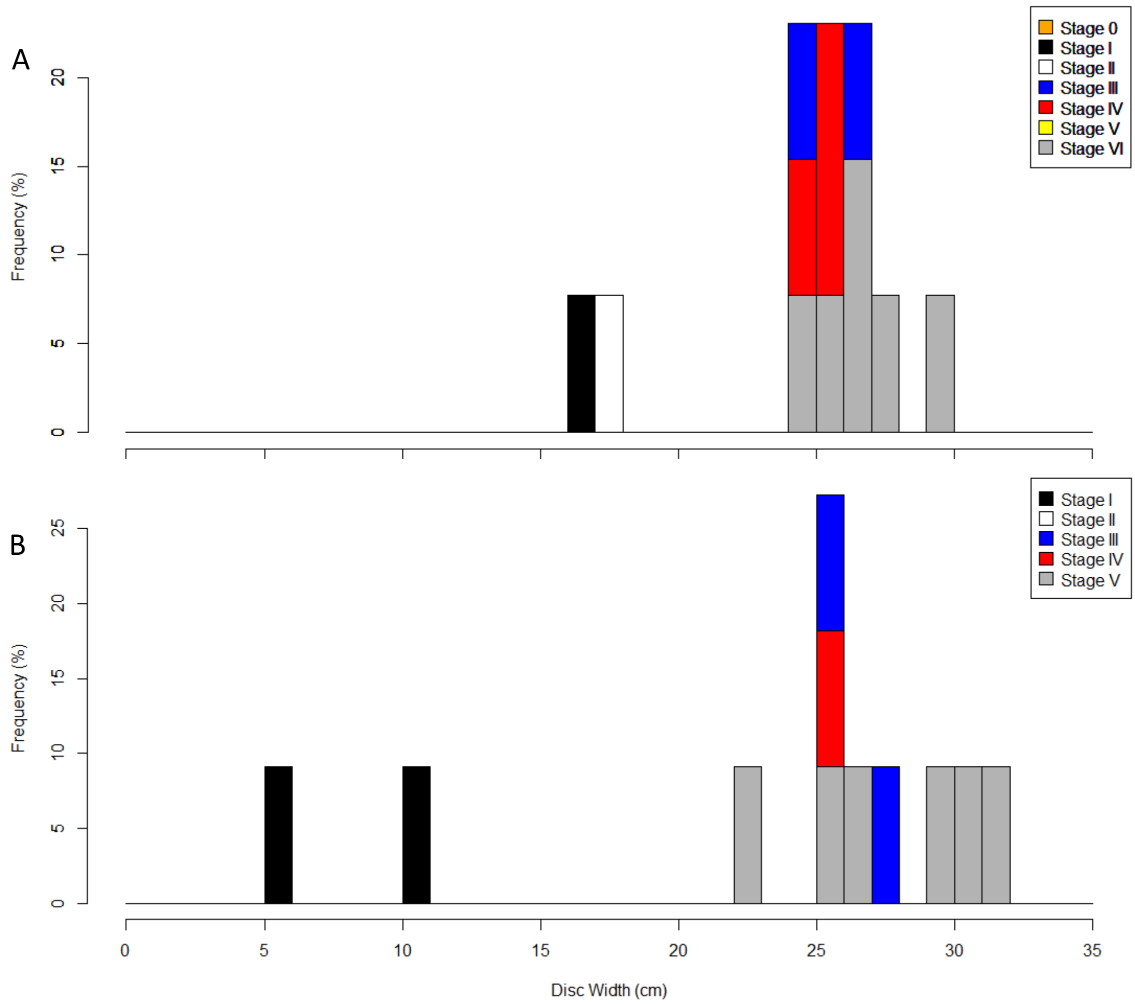


Fig 66. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Psammobatis* spp. with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 13) and (B) males (N = 11).

3.4.10 *Bathyraja scaphiops* – Cuphead skate

The total catch of *B. scaphiops* was 9 kg (Table 2). It was caught at four of the 80 stations sampled during this cruise (5.0%) (Fig 67). Catches ranged from 1.70 to 3.34 kg. Of the four stations all yielded > 1 kg and none > 10 kg. Densities for the survey area ranged from 9.12 to 15.82 kg/km^2 (Fig 67) whereas CPUE ranged from 1.70 to 3.34 kg/hr. Catches of *B. scaphiops* occurred primarily to the north and northeast of the survey area (Fig 67). The number of skates sampled for disc width frequency was 5 (2 females and 3 males). Female disc width was 51 and 52 cm, respectively (Fig 68a), whereas males measured between 43 and 48 cm (mean of 45.67 cm) (Fig 68b). Females were observed Stage III (50%) and Stage IV (50%) (Fig 68a). Males were observed Stage III (33%) and Stage V (67%) (Fig 68b).

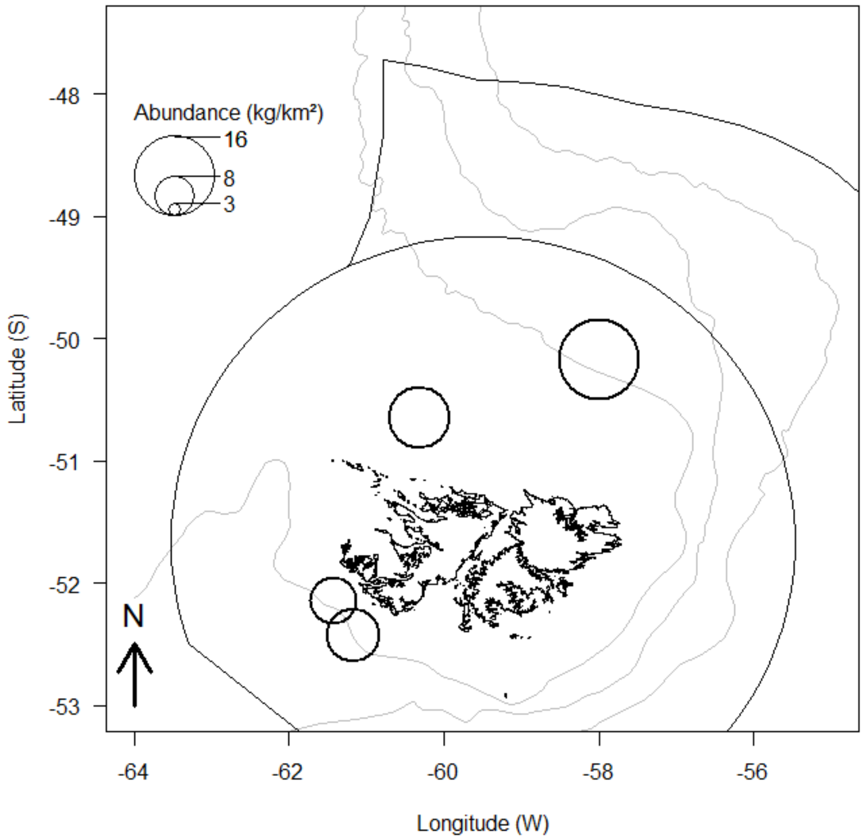


Fig 67. Distribution of densities of *Bathyraja scaphiops*.

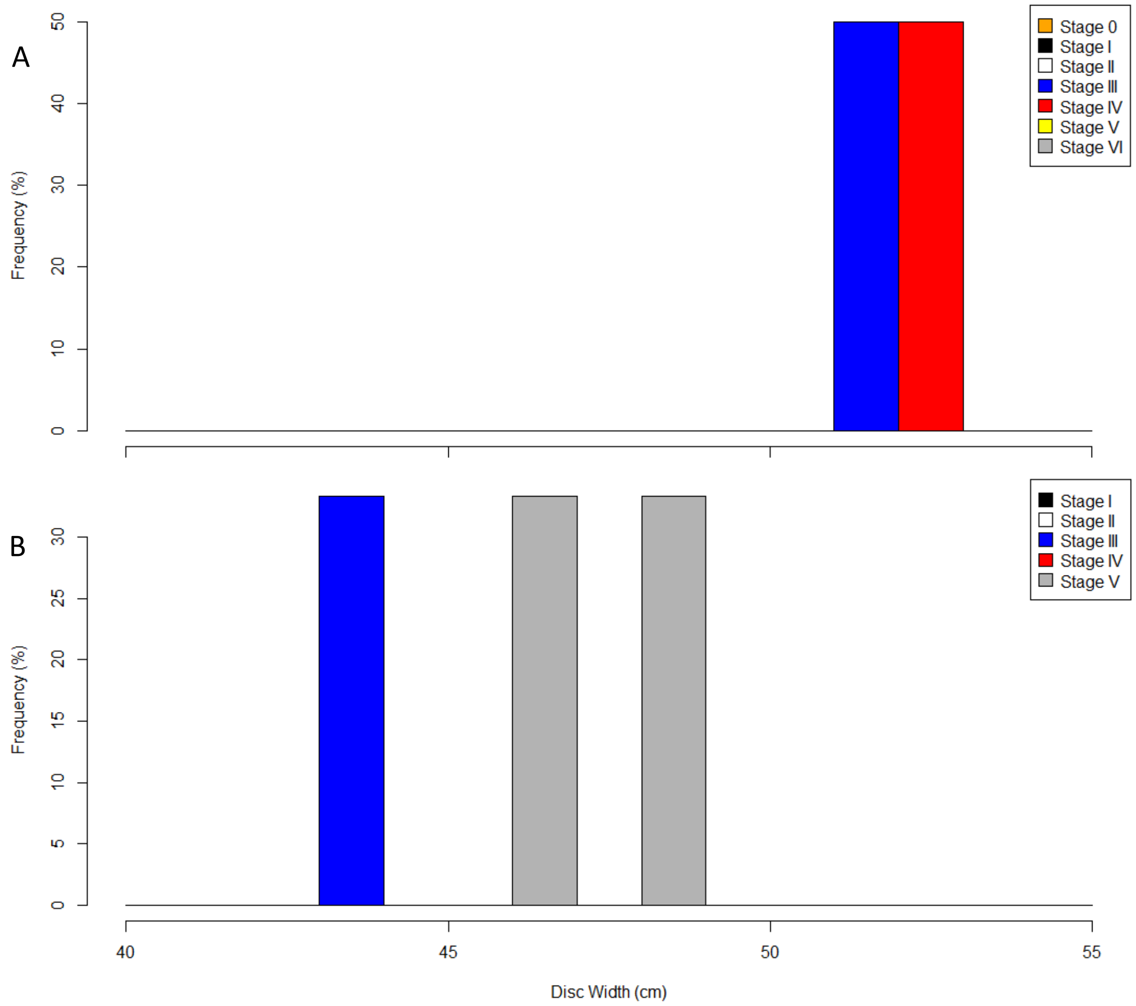


Fig 68. Width frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Bathyraja scaphiops* with associated maturity stages (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 2) and (B) males (N = 3).

3.5 Biological information on shark species

3.5.1 *Schroederichthys bivius* – Narrowmouthed catshark

The total catch of *S. bivius* was 146 kg (Table 2). It was caught at 55 of the 80 stations sampled during this cruise (68.8%) (Fig 69). Catches ranged from 0.12 to 10.06 kg. Of the 55 stations 38 yielded > 1kg (69.1%), one > 10 kg (1.8%), and none > 100 kg. Densities ranged from 0.57 to 46.66 kg/km^2 (Fig 69) whereas CPUE ranged from 0.12 to 10.06 kg/hr. Catches of *S. bivius* occurred throughout the survey area, but primarily in the northwest in shallower waters of the survey area (Fig 69). The number of sharks sampled for length frequency was 387 (227 females and 160 males). Female T_L ranged from 28 to 61 cm (mean of 48.63 cm) (Fig 70a), whereas males measured between 25 and 79 cm (mean of 54.04 cm) (Fig 70b). Females were observed Stage I (15%), Stage II (21%), Stage III (9%), Stage IV (30%), Stage V (9%), and Stage VI (11%) (Fig 70a). The maturity was not assessed for 5% of individual female sharks. Males were observed Stage I (39%), Stage II (16%), Stage III (19%), Stage IV (24%), and Stage V (2%) (Fig 70b). Most small individuals, smaller or equal to the median T_L of 51 cm for females (N = 139) and 53.5 cm for males (N = 80), were found in the northwest of the sampling area (Fig 71a), whereas larger individuals (88 females and 80 males) were caught mostly in the north of the sampling area (Fig 71b).

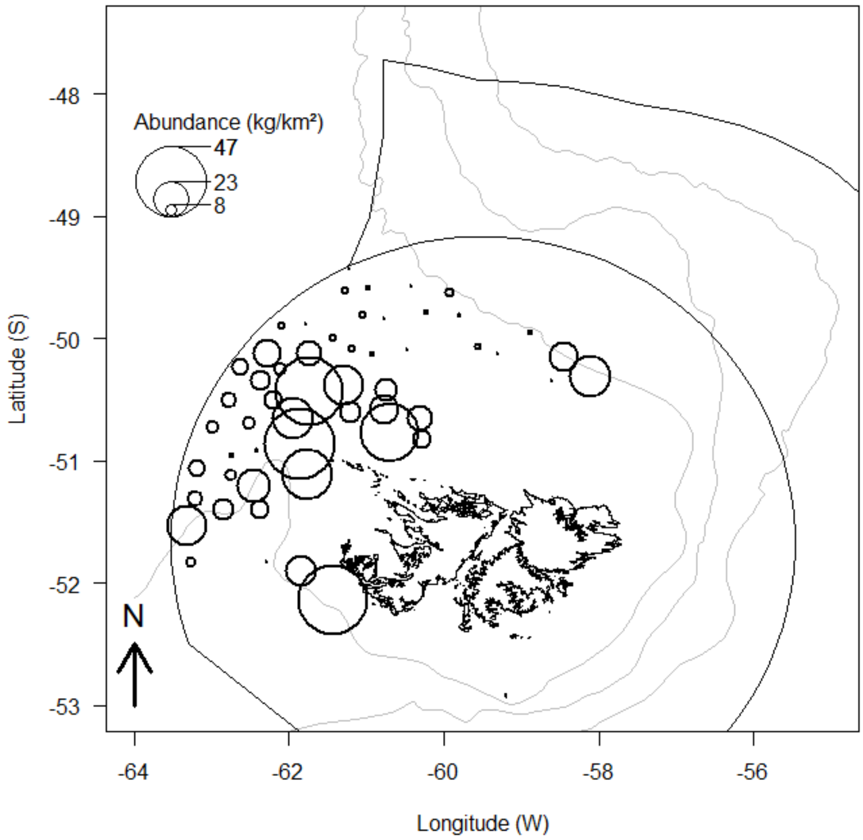


Fig 69. Distribution of densities of *Schroederichthys bivius*.

