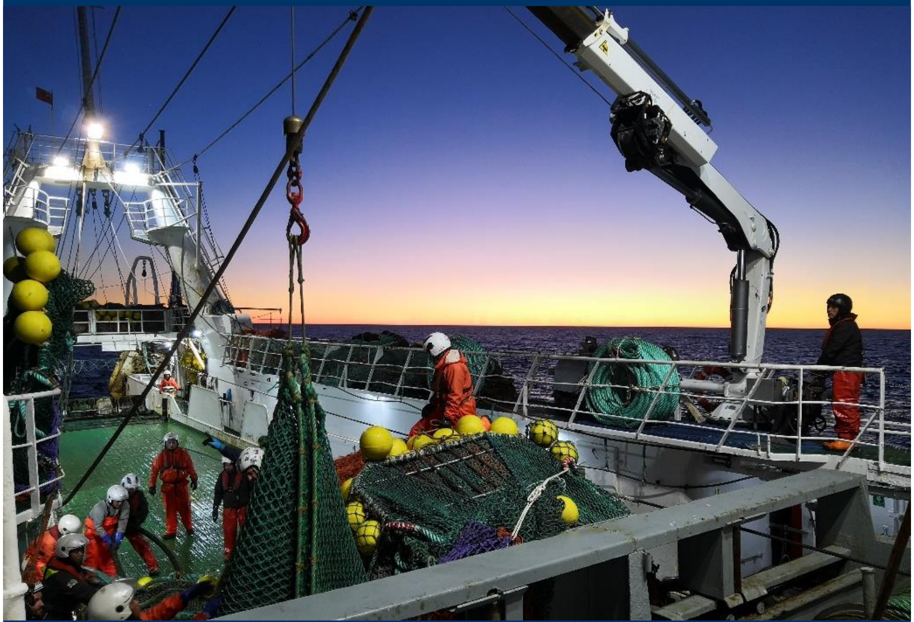
Cruise Report 2024-07-ZDLT1

Groundfish survey



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1. Introduction

The Falkland Islands shelf is located within the Patagonian large marine ecosystem, one of the most productive areas in the world (Arkhipkin et al. 2012). The Patagonian large marine ecosystem is comprised of a southern temperate ecosystem in the north and a sub-Antarctic ecosystem in the south, divided by a boundary that runs from the south-west to the north-east through the Falkland Islands (Boltovskoy 1999). This marine ecosystem lies within waters of subtropical origin, transported onto the shelf by the Brazil Current and mixed with temperate shelf waters. Several productive zones are revealed in this ecosystem, mainly due to the existence of tidal mixing oceanographic fronts, as well as seasonal fronts originating from cold fresh water inflows into the Strait of Magellan. The sub-Antarctic ecosystem lies within waters of sub-Antarctic origin transported onto the shelf by the Falkland Current (Peterson & Whitworth 1989). The Falkland Current diverges from the main stream of the Antarctic Circumpolar Current in the Drake Passage and turns northwards. The Falkland Current splits at the continental slope south of the Falkland Islands into a weak branch and a stronger branch that flow around the west and east of the Islands, respectively (Bianchi et al. 1982). These oceanographic features affect the distribution and abundance of marine species such as the Argentine shortfin squid (*Illex argentinus*) and hoki (*Macruronus magellanicus*) that migrate to frontal zones for feeding and back to non-frontal zones for spawning (Agnew 2002). In contrast, the intrusion of sub-Antarctic waters favour the migration of deep-water fish such as toothfish (*Dissostichus eleginoides*) into the shelf (Laptikhovsky et al. 2008; Arkhipkin & Laptikhovsky 2010).

Scientific surveys are key sources of fisheries independent data for fisheries ecology and that benefit from a standardised sampling plan and constant catchability (Hilborn & Walters 1992; Alglave et al. 2022; Gallo et al. 2022). The Falkland Islands Fisheries Department (FIFD) has carried out annual fisheries independent groundfish surveys that consist of a fixed array of bottom trawls to the west and north in the Falkland Islands Interim Conservation and Management Zone (FICZ) and in the northern part of the Falkland Islands Outer Conservation Zone (FOCZ) during summer[1] (February 2010, 2011, 2015–2023) and winter (July 2017 and 2022). The February groundfish surveys were originally conducted to estimate the biomass of the former index species (i.e., rock cod *Patagonotothen ramsayi*). However, the aim of the February groundfish survey extended to other commercial and bycatch species in recent years. Biomass estimates from February groundfish surveys conducted in parallel with calamari pre-season surveys in the 'Loligo Box' revealed the decrease of rock cod, red cod (*Salilota australis*), and southern hake (*Merluccius australis*) abundances over the last decade. Banded whiptail grenadier (*Coelorinchus fasciatus*), hoki, southern blue whiting (*Micromesistius australis*), and toothfish had declining trends from 2010 to 2019–2020, with subsequent biomass increase since 2021. Only the common hake (*Merluccius hubbsi*) had a significant increase in biomass from 2010 to 2023 (Ramos & Winter 2023). The July groundfish surveys, being more recent and therefore having a shorter time series, were also conducted to examine the biomass of commercial species but with emphasis on the common hake (Gras et al. 2017; Lee et al. 2022; Ramos et al. 2023). Increasing abundance of common hake in the Falkland Shelf in recent years (Ramos & Winter 2022a, 2023) triggered a demography survey conducted exclusively for this species during July 2020 (Randhawa et al. 2020). The FIFD aim to build a solid time series of abundance, distribution, and biological data of commercial species during February and July, to be able to compare patterns through the years, and between summer and winter, and to examine how these patterns are affected by environmental, ecological, and anthropogenic factors. Therefore, the following objectives were established for the July 2024 groundfish survey:

1.1. Survey objectives

1. To examine the abundance, distribution, and biology of demersal fish and squid species along the west and north in the Falkland Shelf.

[1] Austral seasons are referred to in this report.

2. To carry out an oceanographic survey along the west and north in the Falkland Shelf.
3. To collect gonads of common hake (*Merluccius hubbsi*), red cod (*Salilota australis*), rock cod (*Patagonotothen ramsayi*), southern blue whiting (*Micromesistius australis*), and toothfish (*Dissostichus eleginoides*) for histological analysis, for validation of maturity stages.

2. Material and Methods

2.1. Vessel

The July 2024 groundfish survey (2024-07-ZDLT1) was conducted aboard the F/V Castelo (ZDLT1), registered in the Falkland Islands (LOA 67.8 m, GT 1321).

2.2. Survey plan and key dates

The standard plan of the groundfish survey consists of 84 bottom trawl fixed stations of 60 min. The fixed station number, corresponding coordinates, course and depth are indicated in a master list (Appendix I) used as a reference during the survey. Typically, four trawl stations are conducted per day over a 21-day sampling period. Each trawl is preceded or succeeded by an oceanographic station (CTD). These stations are replicated each year according to a systematic transect design based on the division of the shelf area into 0.5 longitude by 0.25 latitude decimal degree grid squares, and each trawl station is allocated to a different grid square to ensure coverage of the entire study area.

The July 2024 groundfish survey was shortened by one day due to health issues of the crew, which delayed the arrival of the ship to Stanley, Falkland Islands from the port of Vigo in Spain. Four stations were excluded due to this delay, i.e., fixed stations 61, 64, 78, and 83 from the master list (Appendix I). The stations that had to be excluded were amongst the same stations that were deliberately excluded in the July 2022 and July 2023 groundfish surveys due to delays of the vessel for the start of the survey. Four stations were not conducted due to bad weather, i.e., fixed stations 5, 15, 26, and 91. Fixed stations 5 and 91 were excluded to allow conducting stations 8 and 10 instead, which were originally cancelled due to rough weather on day 18 of fishing. The retained stations covered the full survey area (Fig. 1). The ship departed from Stanley at 20:30 on July 4th 2024. The first trawl station was conducted to the north of East Falkland early in the morning on July 5th 2024, an area where catches are usually small. This allowed the new scientific staff to familiarise with the routine of the survey during less busy stations. Four trawls were conducted per day; an oceanographic station (CTD) preceded each trawl, except for the last trawl of the day that was succeeded by the oceanographic station to complete the four trawls during daylight, as there are less hours of daylight during winter compared with summer. The last trawl of the survey was hauled on July 24th 2024 to the south-west of West Falkland. A total of 76 trawl and CTD stations were finally conducted, respectively. The ship arrived to Stanley on July 25th 2024, and the scientific crew disembarked at 9:30 at FIPASS.

2.3. Trawling

A bottom trawl net owned by the FIFD was used; the net was equipped with rockhopper gear fitted with Morgère V3 (1,800 kg; 3,180 cm × 2,480 cm) bottom doors. The cod-end had a 90 mm mesh size fitted with a 40 mm cod-end liner. Sweep length was 110 m, bridle length was 29.6 m, and footrope was 36.52 m. The MarPort Net Monitoring System was used to monitor the net geometry; all measurement readings were successfully obtained for all stations. The duration of each trawl was 60 min on the bottom, and trawling speed varied between 2.5 and 5.0 knots. The 76 bottom trawls conducted had corresponding specific survey station numbers ranging from 4131 to 4280 (Table I).

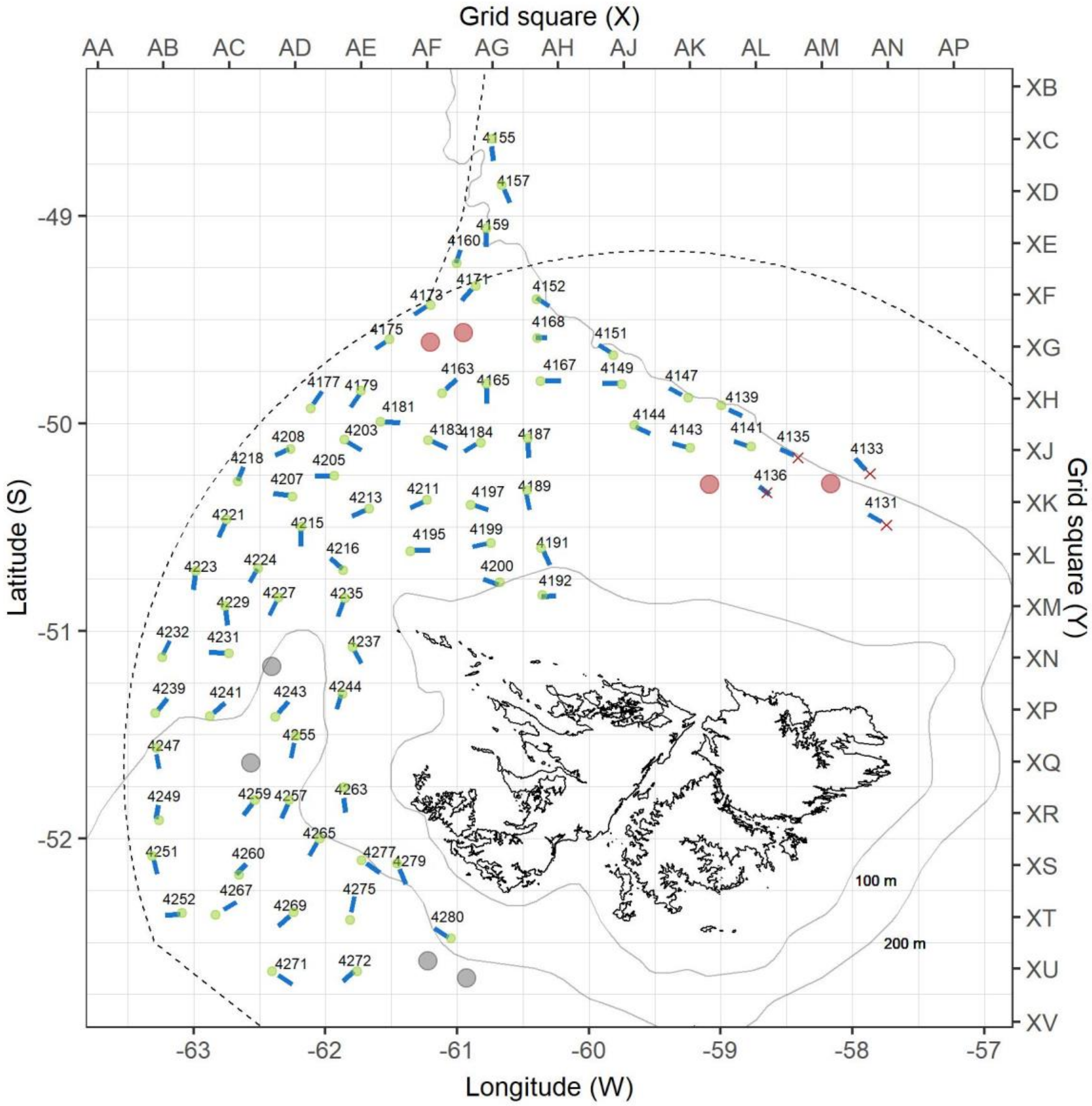

Figure 1. Bottom trawl tracks with survey station numbers conducted (n = 76) during the July 2024 groundfish survey (2024-07-ZDLT1). Bottom trawl stations excluded due to the survey being shortened are indicated with red circles. Bottom trawl stations cancelled due to rough weather are indicated with grey circles. CTD stations with usable oceanographic data are indicated with green dots (n = 72). CTD stations with not usable oceanographic data due to battery failure (n = 3) or with partial data (n = 1) are indicated with a red X.

Table I. Bottom trawl station data of the July 2024 groundfish survey (2024-07-ZDLT1). A total of 76 bottom trawls were conducted during the July 2024 groundfish survey.

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth
4131	05/07/2024	-50.4872	-57.7540	-50.4333	-57.8830	162
4133	05/07/2024	-50.2407	-57.8748	-50.1607	-57.9882	277
4135	05/07/2024	-50.1637	-58.4207	-50.1148	-58.5532	173
4136	05/07/2024	-50.2895	-58.7143	-50.3397	-58.6320	147
4139	06/07/2024	-49.9253	-58.9680	-49.9605	-58.8320	198
4141	06/07/2024	-50.1110	-58.7758	-50.0818	-58.9012	159
4143	06/07/2024	-50.1175	-59.2353	-50.0890	-59.3690	159
4144	06/07/2024	-50.0568	-59.5083	-50.0097	-59.6508	162
4147	07/07/2024	-49.8700	-59.2648	-49.8300	-59.4005	190
4149	07/07/2024	-49.8097	-59.8202	-49.8097	-59.8988	170

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth
4151	07/07/2024	-49.6675	-59.8123	-49.6243	-59.9270	187
4152	07/07/2024	-49.4460	-60.2793	-49.3978	-60.4008	197
4155	08/07/2024	-48.6413	-60.7433	-48.7382	-60.7232	243
4157	08/07/2024	-48.8528	-60.6622	-48.9393	-60.5908	243
4159	08/07/2024	-49.0612	-60.7835	-49.1542	-60.7763	191
4160	08/07/2024	-49.1475	-60.9685	-49.2263	-61.0063	174
4163	09/07/2024	-49.8488	-61.1092	-49.7888	-61.0007	164
4165	09/07/2024	-49.8105	-60.7825	-49.9082	-60.7672	165
4167	09/07/2024	-49.7957	-60.3630	-49.7947	-60.2017	169
4168	09/07/2024	-49.5965	-60.2890	-49.5880	-60.3980	174
4171	10/07/2024	-49.3380	-60.8735	-49.4092	-60.9613	170
4173	10/07/2024	-49.4270	-61.2048	-49.4797	-61.3275	163
4175	10/07/2024	-49.5935	-61.5180	-49.6457	-61.6148	161
4177	11/07/2024	-49.9220	-62.1097	-49.8428	-62.0230	148
4179	11/07/2024	-49.8407	-61.7300	-49.9255	-61.8048	159
4181	11/07/2024	-49.9903	-61.5803	-49.9987	-61.4272	158
4183	11/07/2024	-50.0782	-61.2165	-50.1198	-61.0673	160
4184	11/07/2024	-50.1397	-60.9777	-50.0967	-60.8298	160
4187	12/07/2024	-50.0705	-60.4632	-50.1652	-60.4498	159
4189	12/07/2024	-50.3217	-60.4733	-50.4165	-60.4430	155
4191	12/07/2024	-50.5980	-60.3587	-50.6828	-60.2915	146
4192	12/07/2024	-50.8278	-60.2202	-50.8310	-60.3578	137
4195	13/07/2024	-50.6122	-61.3533	-50.6095	-61.1955	152
4197	13/07/2024	-50.3890	-60.8937	-50.4178	-60.7562	153
4199	13/07/2024	-50.5730	-60.7488	-50.5965	-60.8847	151
4200	13/07/2024	-50.7417	-60.8295	-50.7782	-60.6802	135
4203	14/07/2024	-50.0763	-61.8518	-50.1288	-61.7188	157
4205	14/07/2024	-50.2495	-61.9370	-50.2518	-62.0817	159
4207	14/07/2024	-50.3492	-62.2547	-50.3360	-62.4037	154
4208	14/07/2024	-50.1612	-62.4095	-50.1238	-62.2707	148
4211	15/07/2024	-50.3693	-61.2287	-50.4112	-61.3543	159
4213	15/07/2024	-50.4107	-61.6695	-50.4530	-61.7980	168
4215	15/07/2024	-50.4995	-62.1822	-50.5985	-62.1837	168
4216	15/07/2024	-50.6377	-61.9907	-50.7043	-61.8710	185
4218	16/07/2024	-50.1937	-62.6062	-50.2780	-62.6638	147
4221	16/07/2024	-50.4630	-62.7562	-50.5498	-62.8100	149
4223	16/07/2024	-50.7103	-62.9877	-50.8045	-63.0013	151
4224	16/07/2024	-50.7793	-62.5910	-50.6998	-62.5133	166
4227	17/07/2024	-50.8410	-62.3605	-50.9265	-62.4242	183
4229	17/07/2024	-50.8800	-62.7598	-50.9798	-62.7365	166
4231	17/07/2024	-51.1077	-62.7318	-51.1033	-62.8830	171
4232	17/07/2024	-51.0327	-63.1698	-51.1198	-63.2407	156
4235	18/07/2024	-50.8487	-61.8597	-50.9320	-61.9002	176
4237	18/07/2024	-51.0772	-61.7963	-51.1520	-61.7177	179
4239	19/07/2024	-51.3978	-63.2930	-51.3237	-63.1992	168
4241	19/07/2024	-51.4067	-62.8728	-51.3478	-62.7550	185
4243	19/07/2024	-51.4117	-62.3800	-51.3380	-62.2742	213

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth
4244	19/07/2024	-51.3955	-61.9317	-51.3062	-61.8775	199
4247	20/07/2024	-51.5742	-63.2825	-51.6670	-63.2592	185
4249	20/07/2024	-51.8165	-63.2650	-51.9095	-63.2725	204
4251	20/07/2024	-52.0840	-63.3090	-52.1725	-63.2730	225
4252	20/07/2024	-52.3688	-63.2500	-52.3625	-63.0980	259
4255	21/07/2024	-51.5170	-62.2285	-51.6122	-62.2593	249
4257	21/07/2024	-51.8160	-62.2717	-51.9053	-62.3257	266
4259	21/07/2024	-51.8140	-62.5367	-51.8913	-62.6153	232
4260	21/07/2024	-52.1028	-62.5827	-52.1728	-62.6685	257
4263	22/07/2024	-51.7862	-61.8697	-51.8762	-61.8405	189
4265	22/07/2024	-52.0025	-62.0373	-52.0887	-62.1098	285
4267	23/07/2024	-52.3560	-62.7065	-52.3073	-62.6738	273
4269	23/07/2024	-52.3567	-62.2392	-52.4277	-62.3537	298
4271	23/07/2024	-52.6397	-62.3978	-52.7060	-62.2420	327
4272	23/07/2024	-52.7038	-61.8992	-52.6395	-61.7730	347
4275	24/07/2024	-52.3828	-61.8107	-52.2770	-61.7753	322
4277	24/07/2024	-52.1093	-61.7085	-52.1647	-61.5817	253
4279	24/07/2024	-52.1290	-61.4495	-52.2227	-61.3838	188
4280	24/07/2024	-52.4142	-61.2092	-52.4798	-61.0572	260

2.4. Catch and biological sampling

At each trawl station, all species from the catch were sorted and the total catch was weighed by species with an electronic Marel balance (150 kg capacity). All commercial species and most of the bycatch species were sampled, i.e., up to 100 randomly sampled individuals. Biological sampling of finfish included measurement to the lower cm of total length for common hake, driftfish (*Seriolella porosa*), kingclip (*Genypterus blacodes*), red cod, rock cod, southern blue whiting, and southern hake, or pre-anal length for hoki and grenadiers. Total length, fork length, and standard length were recorded for butterfish (*Stromateus brasiliensis*) to the lower cm. Macroscopic assessment of sex and maturity were conducted following an eight-stage sexual maturity scale (Brickle et al. 2006, modified from Nikolsky 1963). For squid, the sampling included the measurement of dorsal mantle length to the lower 0.5 cm, and recording of sex and maturity using a six-stage sexual maturity scale (Lipinski 1979). For skates, disc width and total length were measured to the lower cm, and weight was measured to the nearest gram; sex and maturity were examined macroscopically using a six-stage sexual maturity scale (Arkhipkin et al. 2008). For sharks, total length was recorded, and sex and maturity were examined macroscopically using a six-stage sexual maturity scale (Arkhipkin et al. 2008). Skates and sharks were dissected only if they looked in poor shape or if they were going to be processed by the fishing crew, otherwise they were released alive.