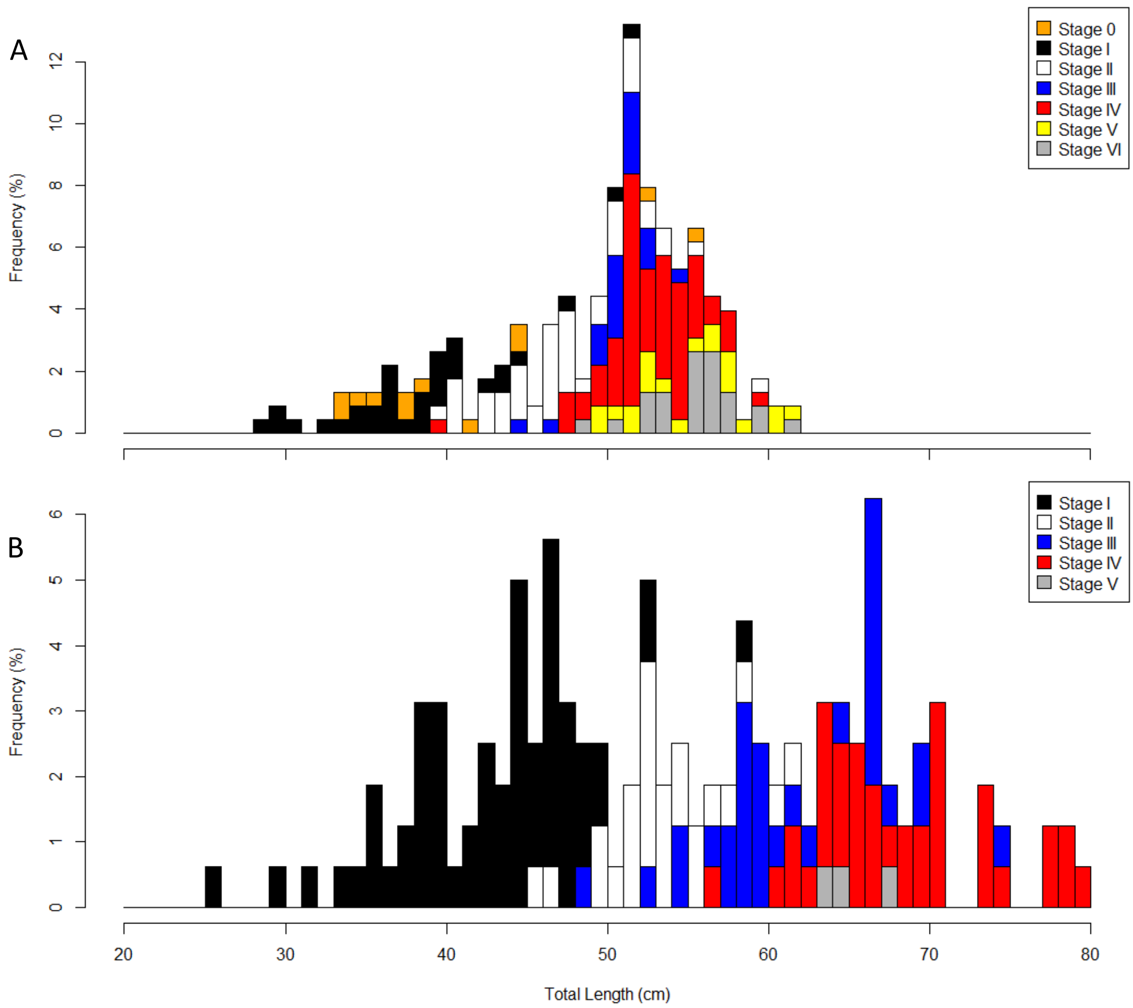


Fig 70. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Schroederichthys bivius* with associated maturity stages (0, not assessed; I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 227) and (B) males (N = 160).

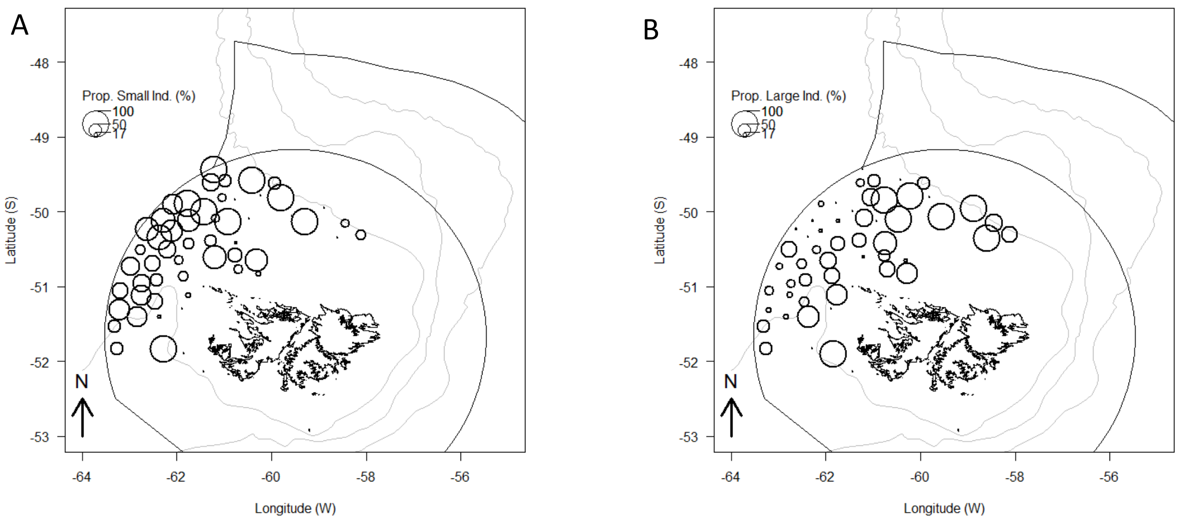


Fig 71. Distribution of the proportion (%) of (A) small (N = 219) and (B) large (N = 168) *Schroederichthys bivius* individuals.

3.5.2 *Squalus acanthias* – Spurdog

The total catch of *S. acanthias* was 494 kg (Table 2). It was caught at 32 of the 80 stations sampled during this cruise (40.0%) (Fig 72). Catches ranged from 0.87 to 118.53 kg. Of the 32 stations 14 yielded > 5kg (43.8%), seven > 25 kg (21.9%), and one > 100 kg (3.1%). Densities ranged from 4.24 to 534.46 kg/km^2 (Fig 72) whereas CPUE ranged from 0.87 to 118.53 kg/hr. Catches of *S. acanthias* occurred primarily in the north and northeast along the 200 m isobath of the survey area (Fig 72). The number of sharks sampled for length frequency was 283 (77 females and 206 males). Female T_L ranged from 55 to 89 cm (mean of 69.99 cm) (Fig 73a), whereas males measured between 58 and 78 cm (mean of 68.65 cm) (Fig 73b). Females were observed Stage I (1%), Stage II (16%), Stage III (23%), Stage IV (9%) and Stage V (8%) (Fig 73a). The maturity was not assessed for 43% of individual female sharks (Stage 0). Males were observed Stage III (5%), Stage IV (70%), and Stage V (25%) (Fig 73b). Most small individuals, smaller or equal to the median T_L of 69 cm for females (N = 39) and 68.5 cm for males (N = 103), were found in shallower waters of the sampling area (Fig 74a), whereas larger individuals (38 females and 103 males) were caught mostly in deeper waters of the sampling area (Fig 74b).

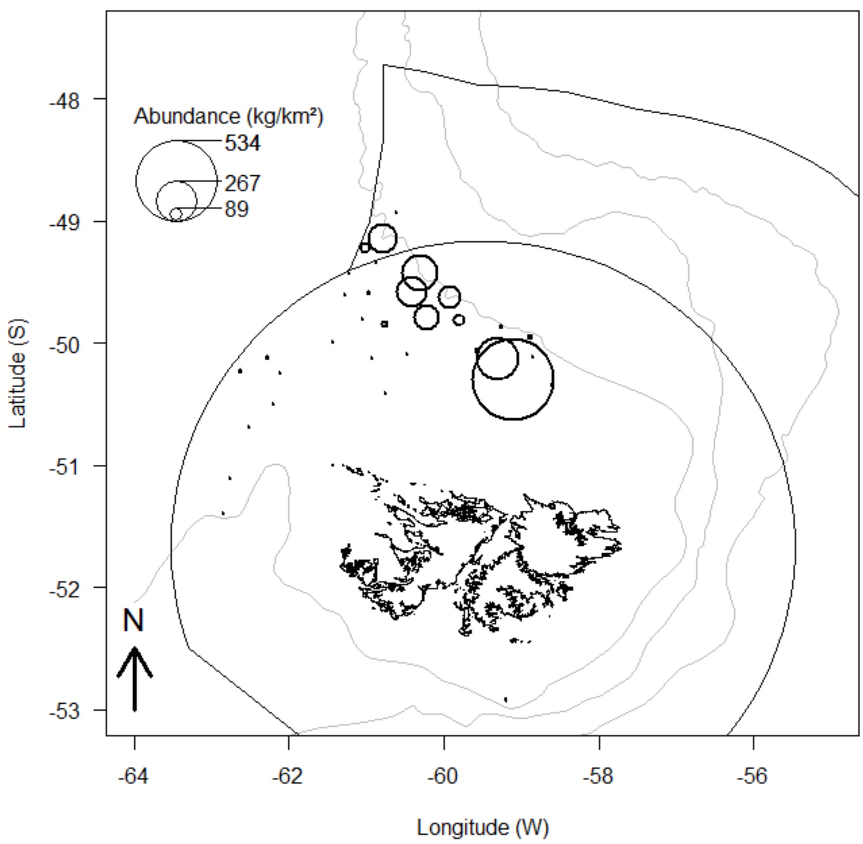


Fig 72. Distribution of densities of *Squalus acanthias*.

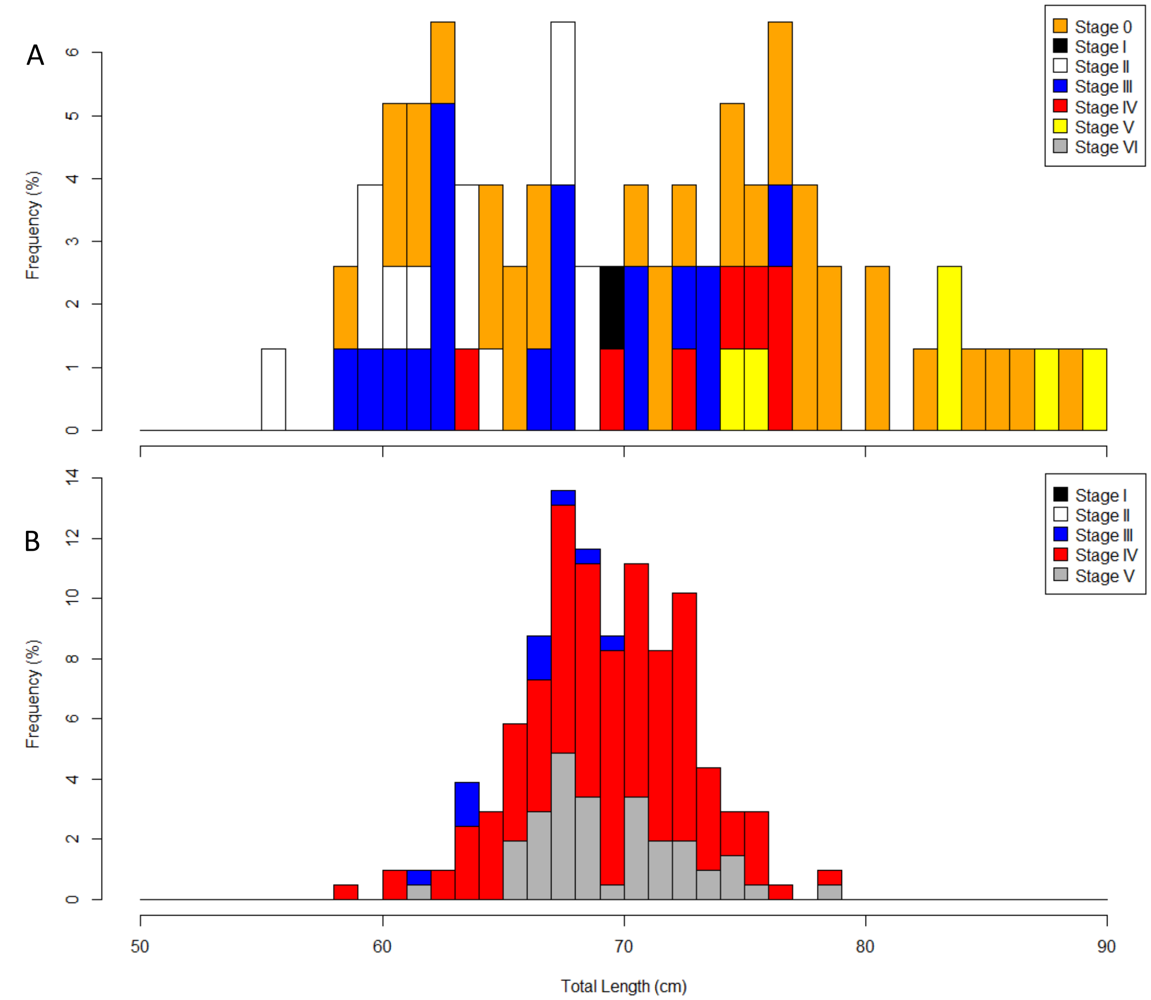


Fig 73. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Squalus acanthias* with associated maturity stages (0, not assessed; I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting) for (A) females (N = 77) and (B) males (N = 206).

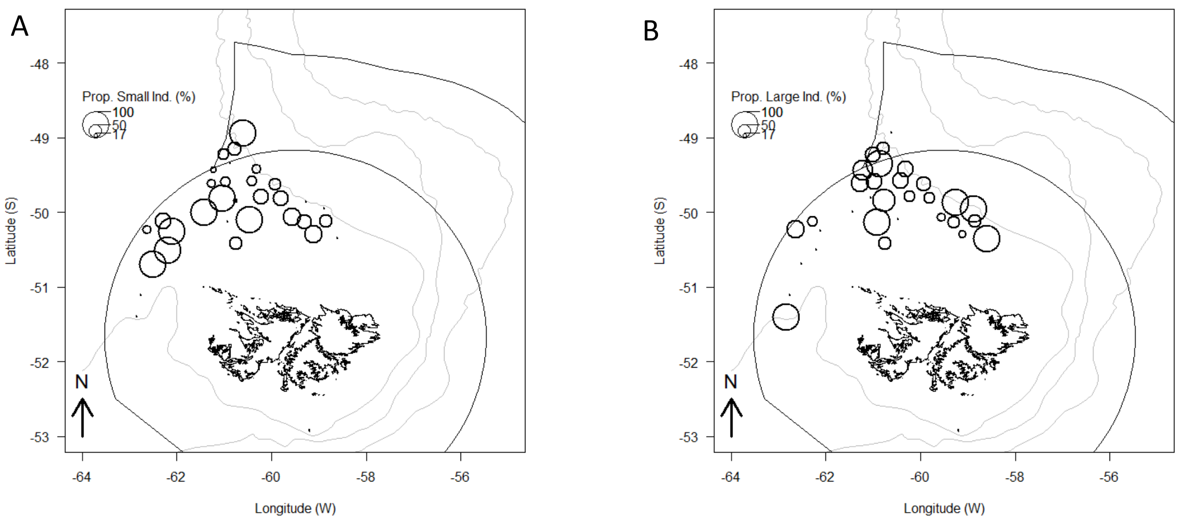


Fig 74. Distribution of the proportion (%) of (A) small (N = 142) and (B) large (N = 141) *Squalus acanthias* individuals.

3.6 Inshore stations

A total of 1,854.6 kg of biomass, comprised of 61 species, was caught in the four shallow inshore stations (Stations 2968, 2970, 2971, and 2976; Fig 1). The majority of the catch consisted of *Munida gregaria* (84.5%); the only species to exceed 100 kg (Table 3). The top five species by catch consisted of *M. gregaria*, the squid *D. gahi* (77.06 kg; 4.2%), and three teleosts: *Champsocephalus esox* (55.45 kg; 3.0%), *P. ramsayi* (45.09 kg; 2.4%), and *Patagonotothen tessellatta* (23.78 kg; 1.3%) (Table 3). The remaining 56 species made up 4.6% (85.93 kg) (Table 3). The catch included five commercial species (*D. gahi*, *P. ramsayi*, *Bathyraja magellanica*, *S. australis,* and *M. australis*) for a total of 125.44 kg or 6.8% of the total catch.

Table 3. Catch composition by weight of all species caught during the demersal survey (ZDLT1-02-2020) at four shallow inshore stations with information on sample weights and discards.

Species code	Latin name	Total catch (kg)	Total sampled (kg)	Total discarded (kg)	No. Stations	% of catch
MUG	*Munida gregaria*	1,567.336	2.130	1,566.586	4	84.51
LOL	*Doryteuthis gahi*	77.062	8.220	8.220	4	4.16
CHE	*Champsocephalus esox*	55.445	7.870	49.821	4	2.99
PAR	*Patagonotothen ramsayi*	45.089	11.232	33.682	4	2.43
PTE	*Patagonotothen tessellatta*	23.784	1.328	22.456	4	1.28
SPN	Porifera	19.526	-	19.526	4	1.05
ALF	*Allothunnus fallai*	14.045	14.045	14.045	1	0.76
LIS	*Lithodes santolla*	11.136	-	1.916	3	0.60
DGH	*Schroederichthys bivius*	6.704	-	6.704	3	0.36
CGO	*Cottoperca gobio*	5.838	1.500	4.952	4	0.31
GOC	*Gorgonocephalus chilensis*	3.706	-	3.706	3	0.20
WRM	*Chaetopterus variopedatus*	3.511	-	3.511	4	0.19
RMG	*Bathyraja magellanica*	3.212	-	3.212	2	0.17
PAG	*Paralomis granulosa*	3.148	-	3.148	1	0.17
ALG	Algae	3.013	-	3.013	4	0.16
SQT	Ascidiacea	1.784	-	1.784	4	0.10
ANM	Anemone	1.624	-	1.624	2	0.09
BUT	*Stromateus brasiliensis*	1.338	1.338	1.338	4	0.07
PYR	Pyrosome	1.215	-	1.162	3	0.07
OCT	*Octopus* spp.	0.922	-	0.922	1	0.05
HYD	Hydrozoa	0.782	-	0.782	4	0.04
COG	*Patagonotothen guntheri*	0.674	0.674	0.660	3	0.04
SUN	*Labidaster radiosus*	0.500	-	0.500	3	0.03
BRY	Bryozoa	0.428	-	0.428	4	0.02
FUM	*Fusitriton m. magellanicus*	0.342	-	0.342	1	0.02
EUL	*Eurypodius latreillei*	0.220	-	0.220	4	0.01
ZYP	*Zygochlamys patagonica*	0.208	-	0.208	1	0.01
AST	Asteroidea	0.200	-	0.200	4	0.01
OCC	Octocorals	0.190	-	0.190	1	0.01
ARD	*Arbacia dufresnii*	0.154	-	0.154	2	0.01
EUO	*Eurypodius longirostris*	0.150	-	0.150	4	0.01
CRY	*Crossaster* sp.	0.146	-	0.146	1	0.01
GOR	Alcyonacea	0.126	-	0.126	3	0.01
SRP	*Semirossia patagonica*	0.114	-	0.114	3	0.01
NUD	Nudibranchia	0.110	-	0.110	4	0.01
ALC	*Alcyoniina*	0.095	-	0.095	1	0.01
CEX	*Ceramaster* sp.	0.073	-	0.073	1	<0.01
CYX	*Cycethra* sp.	0.070	-	0.070	3	<0.01
SAR	*Sprattus fuegensis*	0.070	0.070	0.070	1	<0.01

Species code	Latin name	Total catch (kg)	Total sampled (kg)	Total discarded (kg)	No. Stations	% of catch
POA	*Porania antarctica*	0.065	-	0.065	2	<0.01
HCR	Paguroidea	0.059	-	0.059	3	<0.01
AUC	*Austrocidaris canaliculata*	0.054	-	0.054	3	<0.01
HEX	*Henricia* sp.	0.044	-	0.044	3	<0.01
AGO	*Agonopsis chilensis*	0.040	-	0.040	2	<0.01
CAV	*Campylonotus vagans*	0.040	-	0.040	2	<0.01
PES	*Peltarion spinosulum*	0.038	-	0.038	2	<0.01
BAC	*Salilota australis*	0.038	0.038	-	1	<0.01
BLU	*Micromesistius australis*	0.038	0.038	-	1	<0.01
BAL	*Bathydomus longisetosus*	0.036	-	0.036	1	<0.01
CAZ	*Calyptraster* sp.	0.017	-	0.017	2	<0.01
PSX	Psolidae sp.	0.014	-	0.014	1	<0.01
MUU	*Munida subrugosa*	0.010	-	0.010	1	<0.01
GAY	Gastropoda	0.008	-	0.008	2	<0.01
OPH	Ophiuroidea	0.007	-	0.007	2	<0.01
POL	Polychaeta	0.006	-	0.006	2	<0.01
PYX	Pycnogonida	0.005	-	0.005	2	<0.01
HOL	Holothuroidea	0.005	-	0.005	1	<0.01
MAV	*Magellania venosa*	0.005	-	0.005	1	<0.01
CRI	Crinoidea	0.002	-	0.002	1	<0.01
EGG	Eggmass	0.002	-	0.002	1	<0.01
ISO	Isopoda	0.001	-	0.001	1	<0.01

3.6.1 *Munida gregaria* – Lobster krill

The total catch of *M. gregaria* was 1,567 kg (Table 3). It was caught at all four shallow inshore stations sampled during this cruise (Fig 75). Catches ranged from 87.04 to 749.06 kg (Fig 75). Of the four stations all yielded > 10kg, three > 100 kg (75.0%), and one > 500 kg (25.0%). CPUE ranged from 88.52 to 749.06 kg/hr. The number of *M. gregaria* sampled for length frequency was 379 (151 females and 228 males). Female cephalothorax length ranged from 1.4 to 2.2 cm (mean of 1.80 cm) (Fig 76a), whereas males measured between 1.5 and 2.4 cm (mean of 1.80 cm) (Fig 76b).

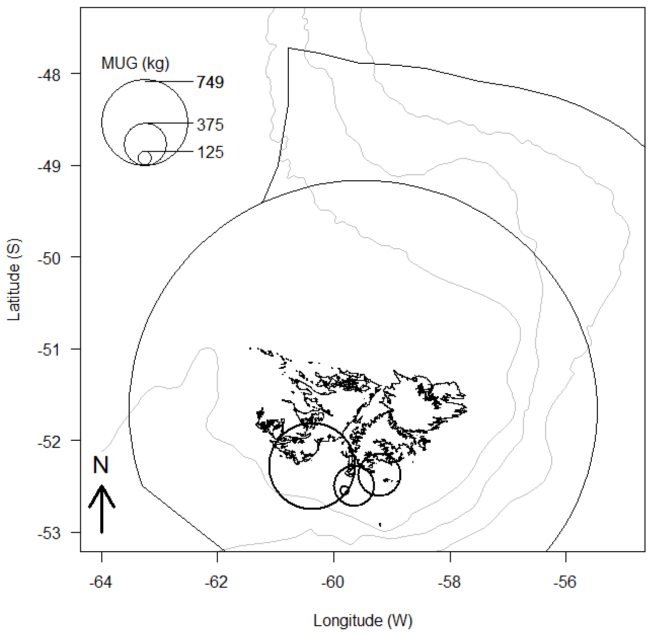


Fig 75. Distribution of catches of *Munida gregaria*.

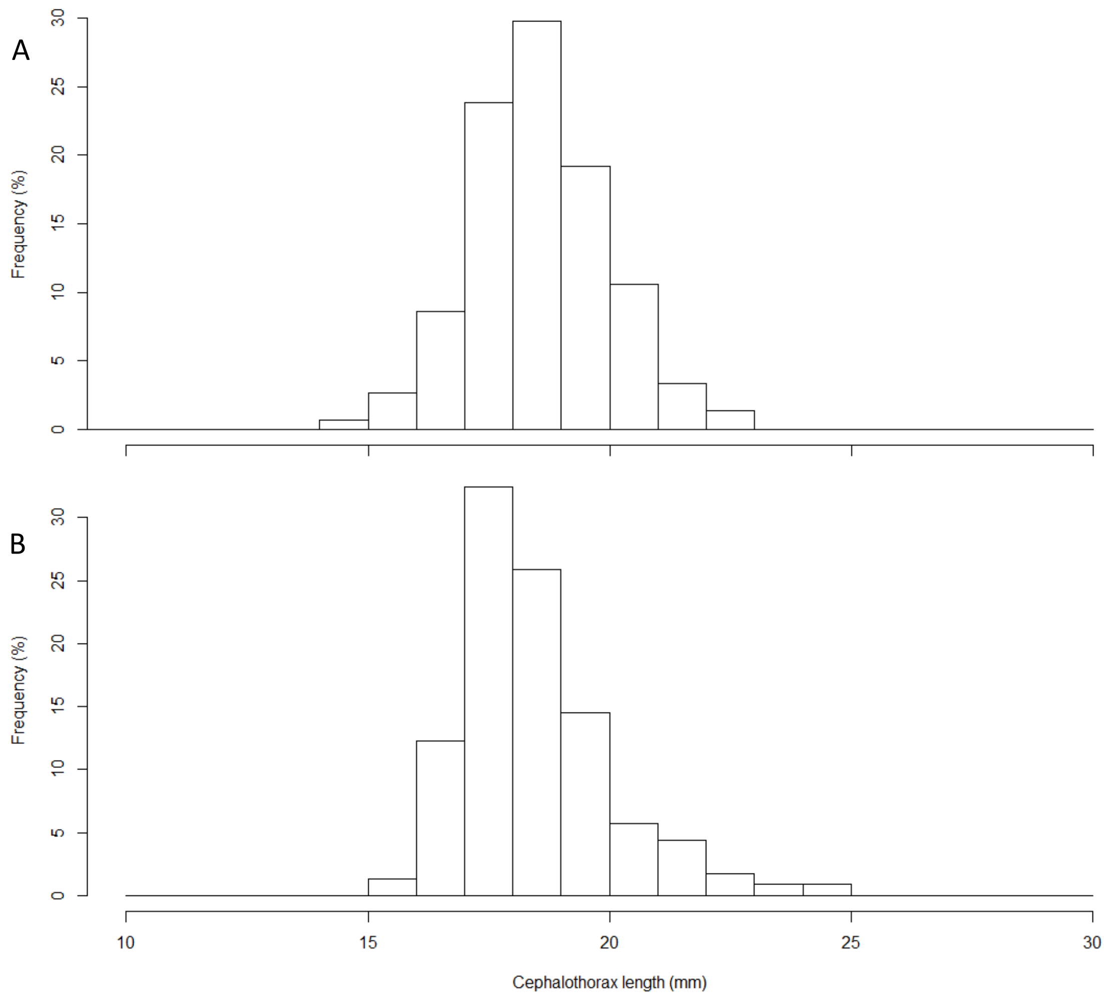


Fig 76. Cephalothorax length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population of *Munida gregaria* for (A) females (N = 151) and (B) males (N = 228).

3.6.2 *Doryteuthis gahi* – Patagonian longfin squid

The total catch of *D. gahi* was 77 kg (Table 3). It was caught at all four shallow inshore stations sampled during this cruise (Fig 77). Catches ranged from 4.19 to 40.97 kg (Fig 77). Of the four stations two yielded > 10kg (50.0%) and none > 50 kg. CPUE ranged from 4.26 to 41.67 kg/hr. The number of squid sampled for length frequency was 493 (239 females, 241 males and 13 juveniles). Female dorsal mantle length ranged from 4.0 to 14.5 cm (mean of 7.58 cm) (Fig 78a), whereas males measured between 4.0 and 15.0 cm (mean of 7.93 cm) (Fig 78b). Juveniles measured between 3.5 and 6.0 cm (mean of 4.58 cm). Females were observed Stage I (28%), Stage II (55%), Stage III (1%), Stage IV (3%), and Stage V (13%) (Fig 78a). Males were observed Stage I (27%), Stage II (56%), Stage III (8%), Stage IV (7%), and Stage V (1%) (Fig 78b).

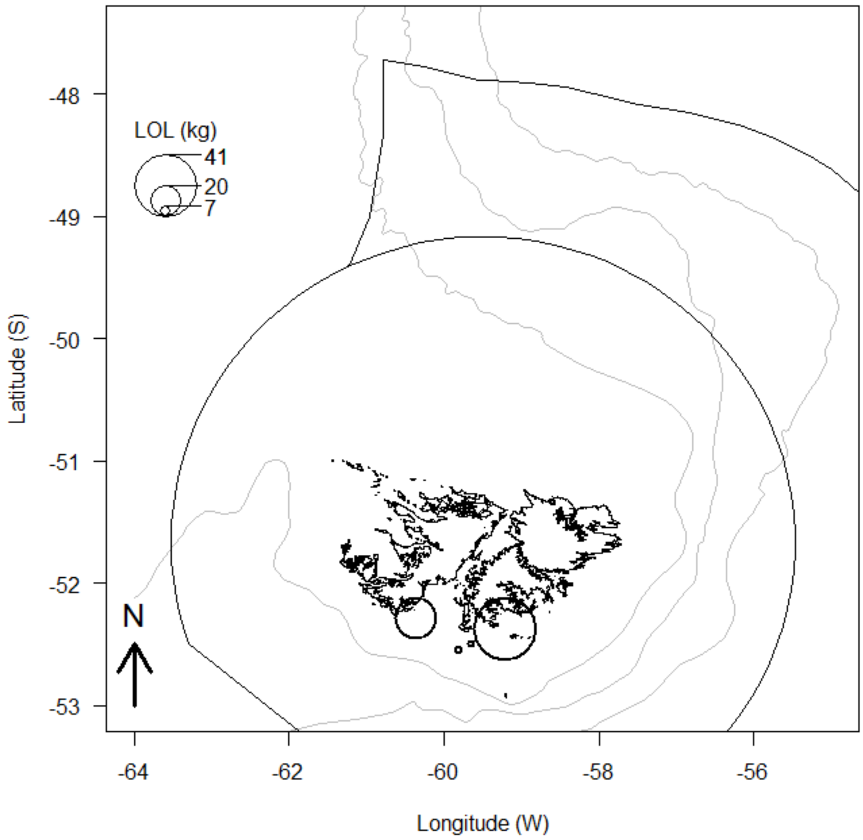


Fig 77. Distribution of catches of *Doryteuthis gahi* at four shallow inshore stations.