Otoliths were taken from fish according to a combined fixed (FOS) and random (ROS) otolith sampling strategy. For the FOS, otoliths were extracted from 2 to 5 individuals for each 1 cm length bin per sex. Otoliths from an additional 5 to 10 individuals (hake, kingclip, red cod, rock cod and toothfish) were also randomly extracted per station as part of the ROS strategy. During otolith collection, individual length was measured to the lower cm and total body weight was measured to the nearest gram. A total of 100 individuals of Argentine shortfin squid (*I. argentinus*) and Patagonian squid (*Doryteuthis gahi*) each, were collected from the north and south, in deep (>250 m) and shallow (≤150 m) stations, and frozen for statolith extraction at the FIFD laboratory. In addition, several fish specimens were frozen for further analyses ashore, including common hake, rock cod, and rays for training of scientific observers on species and maturity stage identification.

2.5. Finfish gonads sampling for histology

Gonad sampling, including ovaries and testes, was conducted opportunistically for five species: common hake, red cod, rock cod, southern blue whiting, and toothfish. Preliminary identification of the maturity stage of the gonad was made based on macroscopic characteristics following the eight-stage maturity scale used at FIFD (Brickle et al. 2006, modified from Nikolsky 1963). Fresh gonads were photographed for morpho-chromatic analysis, and fixed in 10% neutral buffered formaldehyde for histological examination.

2.6. Catch density

Catch density per species (D; kg/km^2) was calculated at each trawl station following Gras (2016):

$$\mathrm{D} = \frac{\mathrm{C}}{\mathrm{d} \times \mathrm{HNO}}$$

where C = catch (kg), d = trawl distance covered (km) calculated as the distance between the initial and the final position of the net at the seabed, and HNO = horizontal net opening (km) recorded by the MarPort Net Monitoring System.

2.7. Interactions with pinnipeds

The presence of pinnipeds around the vessel during shooting, hauling, or manoeuvring, and incidental bycatch and mortality were recorded.

2.8. Oceanography

An oceanographic station using a CTD (SBE-25, Sea-Bird Electronics Inc., Bellevue, USA) preceded or succeeded each bottom trawl station (Table II). The CTD was deployed to a depth of c.10 m below the surface for a soak time of two minutes to allow the pump to start circulating water and to flush the system. Then the CTD was raised to about 2 m below surface, and it was immediately lowered towards the seabed at approximately 1 m/sec to a maximum depth of around 1 m above seabed. The CTD recorded chlorophyll (µg/l), temperature (°C), dissolved oxygen (ml/l), salinity (PSU), and density (sigma t = kg/m^3 - 1000). 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 were filtered out. Depth was calculated from pressure using the latitude of each station. Ocean Data View version 5.15 (Schlitzer, R., Ocean Data View, http://odv.awi.de, 2013) was used to make the plots of each environmental variable at 10 m, 100 m, and seabed, except for chlorophyll that was plotted at 10 m, 30 m, and 50 m depths. The CTD memory capacity allows storing about 30 runs; nonetheless, oceanographic data were downloaded after every CTD run to corroborate that the CTD was working properly and to avoid loss of data.

Table II. CTD station data of the July 2024 groundfish survey (2024-07-ZDLT1). A total of 76 CTD stations were conducted during the July 2024 groundfish survey. †CTD cast not usable due to battery failure. * CTD cast only recorded data from the surface to approximately 60 m depth due to winch failure.

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth
4130†	05/07/2024	-50.4908	-57.7413	-50.4902	-57.7448	163
4132†	05/07/2024	-50.2440	-57.8652	-50.2420	-57.8700	275
4134†	05/07/2024	-50.1678	-58.4123	-50.1652	-58.4163	179
4137*	05/07/2024	-50.3347	-58.6472	-50.3318	-58.6550	145
4138	06/07/2024	-49.9150	-58.9977	-49.9117	-59.0015	209
4140	06/07/2024	-50.1118	-58.7705	-50.1110	-58.7733	157

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth
4142	06/07/2024	-50.1187	-59.2318	-50.1178	-59.2330	158
4145	06/07/2024	-50.0073	-59.6550	-50.0060	-59.6583	163
4146	07/07/2024	-49.8750	-59.2478	-49.8738	-59.2480	193
4148	07/07/2024	-49.8122	-59.7510	-49.8098	-59.7510	171
4150	07/07/2024	-49.6697	-59.8180	-49.6693	-59.8122	185
4153	07/07/2024	-49.4012	-60.4000	-49.4013	-60.3955	199
4154	08/07/2024	-48.6285	-60.7390	-48.6270	-60.7370	249
4156	08/07/2024	-48.8505	-60.6638	-48.8515	-60.6648	240
4158	08/07/2024	-49.0612	-60.7815	-49.0600	-60.7807	195
4161	08/07/2024	-49.2278	-61.0042	-49.2253	-61.0023	171
4162	09/07/2024	-49.8548	-61.1160	-49.8525	-61.1133	164
4164	09/07/2024	-49.8102	-60.7823	-49.8093	-60.7800	166
4166	09/07/2024	-49.7977	-60.3712	-49.7965	-60.3663	168
4169	09/07/2024	-49.5892	-60.3978	-49.5868	-60.3905	174
4170	10/07/2024	-49.3398	-60.8550	-49.3377	-60.8697	170
4172	10/07/2024	-49.4288	-61.2025	-49.4277	-61.2015	165
4174	10/07/2024	-49.5958	-61.5178	-49.5940	-61.5160	159
4176	11/07/2024	-49.9280	-62.1157	-49.9255	-62.1130	148
4178	11/07/2024	-49.8417	-61.7338	-49.8397	-61.7325	158
4180	11/07/2024	-49.9935	-61.5852	-49.9917	-61.5833	162
4182	11/07/2024	-50.0798	-61.2248	-50.0778	-61.2212	160
4185	11/07/2024	-50.0943	-60.8247	-50.0917	-60.8207	160
4186	12/07/2024	-50.0717	-60.4660	-50.0700	-60.4618	160
4188	12/07/2024	-50.3237	-60.4738	-50.3217	-60.4712	156
4190	12/07/2024	-50.5993	-60.3642	-50.5985	-60.3620	148
4193	12/07/2024	-50.8273	-60.3572	-50.8257	-60.3538	137
4194	13/07/2024	-50.6150	-61.3610	-50.6132	-61.3575	154
4196	13/07/2024	-50.3928	-60.8992	-50.3903	-60.8965	154
4198	13/07/2024	-50.5750	-60.7457	-50.5735	-60.7445	151
4201	13/07/2024	-50.7650	-60.6788	-50.7645	-60.6758	135
4202	14/07/2024	-50.0770	-61.8623	-50.0752	-61.8572	157
4204	14/07/2024	-50.2522	-61.9378	-50.2502	-61.9355	160
4206	14/07/2024	-50.3520	-62.2508	-50.3502	-62.2513	158
4209	14/07/2024	-50.1238	-62.2670	-50.1233	-62.2640	150
4210	15/07/2024	-50.3680	-61.2317	-50.3700	-61.2283	158
4212	15/07/2024	-50.4103	-61.6693	-50.4118	-61.6673	167
4214	15/07/2024	-50.4958	-62.1863	-50.4972	-62.1845	157
4217	15/07/2024	-50.7055	-61.8663	-50.7063	-61.8640	183
4219	16/07/2024	-50.2792	-62.6655	-50.2783	-62.6655	148
4220	16/07/2024	-50.4637	-62.7527	-50.4623	-62.7538	148
4222	16/07/2024	-50.7108	-62.9853	-50.7092	-62.9850	151
4225	16/07/2024	-50.6973	-62.5115	-50.6962	-62.5110	166
4226	17/07/2024	-50.8395	-62.3617	-50.8402	-62.3578	184
4228	17/07/2024	-50.8775	-62.7677	-50.8787	-62.7618	163
4230	17/07/2024	-51.1082	-62.7348	-51.1093	-62.7317	173
4233	17/07/2024	-51.1235	-63.2422	-51.1250	-63.2417	156
4234	18/07/2024	-50.8428	-61.8560	-50.8430	-61.8538	171

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth
4236	18/07/2024	-51.0788	-61.7958	-51.0765	-61.7950	184
4238	19/07/2024	-51.3948	-63.2957	-51.3930	-63.2937	167
4240	19/07/2024	-51.4092	-62.8788	-51.4080	-62.8750	186
4242	19/07/2024	-51.4147	-62.3860	-51.4127	-62.3812	210
4245	19/07/2024	-51.3032	-61.8723	-51.3012	-61.8685	199
4246	20/07/2024	-51.5613	-63.2868	-51.5615	-63.2842	182
4248	20/07/2024	-51.9102	-63.2650	-51.9102	-63.2587	207
4250	20/07/2024	-52.0838	-63.3203	-52.0835	-63.3143	223
4253	20/07/2024	-52.3605	-63.0912	-52.3577	-63.0873	263
4254	21/07/2024	-51.5045	-62.2262	-51.5025	-62.2232	247
4256	21/07/2024	-51.8152	-62.2770	-51.8143	-62.2737	267
4258	21/07/2024	-51.8137	-62.5428	-51.8147	-62.5350	231
4261	21/07/2024	-52.1748	-62.6618	-52.1730	-62.6565	259
4262	22/07/2024	-51.7550	-61.8623	-51.7512	-61.8592	177
4264	22/07/2024	-52.0003	-62.0473	-52.0002	-62.0407	279
4266	23/07/2024	-52.3670	-62.8382	-52.3645	-62.8337	272
4268	23/07/2024	-52.3530	-62.2472	-52.3545	-62.2412	299
4270	23/07/2024	-52.6370	-62.4103	-52.6390	-62.4027	318
4273	23/07/2024	-52.6375	-61.7675	-52.6373	-61.7605	346
4274	24/07/2024	-52.3942	-61.8150	-52.3907	-61.8112	324
4276	24/07/2024	-52.1055	-61.7303	-52.1032	-61.7280	270
4278	24/07/2024	-52.1207	-61.4598	-52.1202	-61.4585	181
4281	24/07/2024	-52.4807	-61.0507	-52.4808	-61.0428	272

3. Results

3.1. Catch composition

Catch weight and composition of squid, finfish, skate, and other demersal and semi-pelagic species are presented in Table III. The most abundant species in terms of catch weight were common hake (catch proportion: 77%), rock cod (8%), kingclip (5%), Patagonian squid (5%), and red cod (3%). Comparative total catch per station during July groundfish surveys is presented in Appendix II.