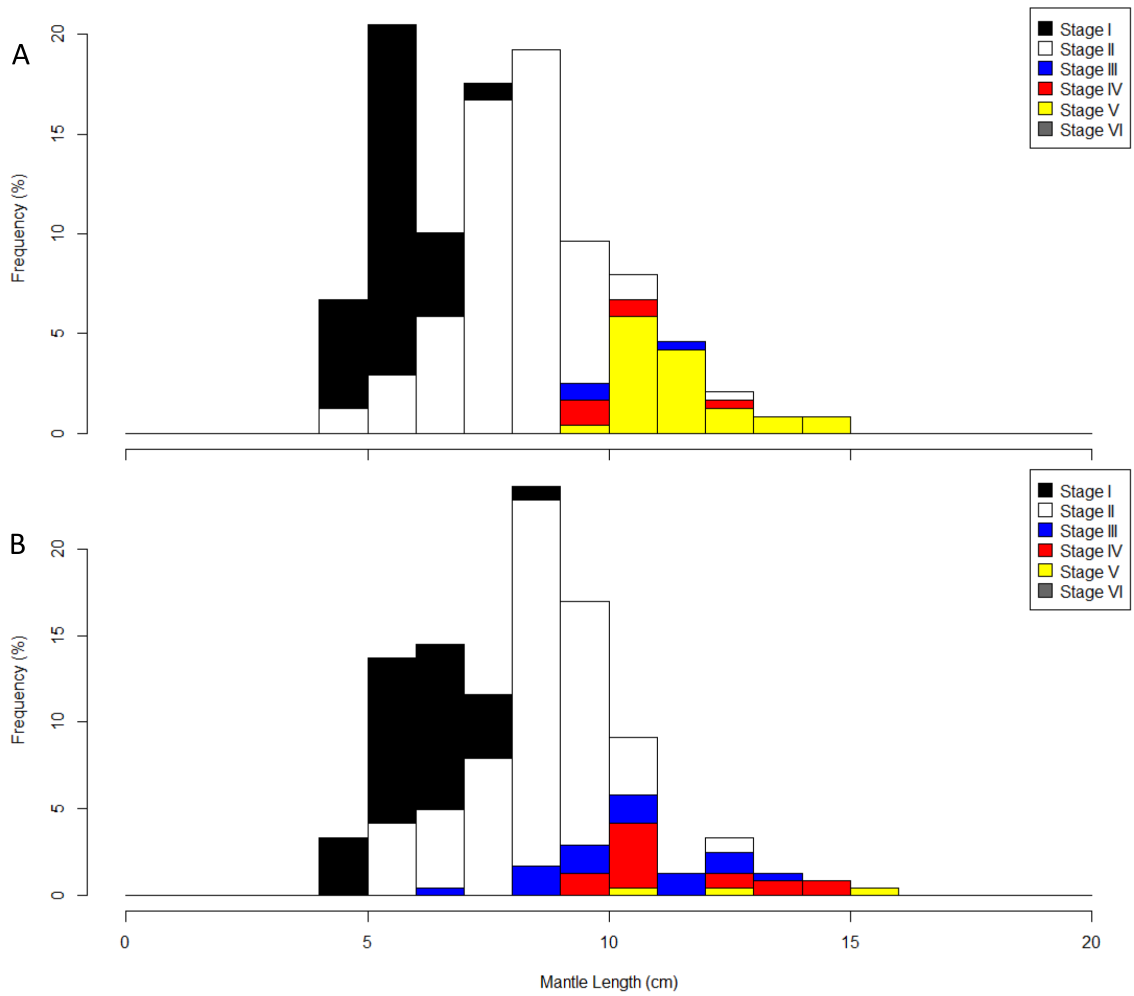


Fig 78. Length frequency (percentage of individuals sampled randomly or as a sub-sample) of the sampled population (at four shallow inshore stations) of *Doryteuthis gahi* with associated maturity stages (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent) for (A) females (N = 239) and (B) males (N = 241).

3.6.3 *Champsocephalus esox* – Icefish

The total catch of *C. esox* was 55 kg (Table 3). It was caught at all four shallow inshore stations sampled during this cruise (Fig 79). Catches ranged from 1.60 to 29.52 kg (Fig 79). Of the four stations three yielded > 5kg (75.0%), one > 20 kg (25.0%), and none > 50 kg. CPUE ranged from 1.63 to 30.02 kg/hr. The number of fish sampled for length frequency was 118 (52 females and 66 males). Female T_L ranged from 12 to 29 cm (mean of 15.21 cm) (Fig 80a), whereas males measured between 12 and 34 cm (mean of 14.91 cm) (Fig 80b). Females were observed Stage I (94%) and Stage II (6%) (Fig 80a). Males were observed Stage I (95%) and Stage II (5%) (Fig 80b).

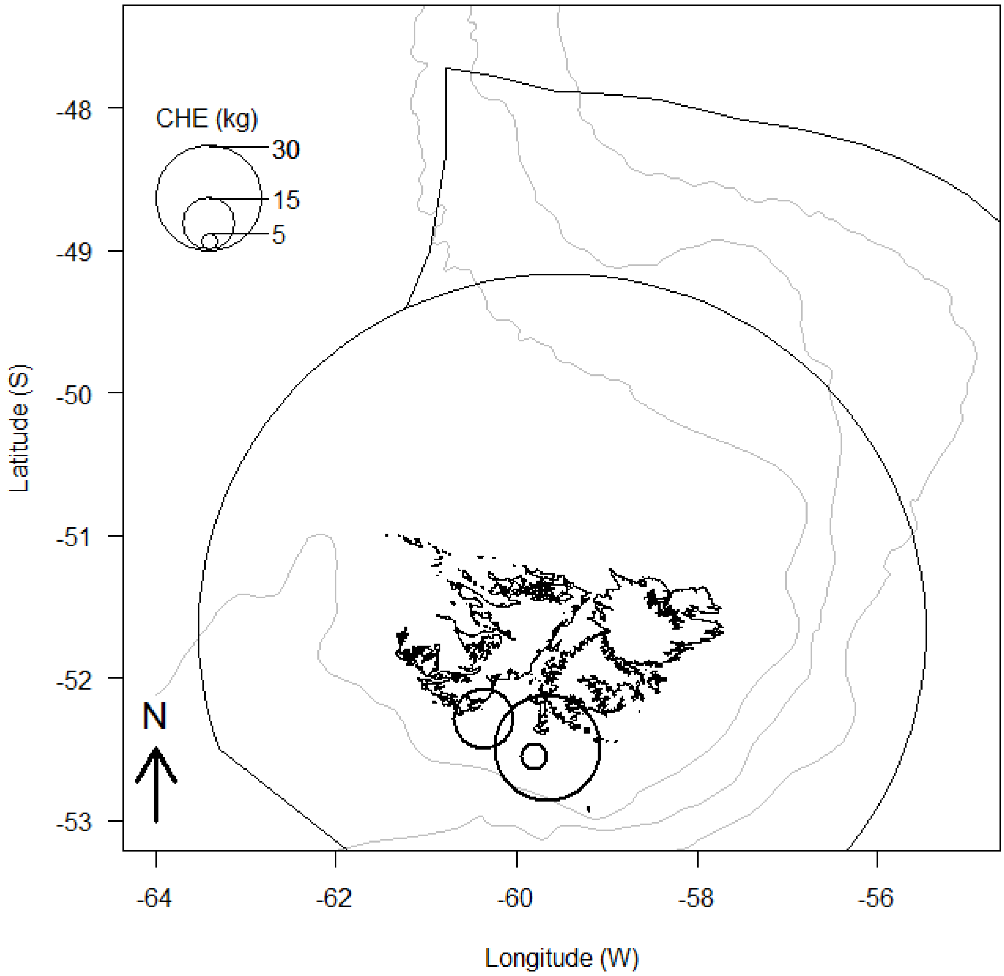


Fig 79. Distribution of catches of *Champsocephalus esox* at four shallow inshore stations.

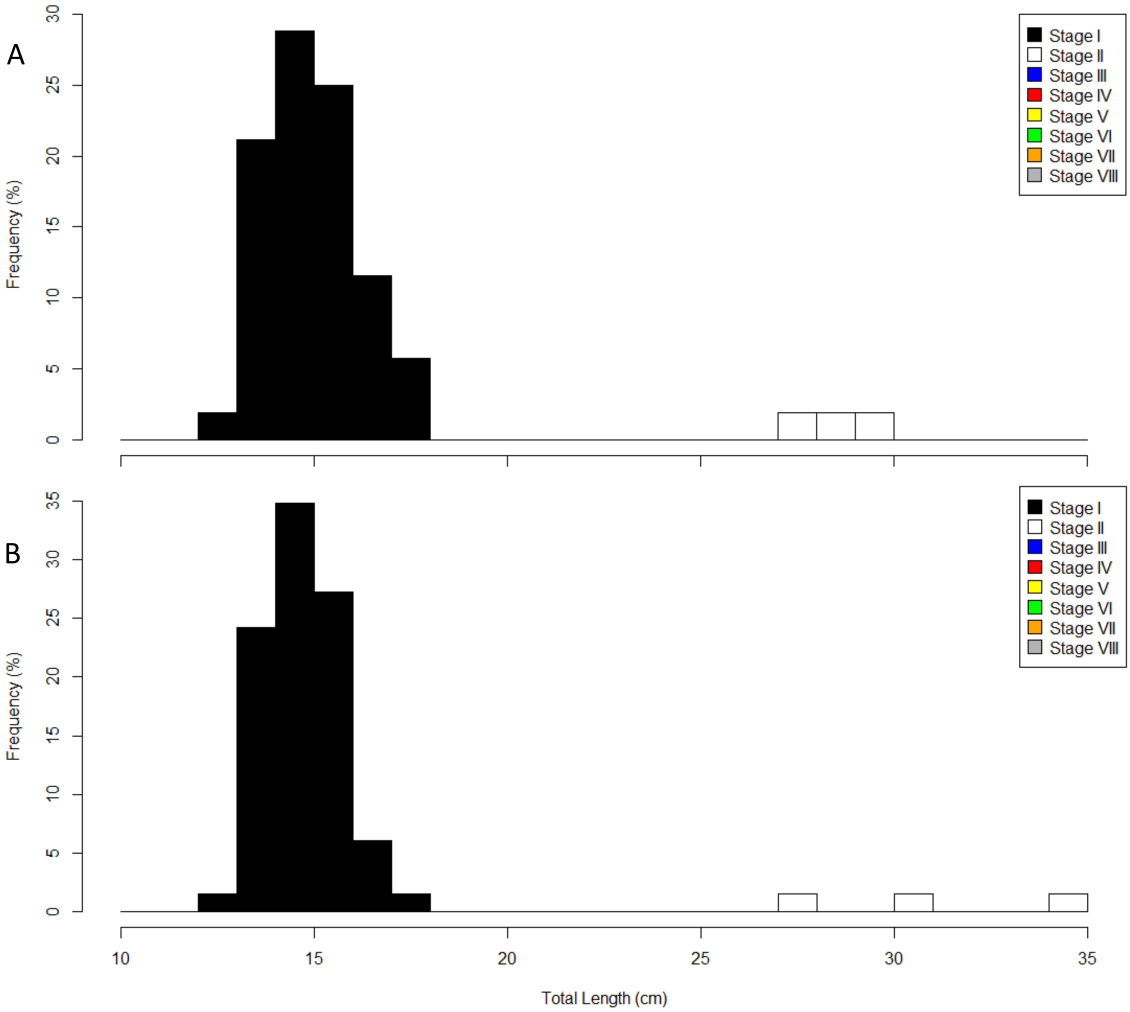


Fig 80. Length frequency (percentage of the total sample collected) of *Champsocephalus esox* individuals sampled for otoliths with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 52) and (B) males (N = 66).

3.6.4 *Patagonotothen ramsayi* – Common rock cod

The total catch of *P. ramsayi* was 45 kg (Table 3). It was caught at all four shallow inshore stations sampled during this cruise (Fig 81). Catches ranged from 0.93 to 20.30 kg (Fig 81). Of the four stations three yielded > 5kg (75.0%), one > 20 kg (25.0%), and none > 50 kg. CPUE ranged from 0.95 to 20.30 kg/hr. The number of fish sampled for length frequency was 345 (98 females, 124 males, and 123 juveniles). Female T_L ranged from 7 to 22 cm (mean of 13.69 cm) (Fig 82a), whereas males measured between 7 and 23 cm (mean of 13.39 cm) (Fig 82b). Juveniles measured between 4 and 6 cm (mean of 4.84 cm) (Fig 82c). Females were observed Stage I (17%), Stage II (70%), and Stage III (12%) (Fig 82a). Males were observed Stage I (52%), Stage II (47%), and Stage III (2%) (Fig 82b).

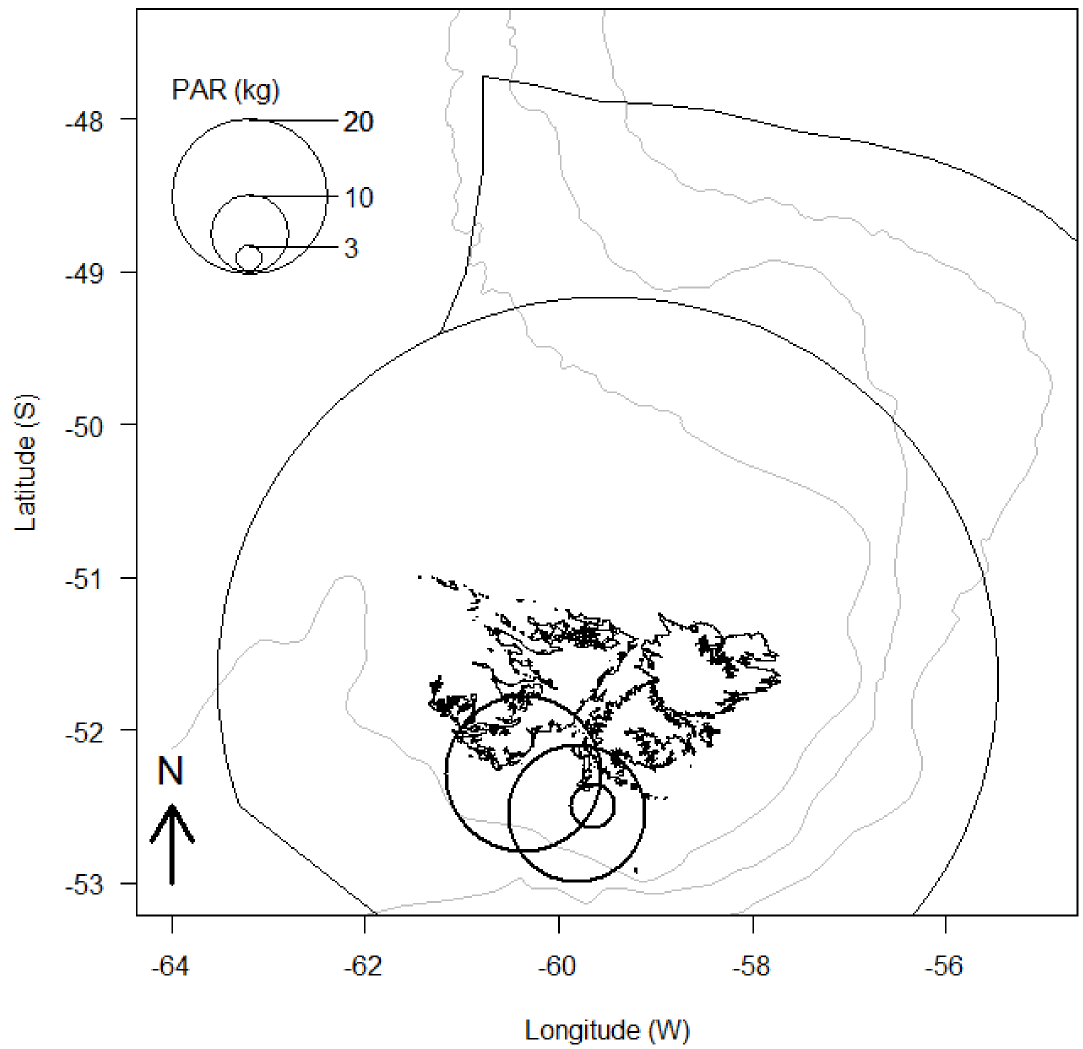


Fig 81. Distribution of catches of *Patagonotothen ramsayi* at four inshore shallow stations.