Table III. Catch composition and weight by species during the July 2024 groundfish survey (2024-07- ZDLT1).

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
HAK	*Merluccius hubbsi*	85808.769	4243.148	4.000	77.413
PAR	*Patagonotothen ramsayi*	8899.403	418.321	8655.923	8.029
KIN	*Genypterus blacodes*	6050.344	1518.644	45.254	5.458
LOL	*Doryteuthis gahi*	5042.741	262.915	271.023	4.549
BAC	*Salilota australis*	2964.465	908.033	23.279	2.674
WHI	*Macruronus magellanicus*	344.823	170.993	86.011	0.311
MED	*Medusa* spp.	193.664	0.000	193.664	0.175
TOO	*Dissostichus eleginoides*	191.300	191.300	165.424	0.173
GRF	*Coelorinchus fasciatus*	179.900	38.764	179.900	0.162

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
DGS	*Squalus acanthias*	178.077	178.077	178.077	0.161
DGH	*Schroederichthys bivius*	161.163	161.163	161.163	0.145
GRC	*Macrourus carinatus*	109.504	109.504	109.504	0.099
HYD	Hydrozoa	105.624	0.000	105.624	0.095
CGO	*Cottoperca gobio*	98.110	98.110	98.110	0.089
RFL	*Dipturus lamillai*	93.348	93.348	93.338	0.084
RBR	*Bathyraja brachyurops*	49.868	47.228	49.868	0.045
ILL	*Illex argentinus*	38.998	31.324	38.998	0.035
PAT	*Merluccius australis*	35.896	35.896	25.504	0.032
ALG	Algae	27.393	0.000	27.393	0.025
ING	*Moroteuthopsis ingens*	28.061	24.722	28.061	0.025
SPN	Porifera	27.899	0.118	27.899	0.025
BLU	*Micromesistius australis*	25.768	25.642	25.768	0.023
COP	*Congiopodus peruvianus*	23.784	1.662	23.784	0.021
SHT	Mixed invertebrates	22.444	0.000	22.444	0.020
ZYP	*Zygochlamys patagonica*	18.978	0.000	18.978	0.017
MUL	*Eleginops maclovinus*	16.636	16.636	16.636	0.015
RGR	*Bathyraja griseocauda*	16.922	16.922	16.922	0.015
SQT	Ascidiacea	16.578	0.000	16.578	0.015
BUT	*Stromateus brasiliensis*	13.580	13.580	13.580	0.012
ALF	*Allothunnus fallai*	8.995	8.995	8.995	0.008
RAL	*Bathyraja albomaculata*	6.284	6.284	6.284	0.006
RED	*Sebastes oculatus*	5.068	5.068	3.048	0.005
BRY	Bryozoa	4.382	0.000	4.382	0.004
CAC	*Callorhinchus callorynchus*	4.518	4.518	4.518	0.004
GOC	*Gorgonocephalus chilensis*	2.876	0.000	2.876	0.003
SEP	*Seriolella porosa*	3.458	3.458	3.458	0.003
ASA	*Astrotoma agassizii*	1.818	0.000	1.818	0.002
MLA	*Muusoctopus longibrachus akambei*	1.786	0.000	1.786	0.002
RDO	*Amblyraja doellojuradoi*	1.860	1.860	1.860	0.002
RMU	*Bathyraja multispinis*	2.282	2.282	2.282	0.002
STA	*Sterechinus agassizii*	2.021	0.000	2.021	0.002
THO	Thouarella	2.172	0.000	2.172	0.002
ANM	Anemonia	0.876	0.050	0.876	0.001
FLX	Flabellum spp.	0.562	0.000	0.562	0.001
FUM	*Fusitriton magellanicus*	0.640	0.000	0.640	0.001
ILF	*Iluocoetes fimbriatus*	1.136	0.000	1.136	0.001
MUN	*Grimothea gregaria*	1.150	0.000	1.150	0.001
OPV	*Ophiosabine vivipara*	0.662	0.000	0.662	0.001
RBZ	*Bathyraja cousseauae*	0.985	0.985	0.985	0.001
RMC	*Bathyraja macloviana*	0.924	0.924	0.924	0.001
ACS	*Acanthoserolis schythei*	0.145	0.001	0.145	<0.001
AGO	*Agonopsis chiloensis*	0.004	0.004	0.004	<0.001
ALC	Alcyoniina	0.086	0.000	0.086	<0.001
ANT	Anthozoa	0.004	0.000	0.004	<0.001

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
AST	Asteroidea	0.085	0.000	0.085	<0.001
AUC	*Austrocidaris canaliculata*	0.553	0.000	0.553	<0.001
AUL	*Austrolycus laticinctus*	0.006	0.000	0.006	<0.001
BAO	*Bathybiaster loripes*	0.004	0.000	0.004	<0.001
BIV	Bivalvia	0.076	0.000	0.076	<0.001
CAS	*Campylonotus semistriatus*	0.362	0.000	0.362	<0.001
CAZ	*Calyptraster* sp.	0.237	0.000	0.237	<0.001
CEX	*Ceramaster* sp.	0.028	0.000	0.028	<0.001
CIR	Cirripedia	0.276	0.000	0.276	<0.001
COL	*Cosmasterias lurida*	0.014	0.000	0.014	<0.001
COT	*Cottunculus granulosus*	0.204	0.000	0.204	<0.001
CTA	*Ctenodiscus australis*	0.403	0.004	0.403	<0.001
CTE	Ctenophora	0.070	0.000	0.070	<0.001
CYX	*Cycethra* sp.	0.062	0.000	0.062	<0.001
DDT	*Desmophyllum dianthus*	0.086	0.000	0.086	<0.001
EGG	Eggmass	0.379	0.000	0.379	<0.001
EUL	*Eurypodius latreillii*	0.028	0.000	0.028	<0.001
EUO	*Eurypodius longirostris*	0.030	0.000	0.030	<0.001
HEO	*Henricia obesa*	0.032	0.000	0.032	<0.001
HEX	*Henricia* sp.	0.168	0.000	0.168	<0.001
HOL	Holothuroidea	0.006	0.000	0.006	<0.001
ISO	Isopoda	0.064	0.000	0.064	<0.001
LIR	*Limopsis marionensis*	0.022	0.000	0.022	<0.001
LIS	*Lithodes santolla*	0.060	0.000	0.060	<0.001
LOA	*Loxechinus albus*	0.002	0.000	0.002	<0.001
LOS	*Lophaster stellans*	0.068	0.000	0.068	<0.001
MAV	*Magellania venosa*	0.010	0.000	0.010	<0.001
MIR	*Mirostenella* sp.	0.330	0.000	0.330	<0.001
MXX	*Myctophidae* spp.	0.006	0.000	0.006	<0.001
NOW	*Paranotothenia magellanica*	0.234	0.234	0.234	<0.001
NUD	Nudibranchia	0.036	0.000	0.036	<0.001
NUH	*Nuttallochiton hyadesi*	0.004	0.000	0.004	<0.001
OCM	*Enteroctopus megalocyathus*	0.318	0.000	0.318	<0.001
ODM	*Odontocymbiola magellanica*	0.155	0.050	0.155	<0.001
OPL	*Ophiuroglypha lymani*	0.253	0.000	0.253	<0.001
OPS	*Ophiactis asperula*	0.004	0.000	0.004	<0.001
PES	*Peltarion spinulosum*	0.117	0.000	0.117	<0.001
PLB	Primnoidae	0.047	0.000	0.047	<0.001
PLU	Primnoidae	0.025	0.000	0.025	<0.001
POA	*Glabraster antarctica*	0.336	0.000	0.336	<0.001
POL	Polychaeta	0.040	0.000	0.040	<0.001
PRX	*Paragorgia* sp.	0.128	0.000	0.128	<0.001
PYM	*Notophycis marginata*	0.098	0.026	0.098	<0.001
PYX	*Pycnogonida*	0.041	0.002	0.041	<0.001
RPX	*Psammobatis* spp.	0.465	0.465	0.465	<0.001

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
SAR	*Sprattus fuegensis*	0.186	0.186	0.186	<0.001
SAT	*Salpa thompsoni*	0.150	0.000	0.150	<0.001
SOR	*Solaster regularis*	0.008	0.000	0.008	<0.001
SUN	*Labidiaster radiosus*	0.182	0.000	0.182	<0.001
TED	*Terebratella dorsata*	0.020	0.000	0.020	<0.001
THB	*Thymops birsteini*	0.155	0.000	0.155	<0.001
TRP	*Tripylaster philippii*	0.004	0.000	0.004	<0.001
WRM	Annelida	0.002	0.000	0.002	<0.001

3.2. Biological information of finfish species

3.2.1. *Salilota australis* – Red cod

Red cod were caught at 41 of the 76 survey trawl stations. Total catch was 2,965 kg, and catches ranged from 0.1 to 769 kg per trawl (CPUE: 39 kg/h). Densities ranged from 0.4 to 3,090 kg/km^2, with higher densities occurring mostly to the south-west of the Falkland Islands (Fig. 2A). Most females were at resting maturity stage (maturity stage II); males were mainly at resting or early developing maturity stages (maturity stages II–III; Fig. 2B). Females were 19–82 cm, and males were 20–62 cm. Length frequency distributions were multimodal, and overlap of lengths did not allow identifying all the length-groups present. Some length modes of females were detected at 22 cm, 28 cm, around 49 cm, 54 cm, and 59 cm length (Fig. 2C). Length modes of males were identified at 22–23 cm, 29 cm, around 40 cm, 45 cm, and 49 cm length (Fig. 2C).

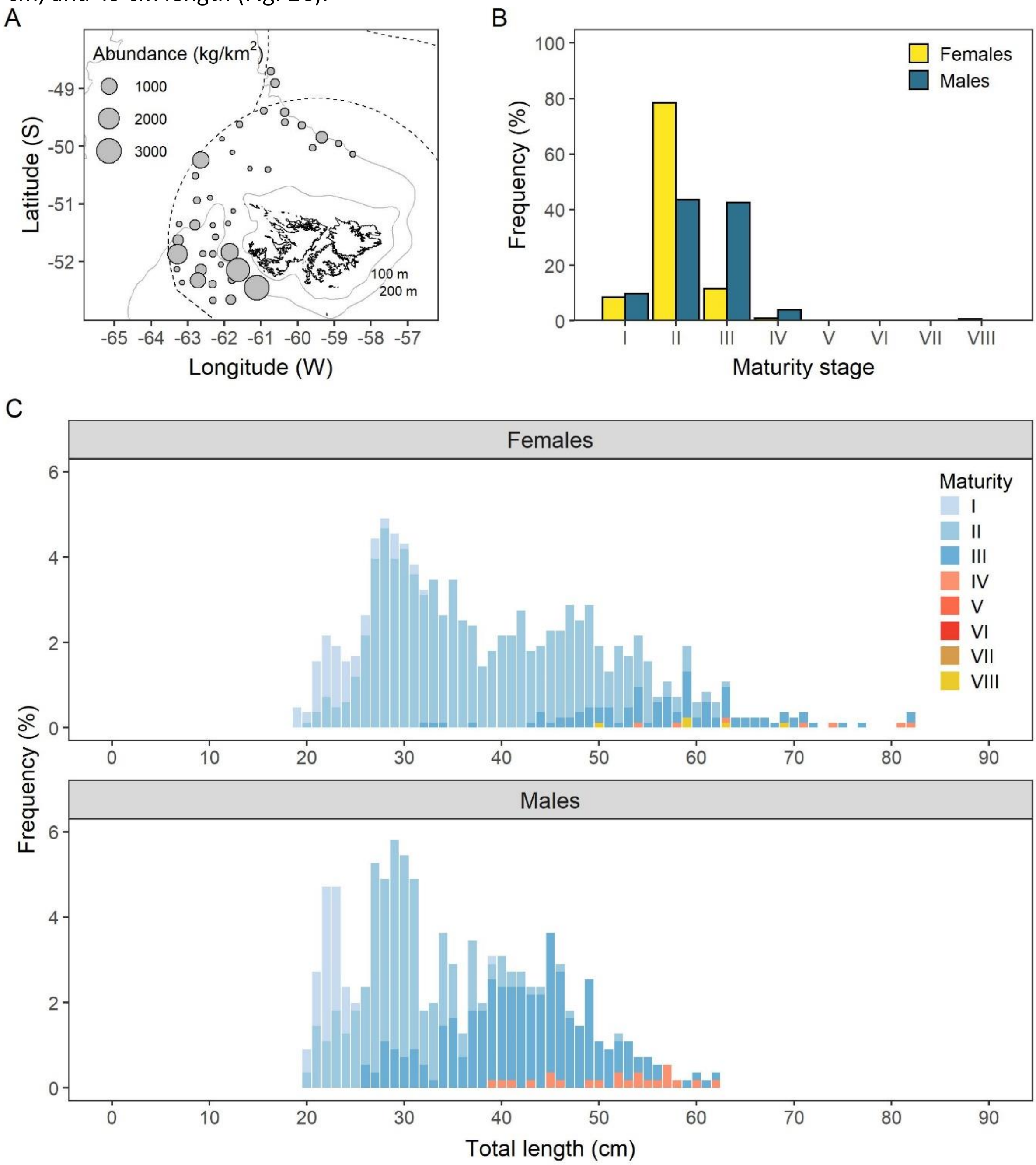

Figure 2. Biological data of *Salilota australis* (Red cod; BAC). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 835) and male lengths (n = 551) with 1 cm size class.

3.2.2. *Micromesistius australis* – Southern blue whiting

Southern blue whiting were caught at 35 of the 76 survey trawl stations. Total catch was 26 kg, and catches ranged from 0.02 to 4 kg per trawl (CPUE: 0.3 kg/h). Densities ranged from 0.09 to 17 kg/km^2, with higher densities at the south-west in the FICZ (Fig. 3A). Females were mainly immature, at resting or early developing maturity stages (maturity stages I–III). Males were mainly immature (maturity stage I), and a few individuals were at resting, developing, or spent maturity stages (maturity stages II–VIII; Fig. 3B). Females were 18–56 cm length and males were 14–52 cm length (Fig. 3C). The small number of females caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 3C), whereas three length-groups with modes at 16 cm, 19 cm, and 50 cm length were detected for males (Fig. 3C).

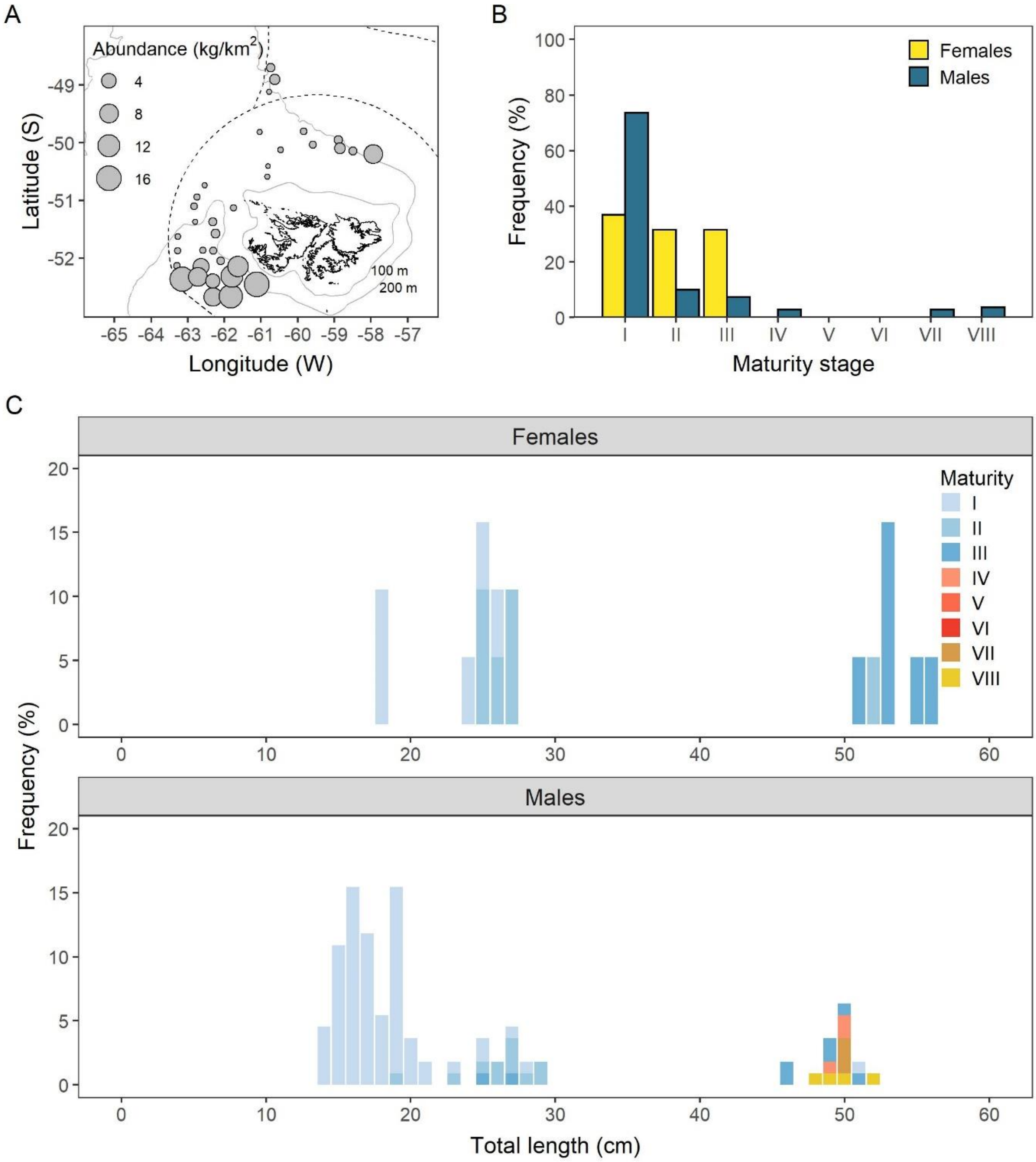

Figure 3. Biological data of *Micromesistius australis* (Southern blue whiting; BLU). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 19) and male lengths (n = 110) with 1 cm size class.

3.2.3. *Merluccius hubbsi* – Common hake

Common hake were caught at the 76 survey trawl stations. Total catch was 85,809 kg, and catches ranged from 31 to 5,908 kg per trawl (CPUE: 1,129 kg/h). Densities ranged from 143 to 26,527 kg/km^2, with high densities through the survey area (Fig. 4A). Most females were at resting or early developing maturity stages (maturity stages II–III; Fig. 4B). Most males were at late developing or at early developing maturity stages (maturity stages IV and III, respectively; Fig. 4B). Females were 28–77 cm length and males were 24–56 cm length. The length frequency histogram allowed identifying one length-group with mode at 41 cm length and 38 cm length for females and males, respectively (Fig. 4C).