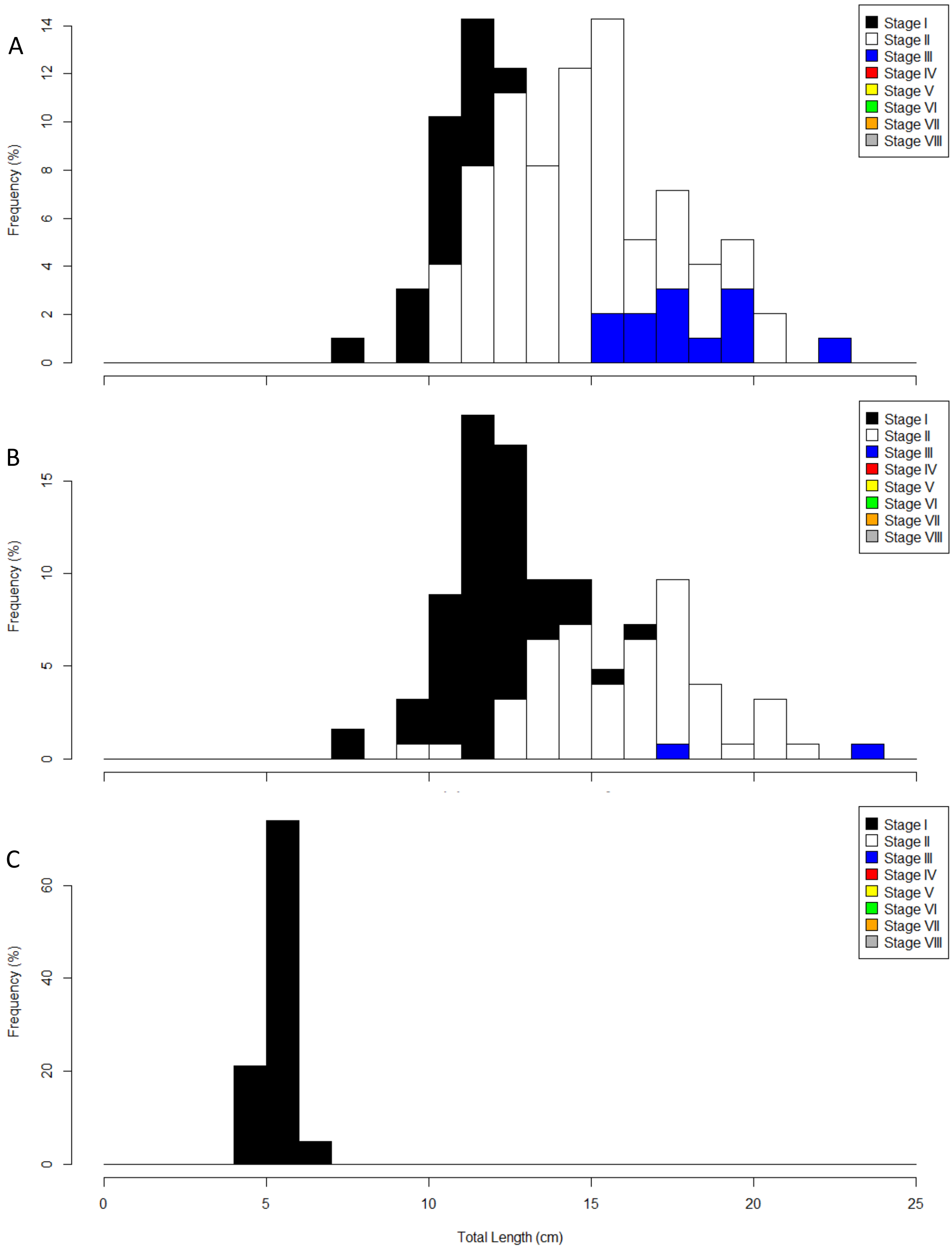


Fig 82. Length frequency (percentage of the total sample collected) of *Patagonotothen ramsayi* individuals sampled from four shallow inshore stations with associated maturity stages (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent) for (A) females (N = 98), (B) males (N = 124), and (C) juveniles (N = 123).

3.7 Benthos

When comparing stations two by two based on a Gower index of similarity, it appears that the benthic community, though relatively similar throughout the zone (60% of similarity between all the stations), is also structured with clear groups of stations discriminated by their assemblage. The hierarchical cluster analysis allows the identification of seven groups, i.e. six groups at 76% similarity and one more group comprised of subgroups 5 and 6 at 80% similarity (Fig 83). Most of these assemblages are segregated spatially (Fig 84). Biomass and species richness summarised by groups of stations are presented in Fig 85.

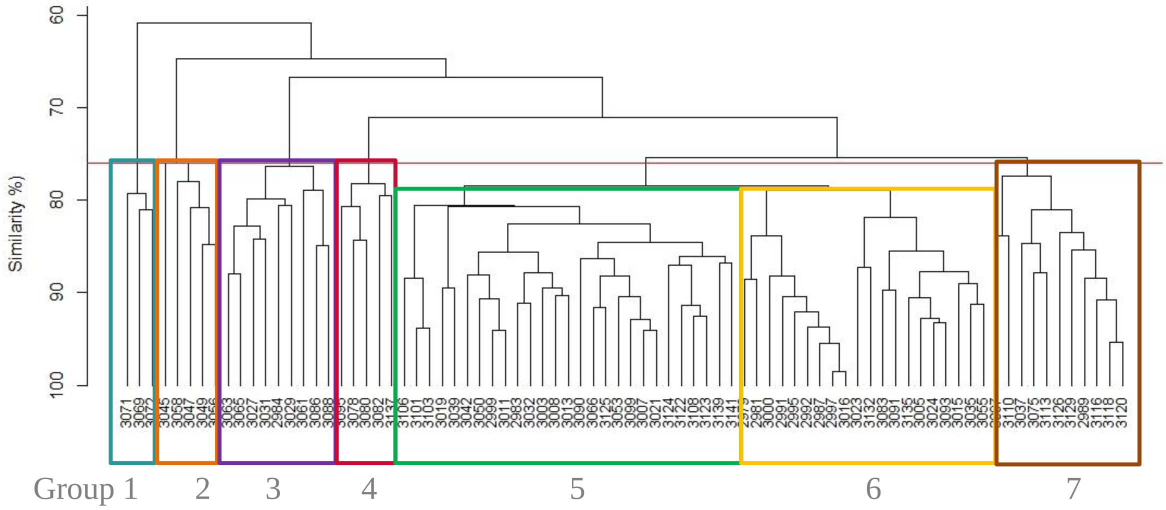


Fig 83. Hierarchical cluster analysis (complete linkage, Gower distance) identifying 7 groups (6 groups at 76% similarity, and one more group comprised of subgroups 5 and 6 at 80% similarity).

High species richness was observed for Group 1 with an average of 26.6 species per station and the second highest total biomass (mean = 115.6 kg/km^2) of all groups. Group 1 included the three stations north of the Jason Islands (Fig 84). The *Indval* procedure identified many indicator taxa for this group of stations, among which the most representative ones are the crustaceans Cirripedia and *M. subrugosa,* and the polychaete *Chaetopterus variopedatus* (identified by the presence of their tubes). Ascidians were particularly abundant in this group, with an average biomass of 19.89 kg/km^2 compared to 1.47 kg/km^2 throughout the sampled area. This group also differs from others by the absence of common species. As a matter of a fact, this group is the only one without hard corals (Anthozoa), Gorgonacea, isopods, the scallop *Zygochlamys patagonica,* and the starfish *Glabraster antarctica*. These taxa are otherwise widely distributed in the rest of the survey area.

Group 2 consists of five stations lying in the east of the surveyed area (Fig 84); it is the most abundant group by weight (mean abundance = 125.9 kg/km^2) (Fig 85a) and has the highest species richness (average of 29 species per station) (Fig 85b). Three taxa are indicators of this group, namely the starfish belonging to the genus *Henricia*, pagurid crustaceans, and the chiton *Nutallochiton hyadesi*; the latter two being present only in this group of stations. Sessile species such as hydroids (Hydrozoa) and sponges (Porifera) show a higher mean abundance in this group of stations than in the rest of the survey area. On the other hand the flat isopod *Acanthoserolis schythei* is present in all groups but this one.

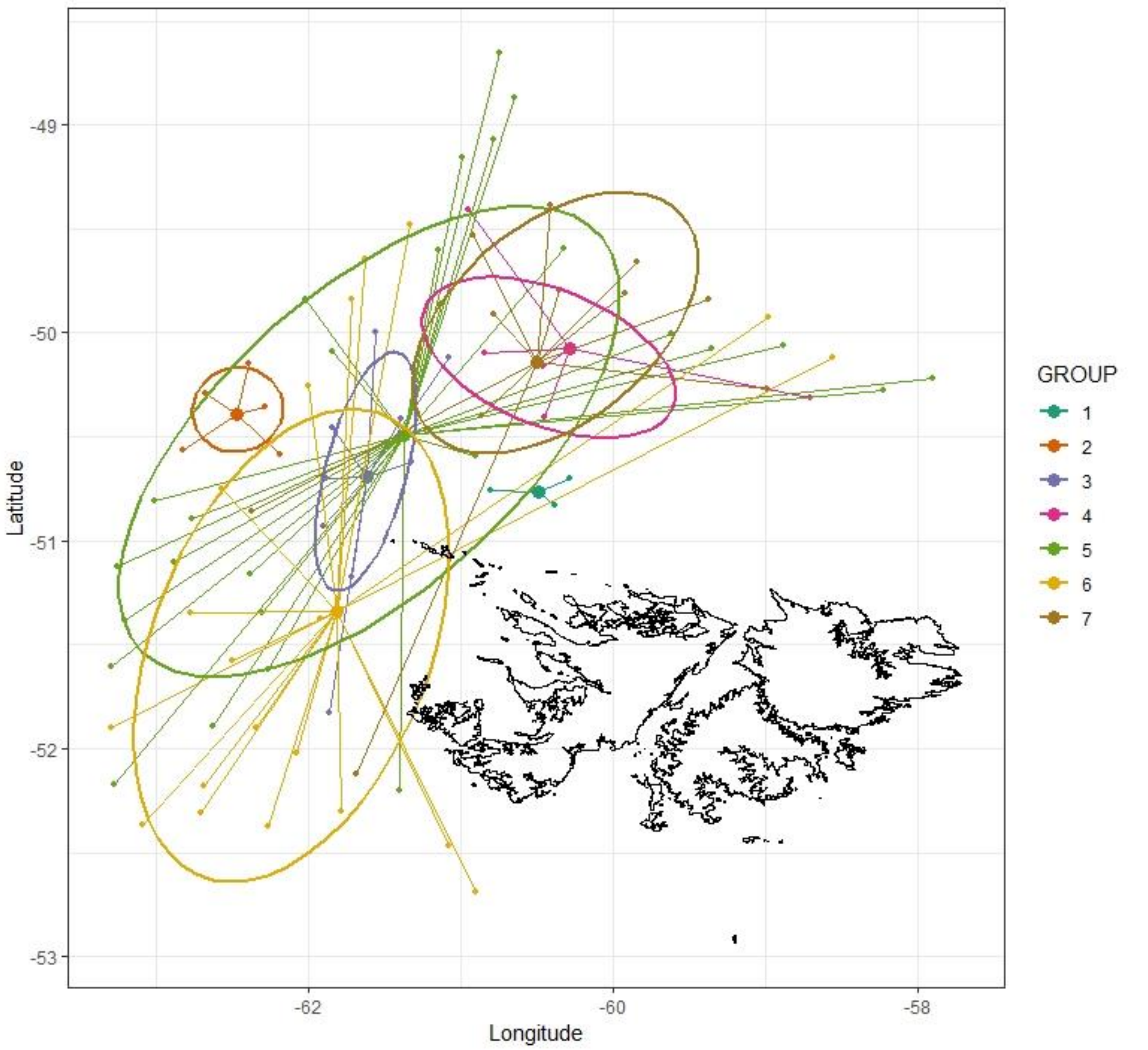


Fig 84. Groups of stations based on the similarity of their benthic assemblages.

Group 3 consists of nine stations and lies between Groups 1 and 2 (Fig 84). Although the average species richness at these stations is also relatively high (22 species per station) (Fig 85b), the total biomass is much lower than in the two previous groups, averaging 27.2 kg/km^2 (Fig 85a). The *Indval* procedure identified two indicator taxa for this group, i.e. Gorgonacea and the starfish *Astrotoma agassizi*. Bryozoans are also relatively abundant and present at eight of the nine stations included within this group, with an average biomass of 14.7 kg/km^2. However, this group of station is the only one without anemones Actinaria.

Group 4 follows the same pattern, with high species richness (average of 26 species per station) (Fig 85b) and relatively low biomass (31.65 kg/km^2) (Fig 85a). It consists of six stations located in the north of the zone (Fig 84). Mixed species of Octocorallia and sea cucumbers (Holothuroidea) have been identified as indicator taxa for this group, which is also characterized by the presence of hydroids and soft corals (Scleractinia) at every station, although in low mean biomass for the later (0.09 kg/km^2 compared to 0.36 kg/km^2 throughout the study area). Sea urchins, represented by two taxa *Sterechinus agassizii* and *Tripilaster* sp., are widely present in this group, i.e. at five and six of the stations, respectively.

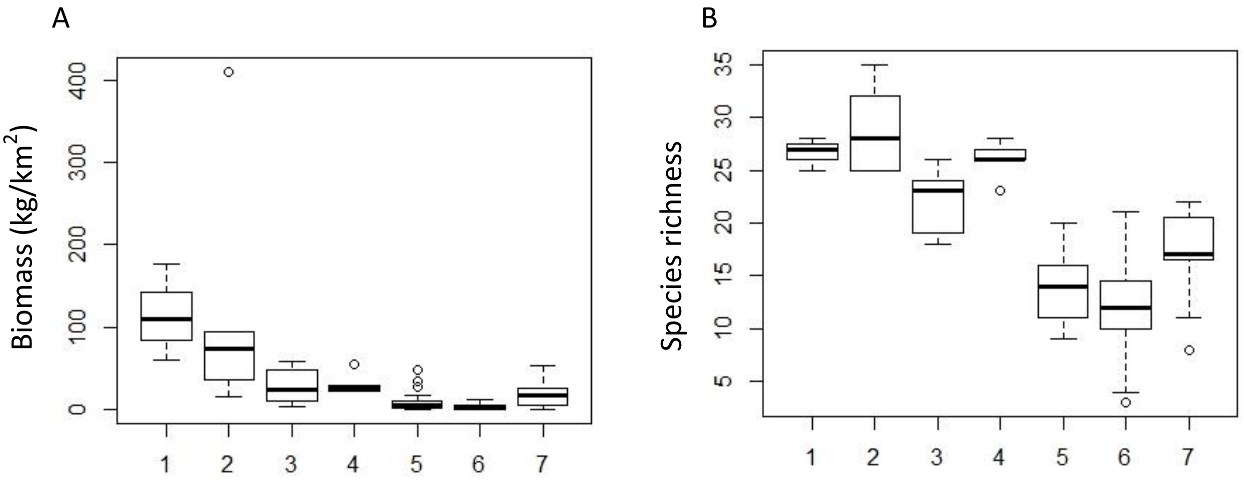


Fig 85. Biomass (A); species richness (B) per group of stations – ANOVA $p < 0.05$ for both.

Groups 5 and 6 have been divided at a higher similarity level, but they are very similar to each other and consist of the majority of the stations present in the study area (Fig 84). Group 5 consists of northern stations and has the second lowest mean biomass (9.0 kg/km^2) (Fig 85a) and second lowest average species richness (14.1 species per station) of the zone (Fig 85b). There are no indicator taxa for this group as it is characterized by low diversity / abundance rather than presence of species. Among others, the mean biomass of sessile species such as sponges, hydroids and bryozoans is much lower than the average in the rest of the survey area.