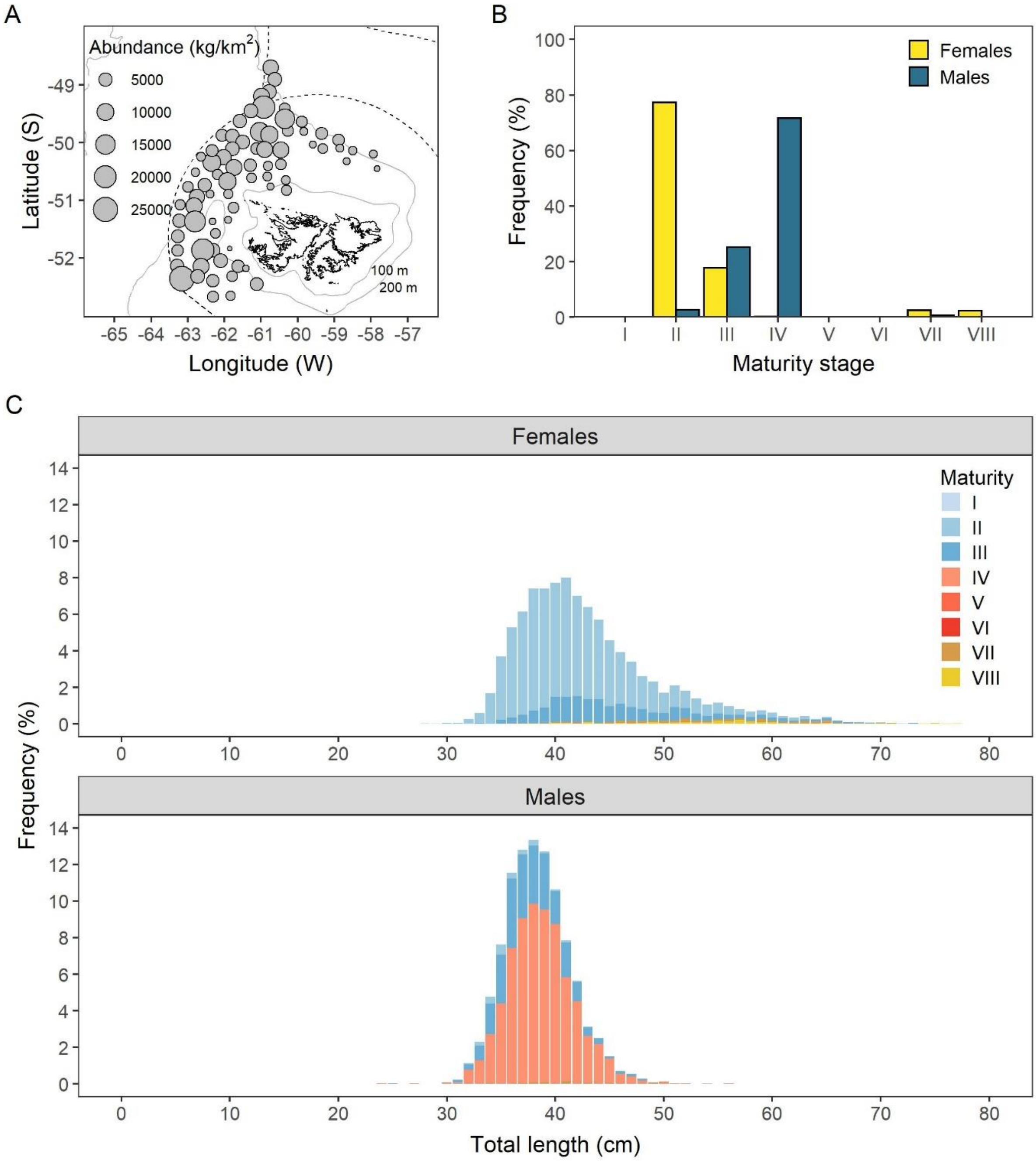

Figure 4. Biological data of *Merluccius hubbsi* (Common hake; HAK). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 5,289) and male lengths (n = 2,163) with 1 cm size class.

3.2.4. *Genypterus blacodes* – Kingclip

Kingclip were caught at 41 of the 76 survey trawl stations. Total catch was 6,050 kg, and catches ranged from 0.3 to 3,952 kg per trawl (CPUE: 80 kg/h). Densities ranged from 1 to 17,220 kg/km^2, with higher densities observed to the north and south-west of West Falkland (Fig. 5A). Most females and males were at resting maturity stage (maturity stage II) and minor proportions at early developing maturity stage (maturity stage III; Fig. 5B). Females were 35–112 cm length, and males were 37–106 cm length. Length frequency distributions were multimodal, and overlap of lengths did not allow identifying all the length-groups present. The main modes were detected at around 62–66 cm and 81 cm length for females, and at 67 cm length for males (Fig. 5C).

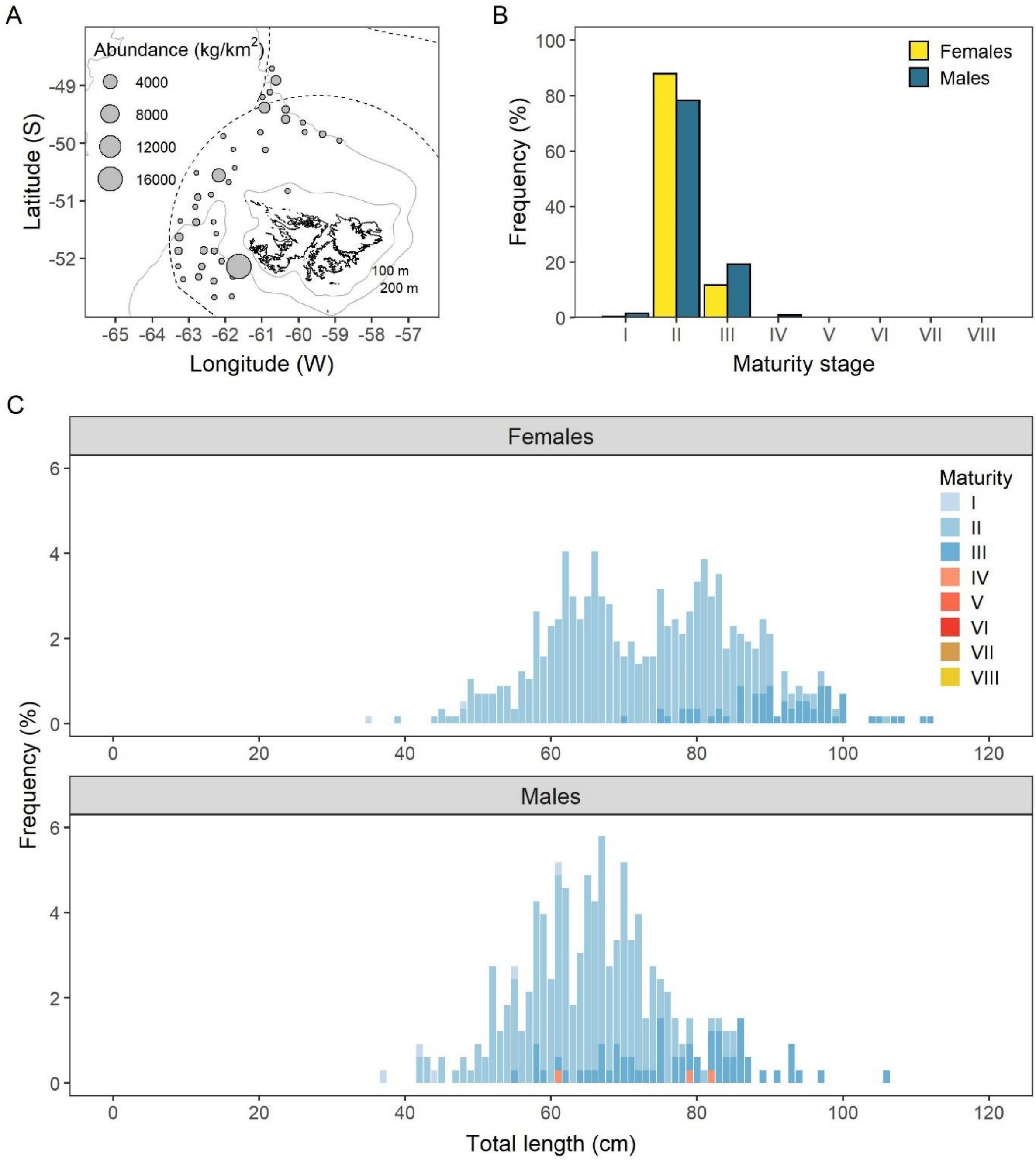

Figure 5. Biological data of *Genypterus blacodes* (Kingclip; KIN). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 570) and male (n = 328) lengths with 1 cm size class.

3.2.5. *Patagonotothen ramsayi* – Common rock cod

Rock cod were caught at the 76 survey trawl stations. Total catch was 8,899 kg, and catches ranged from 0.03 to 4,236 kg per trawl (CPUE: 117 kg/h). Densities ranged from 0.15 to 22,028 kg/km^2, with higher densities observed to the north-west in the FICZ (Fig. 6A). Most females and males were at immature, resting or developing maturity stages (maturity stages ≤IV), with early developing females and resting males being predominant (Fig. 6B). Females were 11–37 cm length, males were 12–35 cm length, and 2 juveniles were 7 cm length, each. Two length-groups were identified; modal lengths of females were 16 cm and 22 cm for females (Fig. 6C), whereas modal lengths of males were 15 cm, and 20 cm (Fig. 6C). More than three length-groups may exist but these were not detected because of the overlap in lengths.