Group 6 follows the same trend but is made of stations that are in the south of the study area (Fig 84). This group is represented by the lowest species richness (average of 11.9 species per station) (Fig 85b) and least biomass (2.93 kg/km^2) of the survey area (Fig 85a). It shares the same lack of sessile species as Group 5, but is also characterized by the low abundance of the sea urchins *S. agassizii* (six of 20 stations; mean biomass of 0.16 kg/km^2 compared to 2.34 kg/km^2 throughout the survey area) and *Tripilaster* sp. (absent), as well as the otherwise widely distributed sea squirts Ascidiacea (two of 20 stations; mean biomass of 0.02 kg/km^2 compared to 0.67 kg/km^2 throughout the rest of the survey area).

Finally, Group 7 is located in the north of the zone (Fig 84) and consists of 11 stations that show an average species richness of 17.3 species per station (Fig 85b), but a relatively low biomass (18.51 kg/km^2) (Fig 85a). The basket starfish *Gorgonocephalus chilensis* is indicative of this group; this species was present at only 14 stations in the zone, nine of which are included in Group 7. This group is distinct from others that show a high species richness by having a low biomass of bryozoans (only present at two of 11 stations), but a high abundance of soft corals Alcyoniina (mean biomass of 2.4 kg/km^2 compared to 0.36 kg/km^2 throughout the study area).

Altogether, the prospected area appears to be split in two. The first half is made of benthic communities relatively homogenous, with further distinctions showing a north / south clustering of stations (Group 5 + 6). The other half consists of pockets of structured, distinct assemblages that are spatially segregated and show higher biomass and species richness than the average observed throughout the study area.

3.8 Oceanography

Oceanographic data were collected at 85 stations (Fig 2). The area covered ranged from 48° 43.59'S to 52° 42.06'S and 57° 59.48'W to 63° 18.07'W. Good data were collected at all stations, all the downcasts at these stations were good, and so up-cast data were removed.

Figures 86 to 88 show the temperature, salinity and density, respectively, gridded using ODV4 DIVA (University of Liège: http://modb.oce.ulg.ac.be/projects/1/diva) gridding algorithm, at depths 10, 50, 120m, and seabed. The first layer at 10m is the shallowest depth common to all CTD casts. The surveyed area covered a depth range of 54 to 340 m.

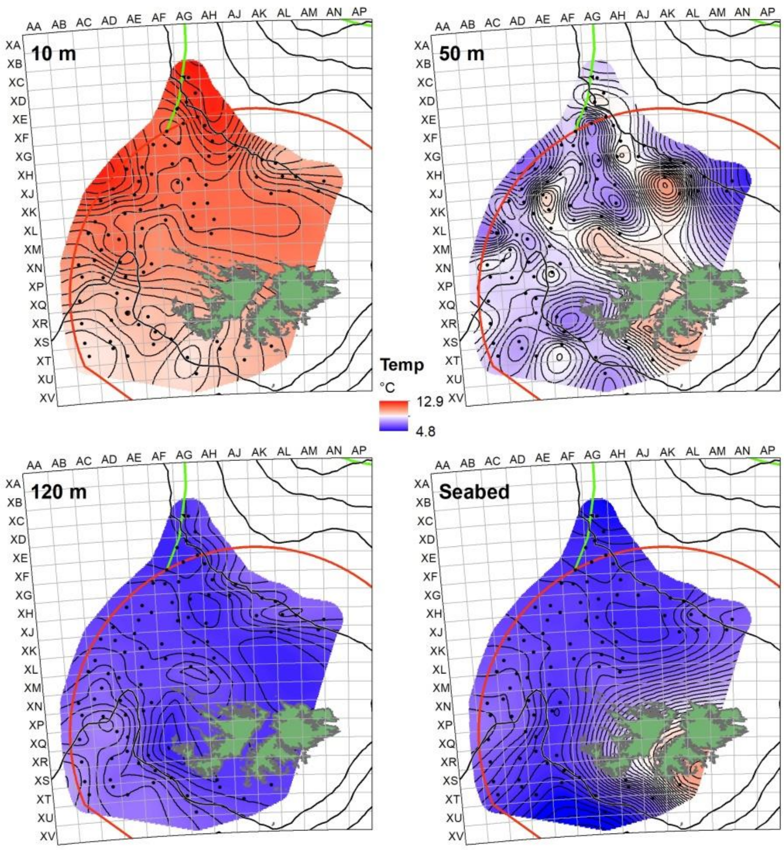


Fig. 86. Temperature at 10m, 50m, 100m and seabed (contours at 0.25°C).

The temperature data (Fig 86) show two distinct patterns, with warm water at the surface along the edge of the shelf, and cooler water pushing north from the southwest. As depth increases there is considerable mixing at 50 m. At the seabed it is possible to see the western branch of the Falklands Current pushing north. However, the return of the eastern branch of the Falklands Current is absent. This pattern is similar in the salinity maps.

Figures 89 and 90 show the change in temperature from 2015 to 2019 (reds are warmer in 2020; blues are cooler in 2020 than the previous data sets). The comparison has been undertaken where the 2020 survey overlapped the previous surveys. For 2015-2017 the February CTD transect was used (in 2018 then January data were used as there was no P5 data in February 2018) to compare data in the shallow area to the south surveyed in 2019 and 2020.

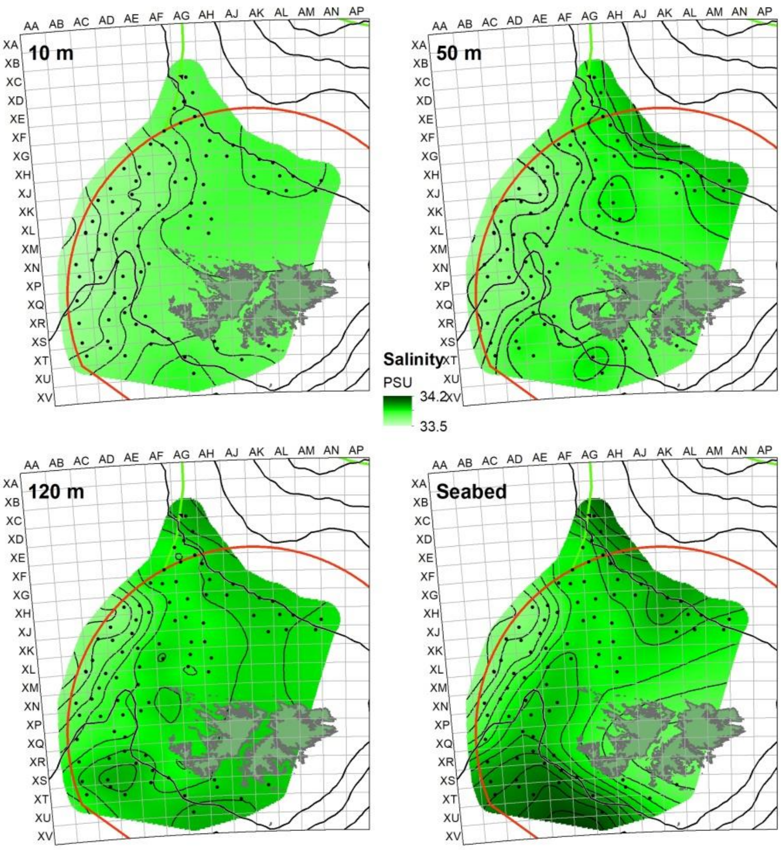


Fig 87. Salinity at 10m, 50m, 100m and seabed (contours at 0.05 PSU).

Sea surface temperatures (SST) were generally warmer in 2020 than observed during previous surveys (Fig 89). The greatest difference in SST was observed between the 2020 data and those from 2015 and 2016, with the 2020 survey SST warmer across the entire shelf (Fig 89). For 2017 to 2018 the SST were cooler in the northwest and southwest, with the area due north of the Falkland Islands slightly warmer in those years (Fig 89). In 2019 the waters were cooler across the shelf, with only a small area to the north and a small area to the west warmer in 2019 in than 2020 (Fig 89).

The temperatures at the seabed were cooler in 2020 than all years except 2016 and were slightly higher than those observed in 2016 (Fig 90). The biggest difference was between 2018 and 2020 with a large area between 0.5 and 1 °C cooler in 2020 (Fig 90).

Fig shows the salinity over the surveyed area. At surface, salinity is fairly stable between 33.5 and 33.8 PSU (Fig 87). As depth increases there is a greater variation, with significant differences at the seabed (Fig 87). In the west, the water is less saline with salinity increasing eastwards and over deeper waters at all mapped levels (Fig 87). At seabed, salinity is higher close to the two branches of the Falklands Current (Fig 87). The waters to the northeast along the shelf edge and in the Falklands Trough to the southwest show measured salinity greater than 34.0 PSU (Fig 87).

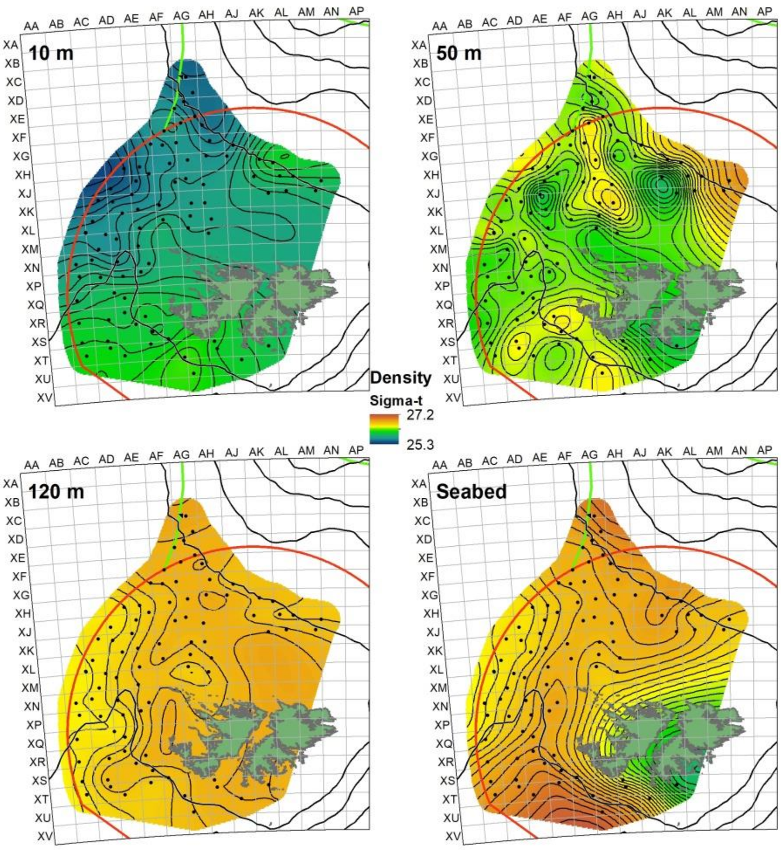


Fig 88. Density at 10m, 50m, 100m and seabed (contours at 0.05 sigma-t).

A plot of conservative temperatures against absolute salinity is shown in Figure with comparison to the survey undertaken in February 2015 to 2020. The surveys in 2017 and 2020 are lacking in any quantity of Patagonian shelf water, with the shallower water dominated by Falklands Shelf waters (Fig 91). Deeper water is always dominated by the Falklands Current, both the east and west branches (Fig 91).

The density map (Fig 88) shows lowest density at 10 m over the shelf, reflecting the higher temperatures and lower salinity (Figs 86; 87). At 50 m there is more mixing with the denser water mass from the West Branch of the Falklands Current moving north and mixing with Falklands Shelf waters (Fig 88). Away from the Falklands, in the seabed layer, there is a higher density water mass pushing from the southwest up the west of the Falklands to join the gyre formed by the eastern branch of the Falklands Current (Fig 88). Densities are greater in the northern-most part of the survey (Fig 88).

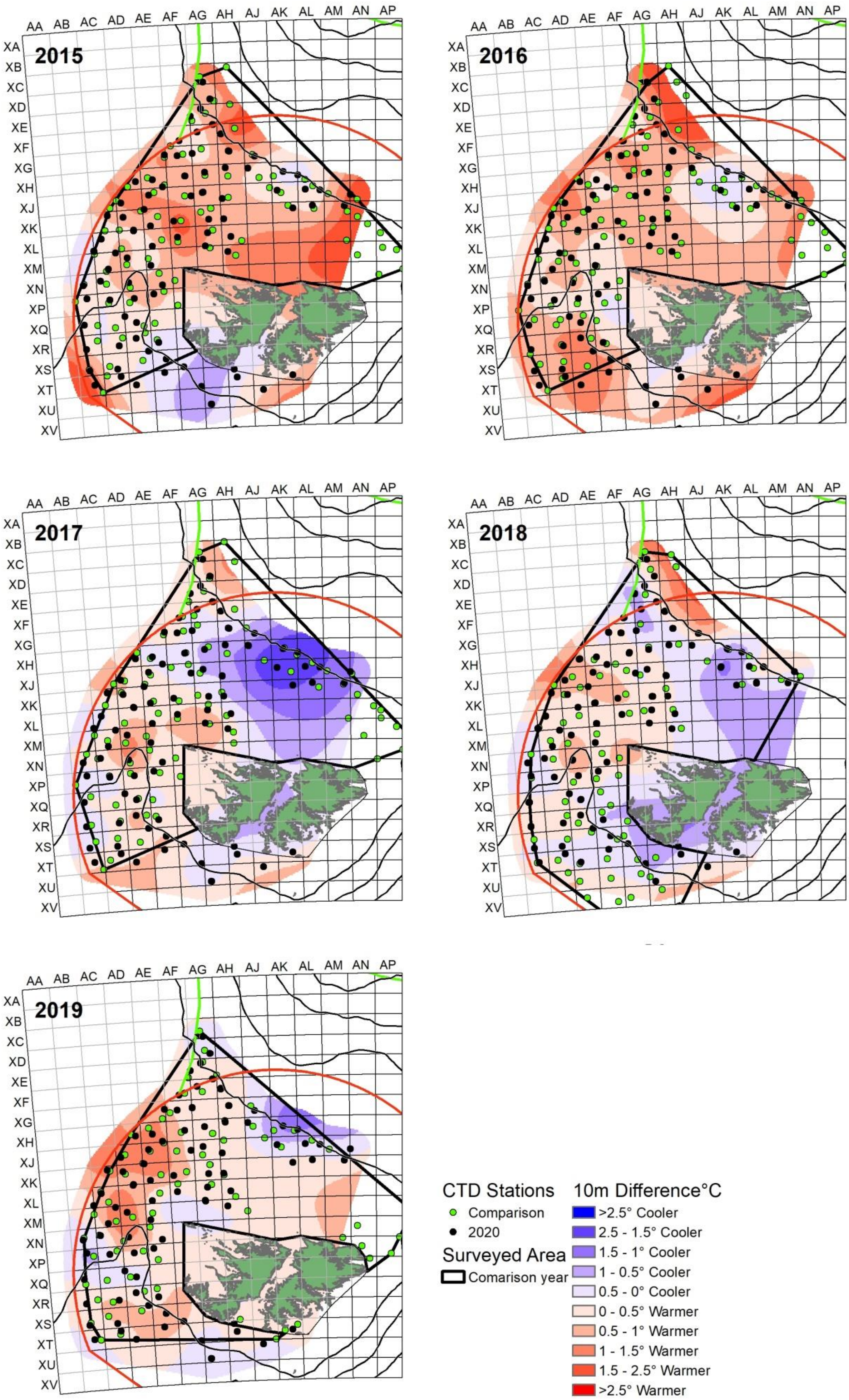


Fig 89. Temperature difference from 2015, 2016, 2017, 2018 and 2019 at 10 m.

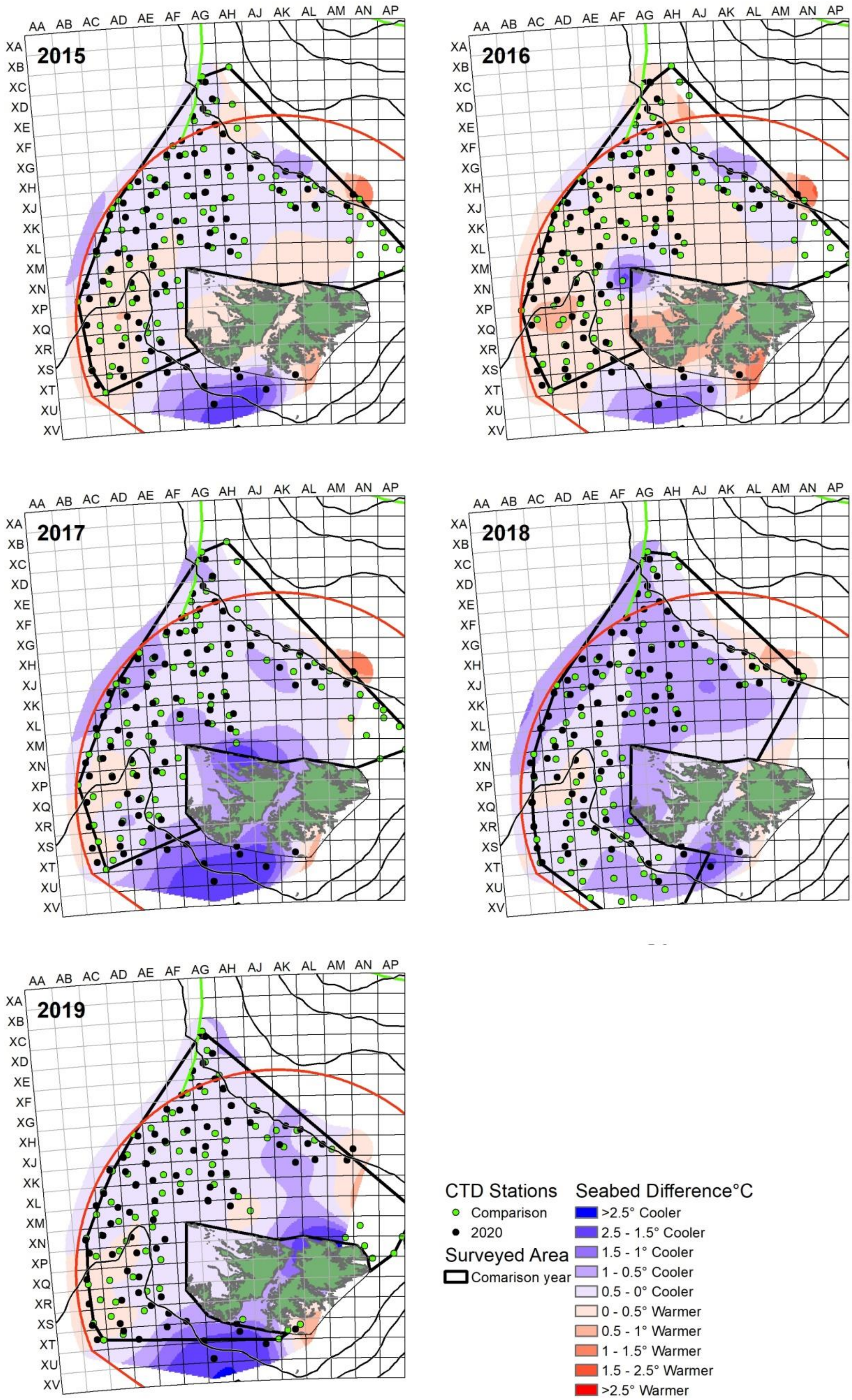


Fig 90. Temperature difference from 2015, 2016, 2017, 2018 and 2019 seabed.

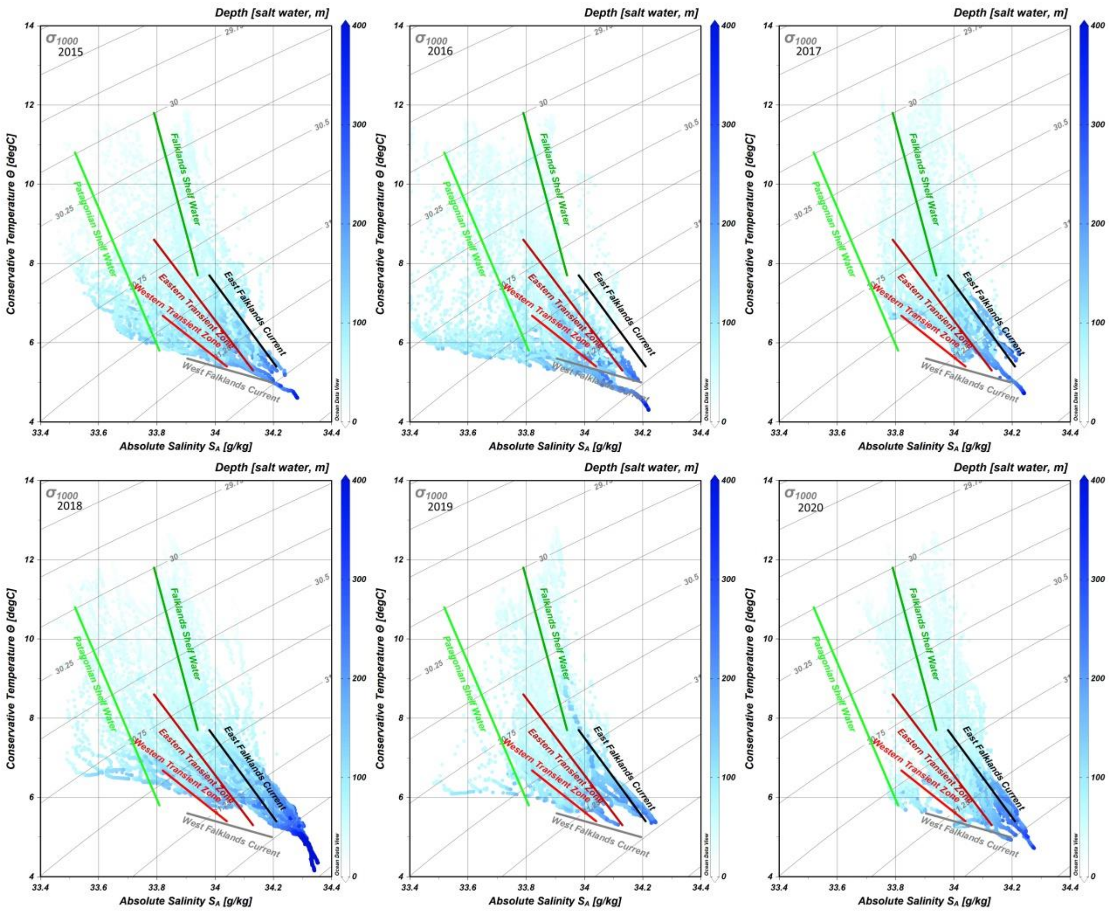


Figure 91 TS plots, 2015 -2020 data on the right (water mass terminology Arkhipkin et al 2013).

Figure shows the oxygen level at 10, 50, 120 m and seabed in mL/L of water. Oxygen concentration was highest at the surface, with levels of 6.0 to 6.9 mL/L (Fig 92). However, in deeper waters, there is clear evidence of the western branch of the Falklands Current bringing oxygenated water onto the shelf, with a highly oxygenated water mass originating in the southwest and travelling north through XQAD-XLAE-XFAE grid squares (Fig 92). To the east of this water mass, there are lower oxygen levels over the shelf, before levels rise on the edge of the slope. The slightly higher water density seen in Fig at grid XHAK is consistent with the presence of slightly higher oxygenated water moving onto the shelf (Fig 92).

Fig shows the chlorophyll concentration in 10 m intervals to 50 m. Below 50 m, levels of chlorophyll are insignificant. When comparing the chlorophyll to other oceanographic data and the bathymetry, it is clear that high levels of nutrients were observed where the western branch of the Falklands Current is lifted by the bathymetry to the southwest of the Falkland Islands and enters the turbulent layer to the northwest and north of West Falkland (Fig 93).

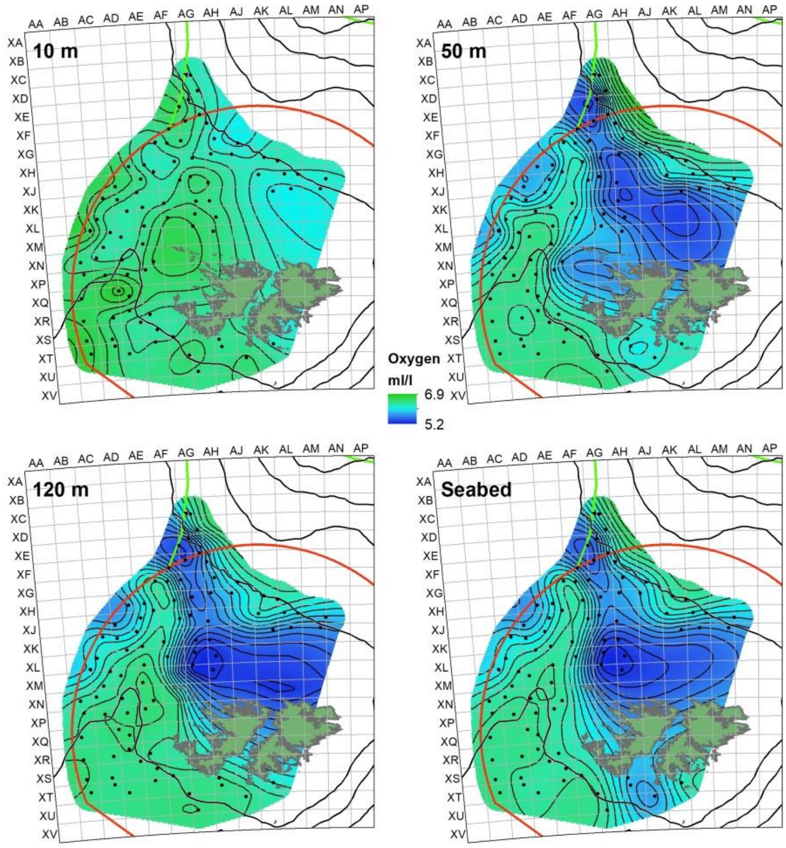


Figure 92 Oxygen at 10m, 50m, 100m and 200m (contours at 0.1mL/L).

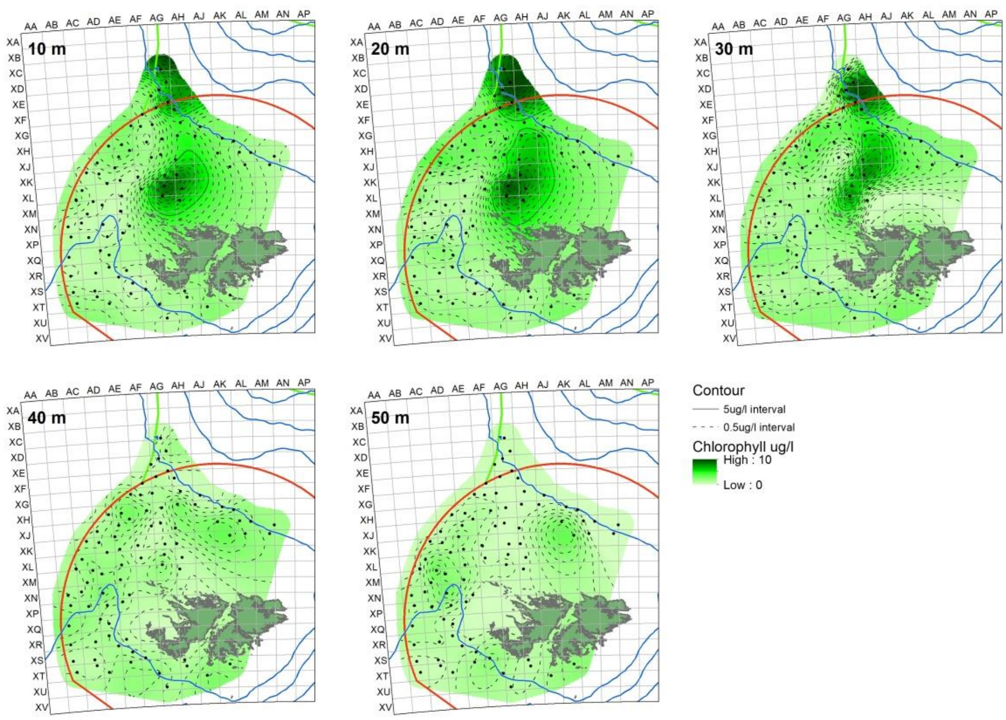


Fig 93. Chlorophyll concentration at 10 to 50 m.

4.0 Discussion

Biomass of *P. ramsayi* has been decreasing at every groundfish survey since 2011; from an estimated high of 1,090,655 t to an estimated low of 22,335 t in 2020 (Ramos & Winter 2020). This trend is reflected also from total catch of *P. ramsayi* during the demersal survey as catches decreased from 116 t in 2011 (Arkhipkin et al 2011) to 1.8 t in 2020 (Table 2), without ever increasing. The past two years are the only ones where the total catch during the survey was less than 10 t (Arkhipkin et al 2019; Table 2 herein). Although caught throughout the survey, the number of stations where the entire catch was sampled due to fewer than 100 individuals caught was indeed surprising. Only 5,401 *P. ramsayi* were sampled this year (Fig 19) compared to 6,536 in 2019 (Arkhipkin et al 2019), 9,834 in 2018 (Gras et al 2018), and 8,993 in 2017 (Gras et al 2017). From 2011 to 2017, the decrease in abundance was not as steep as the decrease in biomass, suggesting that individuals were getting smaller on average (Gras et al 2018). This most worrying trend saw a decrease in mean size over time from 22 to 18 cm between 2010 and 2020 (Ramos & Winter 2020). Last year, the cohort at 14-15 cm (1+ year old) represented approximately 15% of the total sampled population (Arkhipkin et al 2019, whereas nearly 27% of the sampled population in 2020 fell within this size range (19). In 2011, the modal peak was 17-22 cm (2+ year old cohort) compared to a modal peak at 14-15 cm in 2020 (corresponding to 1+ year old cohort). Of note, the 17-22 cm cohort in 2011 was identified as corresponding to 3 year old fish (Arkhipkin et al 2011). An age validation exercise conducted in 2017 (Lee 2017) on *P. ramsayi* otoliths did conclude that ages obtained during 2011 for this species were unreliable, hence the revised age estimate above. Larger *P. ramsayi* individuals were found in greater proportions in waters deeper than 200 m in both the southwest and north of the survey area (Fig 20). Annual commercial effort of the fleet on finfish licences is generally lower in those areas compared to the west and northwest of the FICZ/FOCZ. Furthermore, in 2020, 48% of *P. ramsayi* caught during this survey were discarded (Table 2) compared to 39% in 2015 (Gras et al 2015), 67% in 2016 (Gras et al 2016), 62% in 2017 (Gras et al 2017), 50% in 2018 (Gras et al 2018), and 24% in 2019 (Arkhipkin et al 2019). It is possible that these discards are primarily undersized *P. ramsayi* for commercial processing.