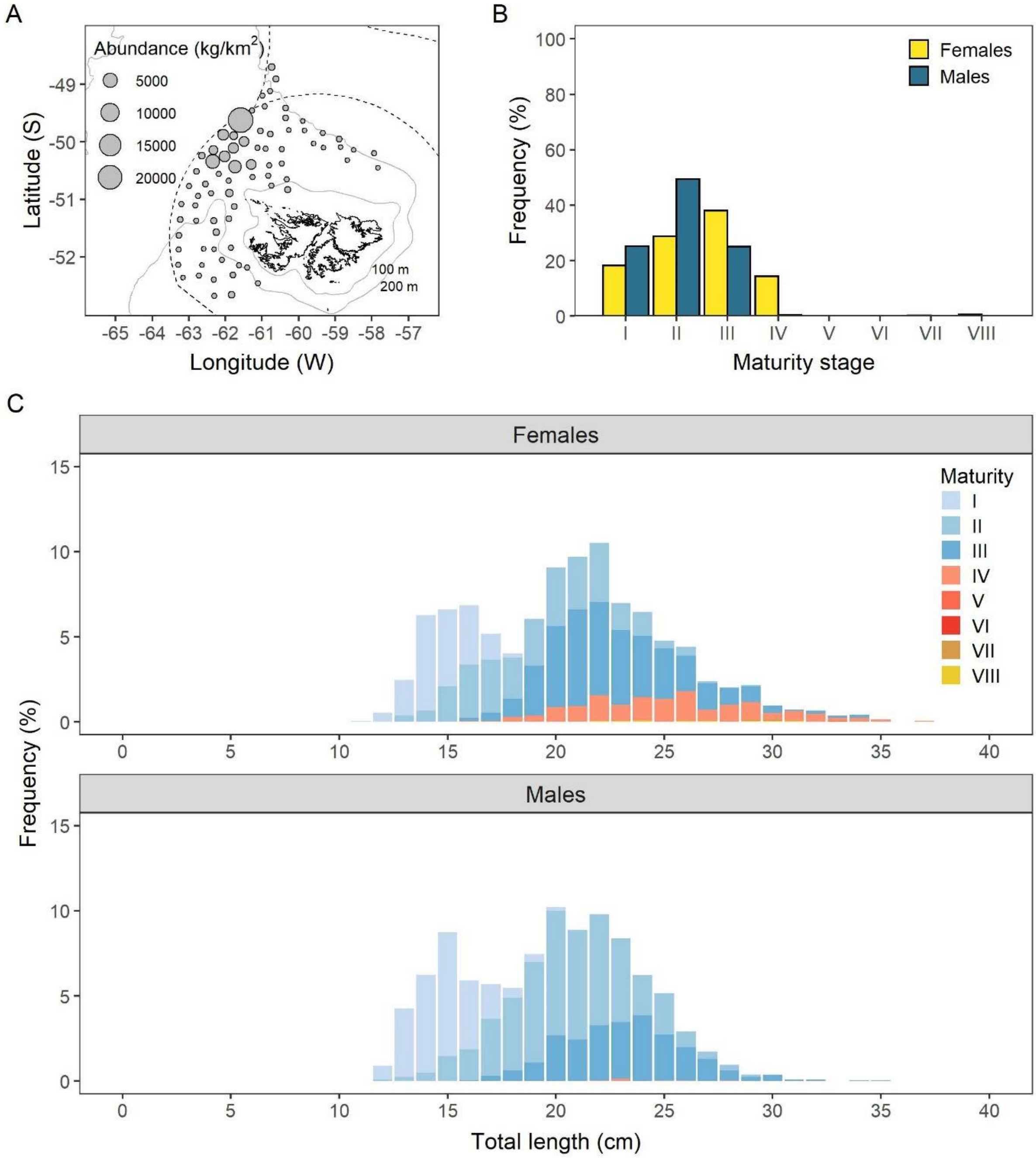

Figure 6. Biological data for *Patagonotothen ramsayi* (Common rock cod; PAR). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 2,060) and male (n = 2,303) lengths with 1 cm size class.

3.2.6. *Merluccius australis* – Southern hake

Southern hake were caught at 8 of the 76 survey trawl stations. Total catch was 36 kg, and catches ranged from 1.7 to 10 kg per trawl (CPUE: 0.5 kg/h). Densities ranged from 7.3 to 39.7 kg/km^2, with higher densities observed to the south-west in the FICZ (Fig. 7A). Most females were at resting or early developing maturity stages (maturity stages ≤III; Fig. 7B). Females were 51–81 cm length; no males were reported caught. The small number of individuals caught or detected during the survey did not allow identifying length-groups nor modal lengths (Fig. 7C). Southern hake is often misidentified as common hake *M. hubbsi*; more southern hake may have been present in the catch given the large volumes of hake caught during the survey.

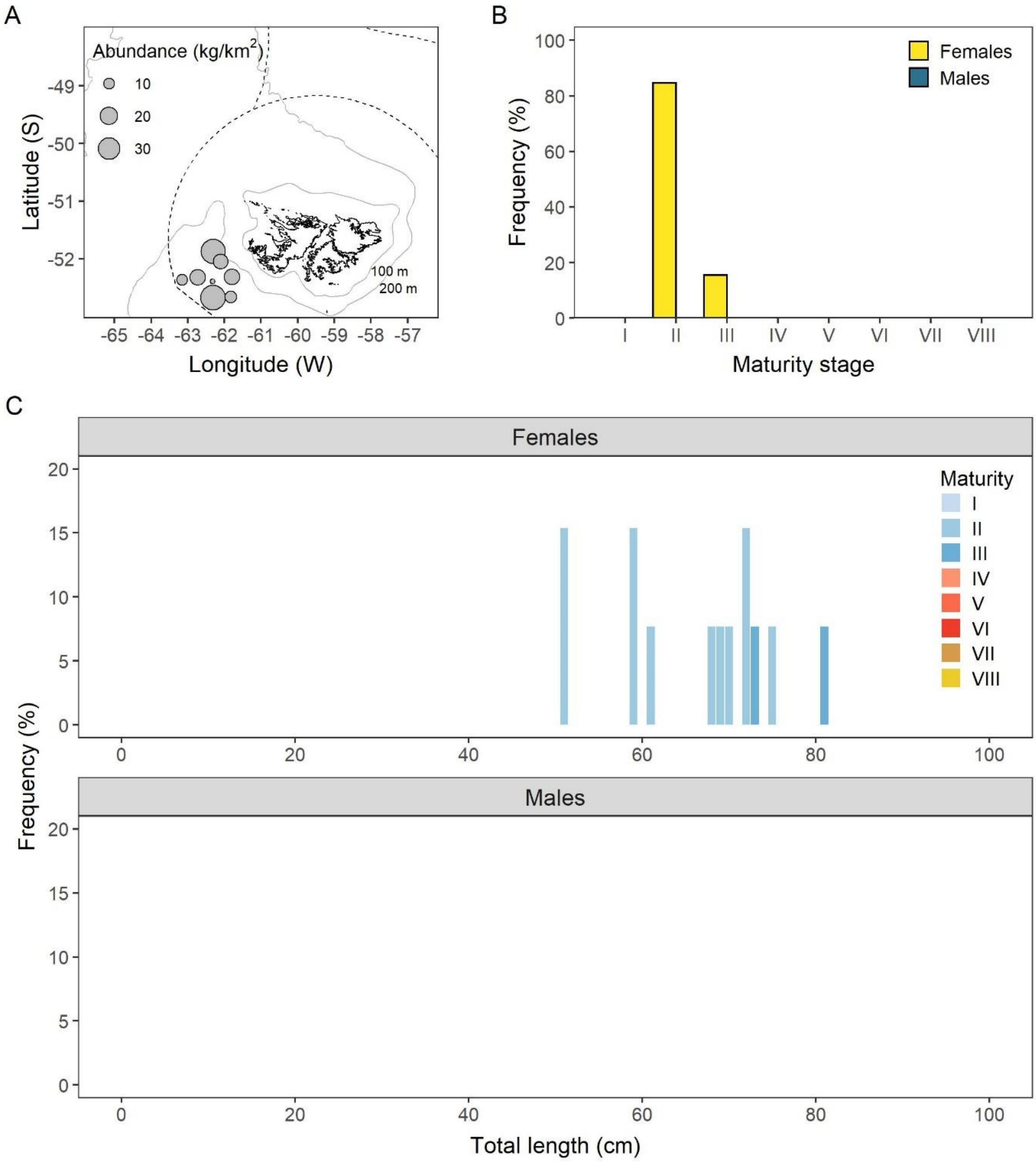

Figure 7. Biological data of *Merluccius australis* (Southern hake; PAT). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 13) and male (n = 0) lengths with 1 cm size class.

3.2.7. *Dissostichus eleginoides* – Patagonian toothfish

Patagonian toothfish were caught at 36 of the 76 survey trawl stations. Total catch was 191 kg, and catches ranged from 0.34 to 32 kg per trawl (CPUE: 3 kg/h). Densities ranged from 1 to 148 kg/km^2, with higher densities observed to the south-west in the FICZ mainly at stations >200 m deep (Fig. 8A). Most individuals were immature or resting (maturity stages ≤II; Fig. 8B). Females were 32–89 cm, males were 35–67 cm. Modal lengths were detected at 39 cm and at 52 cm for females, and at 37 cm and at 52 cm for males. However, as observed in the length frequency distribution, the lengths of the few individuals caught during the survey are spread over a wide range of sizes, which did not allow identifying all length-groups (Fig. 8C).

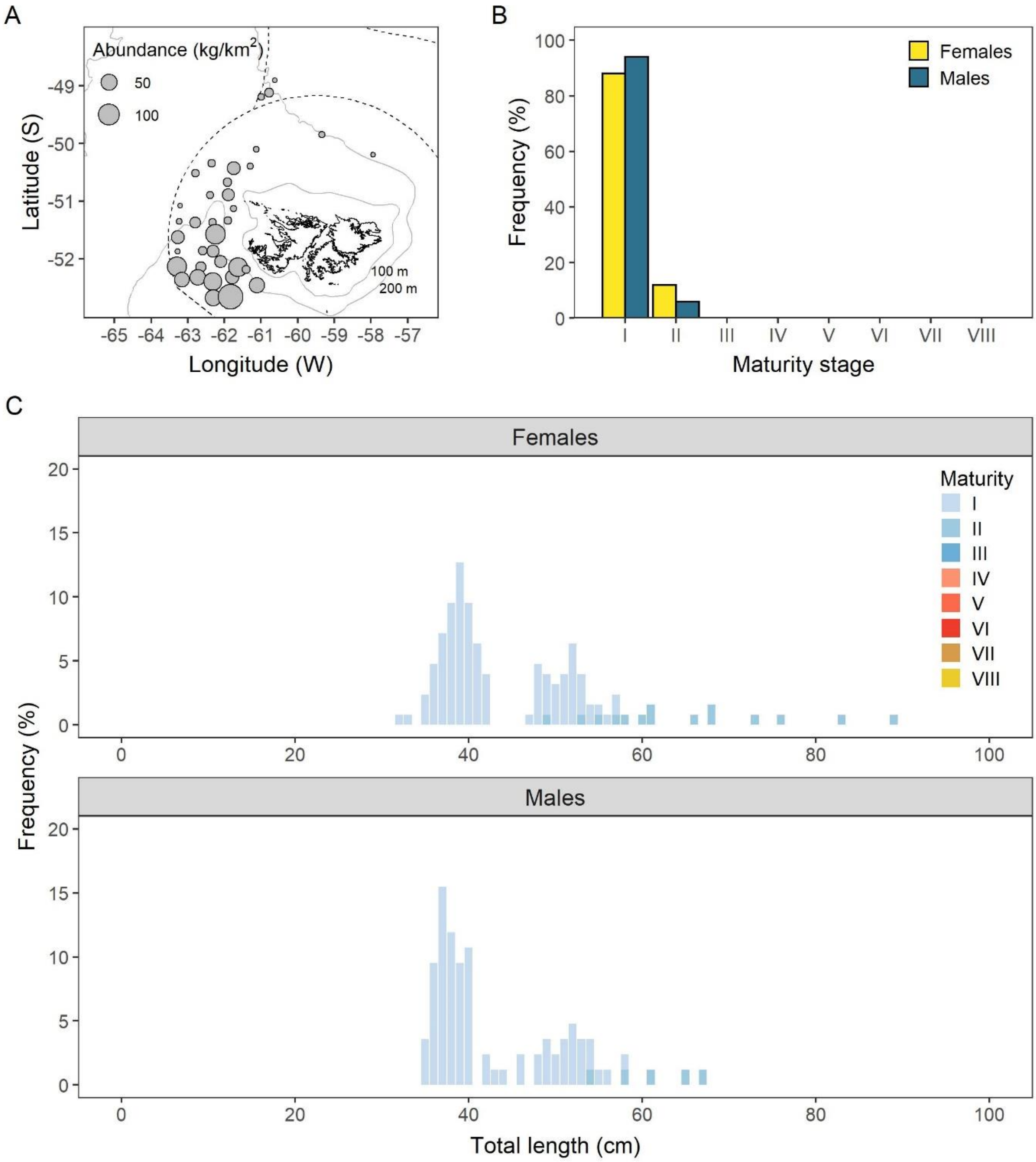

Figure 8. Biological data of *Dissostichus eleginoides* (Patagonian toothfish; TOO). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 126) and male (n = 84) lengths with 1 cm size class.