Illex argentinus biomass estimate for 2020 (148,023 t) is the highest since 2015 (253,660 t) (Ramos & Winter 2020). Catches during the biomass survey reflect this with catches in 2020 equalling 17.9 t (Table 2), the second-highest ever recorded during this survey, except for 2015, when 31.7 t were caught (Gras et al 2015). Generally, sea surface temperatures in the north and northwest of the survey area were warmer than in any year since 2015 (Fig 86). However, seabed temperatures were either similar or cooler in the same areas compared to the previous five years (Fig 90). The warm water inflow into the northwest seems to have brought *I. argentinus* into Falkland waters in early February hence the good catches during the survey. Size of *I. argentinus* females was slightly smaller than last year (modal size of 24.5 in 2019 [Arkhipkin et al 2019] compared to 24.0 in 2020) with similar proportions of mature individuals (Stage V). Although the relationship between catches during the demersal survey and commercial catches on B- and G-licences is not directly proportional, we do expect 2020 to be a good year for *I. argentinus* relative to 2016-2019.

Doryteuthis gahi was sampled at nearly every station during the 2020 survey (Table 2). However, biomass estimates for 2020 are 96,135 t (Ramos & Winter 2020). This is only the third time in the eight year history of this survey that the estimated biomass is slightly below 100,000 t. However, it should be noted that these biomass estimates include data from the *D. gahi* pre-recruitment survey in areas of greater abundance of this squid species. Focusing strictly on the demersal surveys, 2020 catches (3.69 t; Table 2) are the third highest only behind 2019 (5.75 t; Arkhipkin et al 2019) and 2017 (5.44 t; Gras et al 2017). Individuals in 2020 were larger than in 2019 (modal dorsal mantle length of 9.5 *vs.* 9.0 cm [Arkhipkin et al 2019]) and in 2018 (modal dorsal mantle length of 9.5 *vs.* 7.5 cm for females and 8.0 cm for males [Gras et al 2018]), but the proportions for different maturity stages were similar to those reported in 2019 by Arkhipkin et al (2019) (majority immature; Stage II).

The biomass of *M. magellanicus* shows a decreasing trend from a high estimate of 272,080 t to 77,733 t in 2020 (Ramos & Winter 2020). Catches during the demersal survey have been highly variable between 2010 and 2020. However, this year's catch (14,323 t; Table 2) was double of last year's (7,315 t; Arkhipkin et al 2019), but much lower than in 2018 (29,335 t; Gras et al 2018). This might be due to the survey being extended to cover the entire southwest in 2018, having these deeper water stations removed in 2019, and four being re-instated in 2020. As such, given that the abundance of the species is primarily in the southwest of the fishing area, these data need to be interpreted with caution. A declining trend in mean pre-anal length for *M. magellanicus* is apparent between 2010 (28 cm) to 2020 (21 cm) (Ramos & Winter 2020). Furthermore, the modal length and age at 50% maturity have declined significantly for both males and females in recent years (Ramos & Winter 2019a). However, it is the absence of older and larger fish (> 27 cm pre-anal length) in 2019 and 2020 compared to 2010 and 2011 that is more worrying. Additionally, the cohorts at 17-18 cm and 22 cm pre-anal length have decreased in abundance over time (Ramos & Winter 2020).

Although the biomass of *G. blacodes* has decreased from 2015 (79,129 t) to 2016 (24,791 t), it has remained relatively stable between 15,000 and 20,000 t ever since (Ramos & Winter 2020). This is also reflected in catches during the demersal surveys from a high of 14.64 t (Gras et al 2015) to a low of 3.35 t in 2018 (Gras et al 2018) and 3.40 t in 2020 (Table 2). Mean length of *G. blacodes* shows a decreasing trend, albeit not statistically significant (Ramos & Winter 2020), while modal length has also been shown to decrease over time (Gras et al 2018) as with age and length at 50% maturity (Ramos & Winter 2019b). Regardless, large individuals were found in deeper waters to the southwest and northwest with smaller individuals in shallower waters in the west and north (Fig 16). We need more biological data on kingclip from deeper waters and continue working on recommendations presented in Gras et al (2018).

Since 2011, the biomass of *S. australis* has been declining from a high of 161,733 t in 2011 to a low of 22,654 t in 2020 (Ramos & Winter 2020). This decline is reflected in catches during the demersal survey with catches decreasing from a high of 23.10 t in 2011 (Arkhipkin et al 2011) to a low of 3.33 t in 2020 (Table 2); the first time catches are below 10 t. Although the decrease in mean length for *S. australis* between 2010 and 2020, and modal length and age at 50% maturity were not statistically significant, there are clear downward trends (Winter 2018; Ramos & Winter 2020). In fact, the mean length in 2020 of 33 cm would be similar to that of 37 cm observed in 2010 (Brickle et al 2010) if we were to remove the abundant cohort at 17 cm (1+ year old) from the 2020 sample (Fig 5). Modal length and age at 50% maturity has also been shown to decrease significantly in recent years (Winter 2018).

Salilota australis individuals in the 20 to 25 cm range make up a larger proportion of the individuals sampled in 2020 relative to 2019 (Arkhipkin et al 2019). The pre-recruitment cohort at 17-18 cm was mostly absent from the fish sampled during the 2018 survey (Gras et al 2018) and this seems to be confirmed with a lower abundance of 2+ year old fish (22 to 25 cm) in 2019 (Arkhipkin et al 2019). The high abundance of the pre-recruitment cohort in 2019 (modal length of 17 and 18 cm) explains the higher frequency of fish sampled in the 23 to 25 cm range in 2020 (Fig 5). Larger *S. australis* sampled were more abundant in the southwest of the sampled area (Fig 6b) where four additional stations relative to 2019 were sampled, potentially driving up the mean length between 2019 and 2020.

Coelorinchus fasciatus estimated biomass has decreased from 86,113 t in 2010 to 39,381 t in 2020, with a low of 21,026 t in 2019 (Ramos & Winter 2020). Catches during the past demersal surveys have been trending downwards from 8.05 t in 2010 (Brickle et al 2010) to 2.42 t in 2020 (Table 2), the latter being the lowest catch recorded during the demersal survey despite having surveyed more deeper water stations than in any previous survey except for 2018. In fact, catches during the 2018 demersal survey were an anomaly as catches increased from 2.54 t in 2017 (Gras et al 2017) to 6.85 t in 2018 (Gras et al 2018) and then back down to 2.47 t in 2019 (Arkhipkin et al 2019). Abundance of *C. fasciatus* was highest in the southern-most stations in 2020 (Fig 36), but not in 2019 (Arkhipkin et al 2019). Perhaps that estimates of biomass expects greater catches modelled at similar or greater depths, thus explaining the discrepancy between the lowest estimated biomass on record in 2019 (21,026 t) being nearly half of the estimated biomass of 39,381 t in 2020 despite similar catches between both years. However, it should be noted that the confidence intervals between the biomass estimates for 2019 and 2020 overlap (Ramos & Winter 2020). Additionally, catches of *C. fasciatus* were greater in the "*Loligo*" Box in 2020 compared to 2019 (Ramos & Winter 2020). Combined with the fact that some stations to the southwest were conducted in 2020, but not in 2019, there might be a spatial artefact on biomass estimations in Ramos & Winter (2020) explaining the discrepancy in estimates. This species is not a commercial species and all *C. fasciatus* catches were discarded in 2010 (Brickle et al 2010), 2011 (Arkhipkin et al 2011), 2015 (Gras et al 2015), 2016 (Gras et al 2016), 2017 (Gras et al 2017), 2019 (Arkhipkin et al 2019), and in 2020. In 2018, only 74.0% of *C. fasciatus* was discarded (Gras et al 2018). The latter can be explained by *C. fasciatus* caught in deeper waters to the southwest being larger (Fig 39b). Despite *C. fasciatus* not being exploited commercially, it is possible that the population is at risk of overexploitation should the life-history characteristics be comparable with other grenadier species in the zone, i.e. long-lived, slow growing and late-maturing (see Lee et al 2019).

The grenadier *M. carinatus* does reach a larger size and is commercially retained by the commercial fleet. However, given the range of depths sampled during the demersal surveys since 2010 (except for 2018), catches for this species have not been substantial and therefore, credible biomass estimates cannot be generated unless the survey is extended to the southwest in future years.

Biomass estimates of southern blue whiting have been highly variable since 2010 (Ramos & Winter 2020). Gras et al (2018) identified a hotspot for this species in the southwest; further south than previous demersal surveys. Coupled with the high abundance of southern blue whiting caught in deeper waters during the "*Loligo*" pre-recruitment survey (see Ramos & Winter 2020) and the gap to the southwest with the demersal survey, biomass estimates are accompanied by very wide confidence intervals. Trends in biomass for this species need to be interpreted carefully.

Biomass estimates of *M. hubbsi* range from a low of 3,346 t in 2020 to a high of 15,910 t in 2015 with no obvious trend or pattern (Ramos & Winter 2020). The same is true for *M. hubbsi* catches during demersal surveys. This survey is conducted prior to the immigration of hake into the FICZ/FOCZ. The determinants of the timing of this migration, which generally occurs between March and May, are currently under investigation. Fish sampled this year were generally skinny (poor body condition) and spent (Stage VII) or recovering spent (Stage VIII).

Catches of *D. eleginoides* during this survey were the second lowest since 2010. Given potential recruitment failure in 2018 (Arkhipkin et al 2019), it is not surprising that the catches of *D. eleginoides* on the shelf during the 2020 demersal survey were second lowest since 2010 with few 1+ year old fish caught (Fig 25). Furthermore, the absence of juvenile (0+ year old) *D. eleginoides* at our four shallow water stations could indicate another recruitment failure in 2019.

5.0 Recommendations

- The stations should remain consistent from one demersal survey to the next as the inclusion or omission of stations from one year to the next may result in biased estimates and would prevent examination of biomass trends through time. For instance, it is not possible to compare biomass estimates or biological parameters obtained during this survey for *M. carinatus C. fasciatus, M. magellanicus, D. eleginoides,* and *M. a. australis* with much confidence as areas of greater abundance for these species are to the southwest of the sampled area; an area covered partially during this survey, but not in 2019. Therefore, the increase in biomass for some of these species from last year, may be a spatial artefact. It is therefore recommended that the FIFD make a determination prior to the next demersal survey as to what species to prioritise and ensure that the survey design provides adequate spatial coverage for these.
- In 2020, we used a different vessel and different trawl doors compared to 2018 and 2019. Gear and vessel effects can impact on catchability and selectivity, thus affecting biomass estimates. It is therefore recommended to be consistent with gear and vessel use. Alternatively, recording net horizontal opening and distance covered at every station can reduce significantly gear or vessel bias.
- Since most of the small *P. ramsayi*, i.e. < 10 cm T_L, do not make it onto the sorting belt and are often weighed once processing the catch is completed, it is recommended that an additional random sample be processed from these small individuals at each station. Alternatively, the entire catch of *P. ramsayi* could be set aside until all fish have been sorted with a random sample being taken at the end.
- We revealed decreases in modal and mean length for *S. australis*, *G. blacodes*, *M. magellanicus*, and *P. ramsayi* during this cruise. Using the exhaustive otolith collections and length measurements generated during this cruise, we recommend investigating the age and size structures of their respective populations and compare these to previous years going back to 2010; the year of the first February demersal survey.
- There are some limitations with the weighing of small samples on board. Perhaps we can look into implementing an "anti-vibration system" and bring scales with greater precision for smaller samples such as benthos, gonads, and stomach contents.
- During the first CTD on the Research cruise an issue came to light with the crane on the Castelo when switching the power (or hydraulic pump or something else) from the crane to the CTD winch. We recommend that this issue be highlighted with RBC so that this can be addressed in time for the next research cruise.
- There was also an issue with the counter on the CTD winch, and it may be in need of calibration. We recommend that the counter be re-calibrated, cable be run out and measured relative to the counter on the bridge to give a proportional error. Alternatively, the CTD be deployed in deeper water and stopped at specific intervals and the counter depth compared to that recorded on the CTD. This should be accomplished in time for the next research cruise or, if using the CTD to calibrate the counter, be conducted at the very start of the next research cruise.
- The crane was also used to deploy the Isaac-Kidd (IK) Plankton net. The aforementioned issues all affected the crane as the CTD winch was used for the IK

net cable. We recommend highlighting this issue with RBC to develop a revised procedure to deploy the IK net from the Castelo.

6.0 References

Arkhipkin AI, Bakanev S, Laptikhovsky V (2011) Scientific Report: Fisheries research cruise ZDLT1-02-2011. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 37 pp.

Arkhipkin AI, Brickle P, Laptikhovsky V (2013) Links between marine fauna and oceanic fronts on the Patagonian Shelf and Slope. *Arquipelago. Life and Marine Sciences.* 30: 19-37.

Arkhipkin AI, Herrera D, Lee B, Boag T, Bradley K, Cockroft K (2017) Scientific Report, Fisheries Cruise ZDLT1-01-2017. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 34 pp.

Arkhipkin A, Lee B, Goyot L, Ramos JE, Chemshirova I, Roberts G, Costa M, Blake A (2019) Cruise Report ZDLM3-02-2019: Demersal biomass survey. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 44 pp.

Brickle P, Laptikhovsky V (2010) Cruise Report ZDLT1-02-2010: Rock cod biomass survey. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 31 pp.

Brocard D, Gillet F, Legendre P (2011) Numerical Ecology with R. Springer Science+Business Media, New York. 306 pp.

De Cáceres M, Legendre P (2009) Associations between species and groups of sites: indices and statistical inference. *Ecology.* 90: 3566-3574.

Eleftheriou A, McIntyre A (2005) Methods for the study of marine benthos. Blackwell Science. Oxford. 418 p.

Gras M, Blake A, Pompert J, Jürgens L, Visauta E, Busbridge T, Rushton H, Zawadowski T (2015) Report of the 2015 rock cod biomass survey ZDLT1-02-2015. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 45 pp.

Gras M, Pompert J, Blake A, Boag T, Grimmer A, Iriarte V, Sánchez B (2016) Report of the 2016 finfish and rock cod biomass survey ZDLT1–02–2016. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 71 pp.

Gras M, Pompert J, Blake A, Busbridge T, Derbyshire C, Keningale B, Thomas O (2017) Report of the 2017 ground fish survey ZDLT1–02–2017. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 83 pp.

Gras M, Randhawa HS, Blake A, Busbridge T, Chemshirova I, Guest A (2018) Report of the 2018 ground fish survey ZDLM3–02–2018. Stanley, Fisheries Department, Directorate of Natural Resources, Falkland Islands Government. Stanley, Falkland Islands. 81 pp.

Lee B (2017) Rock cod age validation report. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 2 pp.

Lee B, Cockroft K, Arkhipkin AI, Wing SR, Randhawa HS (2019) Age, growth and mortality estimates for the ridged-scale grenadier *Macrourus carinatus* (Günther, 1878) in the south-western Atlantic. *Fisheries Research.* 218: 174-185.

R Core Team (2018) R: A language and environment for statistical computing. R Foundation f or Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Ramos JE, Winter A (2019a) Stock assessment of hoki (*Macruronus magellanicus*) in the Falkland Islands. SA-2019-WHI. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 47 pp.

Ramos JE, Winter A (2019b) Stock assessment of kingclip (*Genypterus blacodes*) in the Falkland Islands, 2017-2018. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 31 pp.

Ramos JE, Winter A (2020) February trawl survey biomasses of fishery species in Falkland Islands waters, 2010–2020. SA–2020–04. Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 58 pp.

Schlitzer R (2013) Ocean Data View, http://odv.awi.de

Winter A (2018) Stock Assessment: Red cod (*Salilota australis*). Fisheries Department, Directorate of Natural Resources, Falkland Islands Government, Stanley, Falkland Islands. 22 pp.