3.2.8. *Macruronus magellanicus* – Hoki

Hoki were caught at 29 of the 76 survey trawl stations. Total catch was 345 kg, and catches ranged from 0.06 to 111 kg per trawl (CPUE: 5 kg/h). Densities were 0.3 to 500 kg/km^2, with higher densities observed to the south-west in the FICZ mainly at stations >200 m deep (Fig. 9A). Most females and males were at immature, resting or early developing maturity stages (maturity stages ≤III; Fig. 9B). Females were 15–26 cm length, and males were 15–29 cm length. Length frequency distributions allowed detecting modal lengths at 20 cm for females and for males (Fig. 9C).

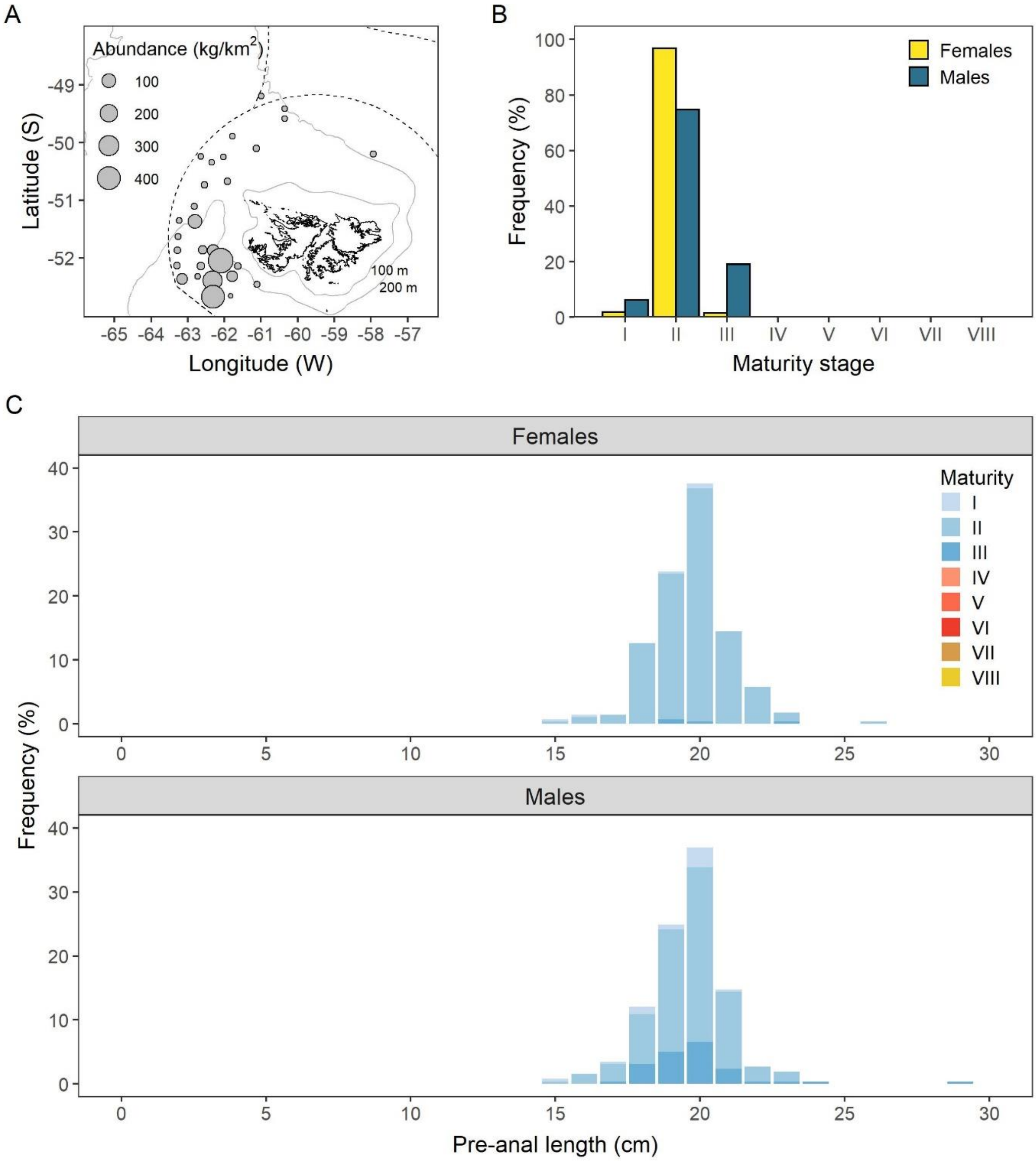

Figure 9. Biological data of *Macruronus magellanicus* (Hoki; WHI). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 277) and male (n = 257) lengths with 1 cm size class.

3.2.9. *Stromateus brasiliensis* – Butterfish

Butterfish were caught at 11 of the 76 survey trawl stations. Total catch was 14 kg, and catches ranged from 0.5 to 3 kg (CPUE: 0.2 kg/h). Densities ranged from 2 to 15 kg/km^2, with higher densities to the north in the FICZ (Fig. 10A). Females were at early developing maturity stage (maturity stage III) and males were mainly at developing maturity stage (maturity stages III–IV; Fig. 10B). Females were 30–37 cm length and males were 32–34 cm length. The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 10C).

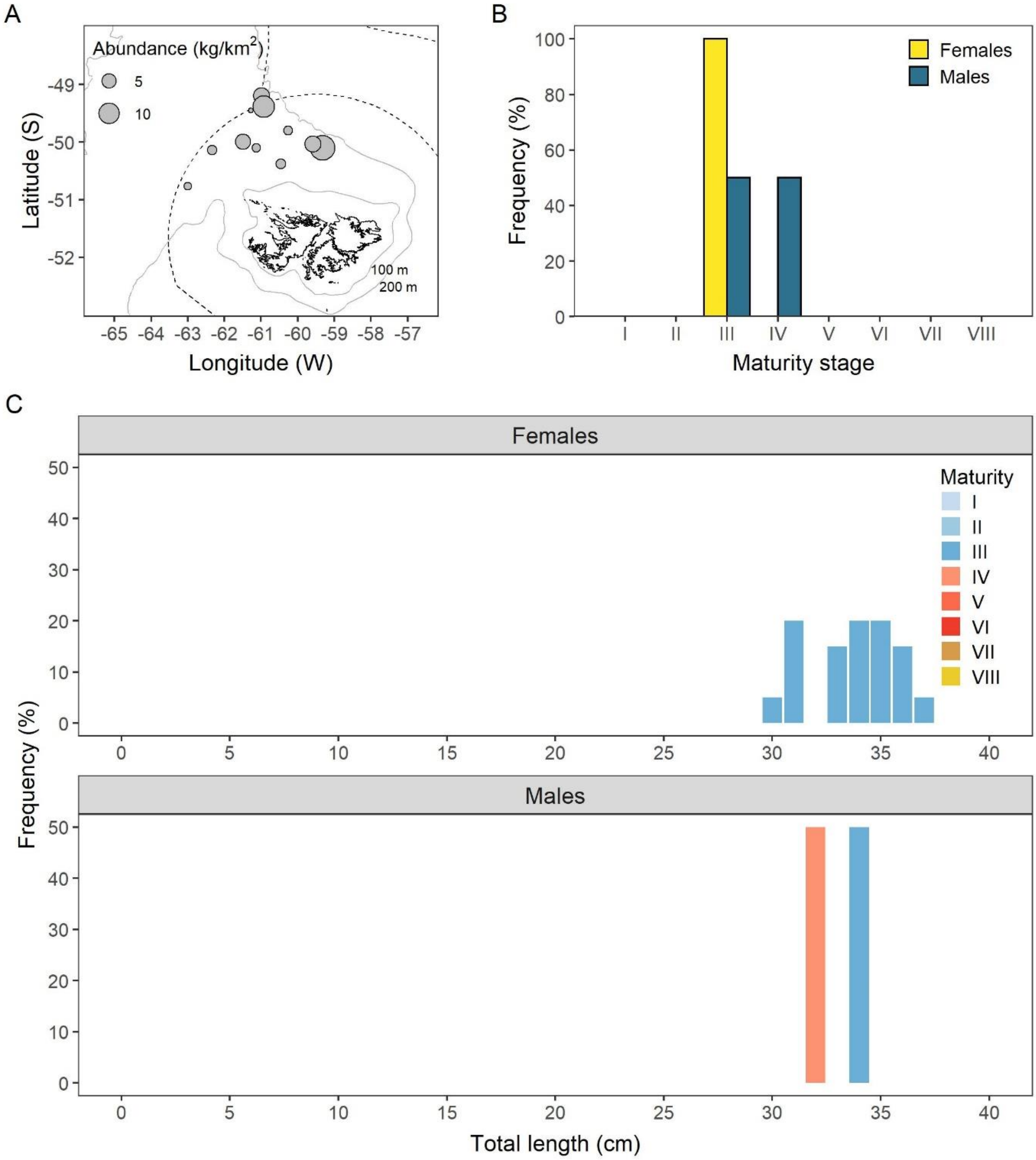

Figure 10. Biological data of *Stromateus brasiliensis* (Butterfish; BUT). A) Map of densities in kg/km2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 20) and male (n = 2) lengths with 1 cm size class.

3.2.10. *Coelorinchus fasciatus* – Banded whiptail grenadier

Banded whiptail grenadier were caught at 14 of the 76 survey trawl stations. Total catch was 180 kg, and catches ranged from 0.03 to 66 kg per trawl (CPUE: 2 kg/h). Densities ranged from 0.1 to 307 kg/km^2, observed to the south-west in the FICZ at stations >200 m deep (Fig. 11A). Females and males were mostly at resting maturity stage (maturity stage II); immature (maturity stage I) and developing maturity stages occurred in minor proportions (maturity stages III–IV; Fig. 11B). Females were 4–12 cm length; males were 4–10 cm length. The length frequency distributions allowed detecting a single length-group with modal length at 8 cm for females and at 7 cm for males (Fig. 11C).

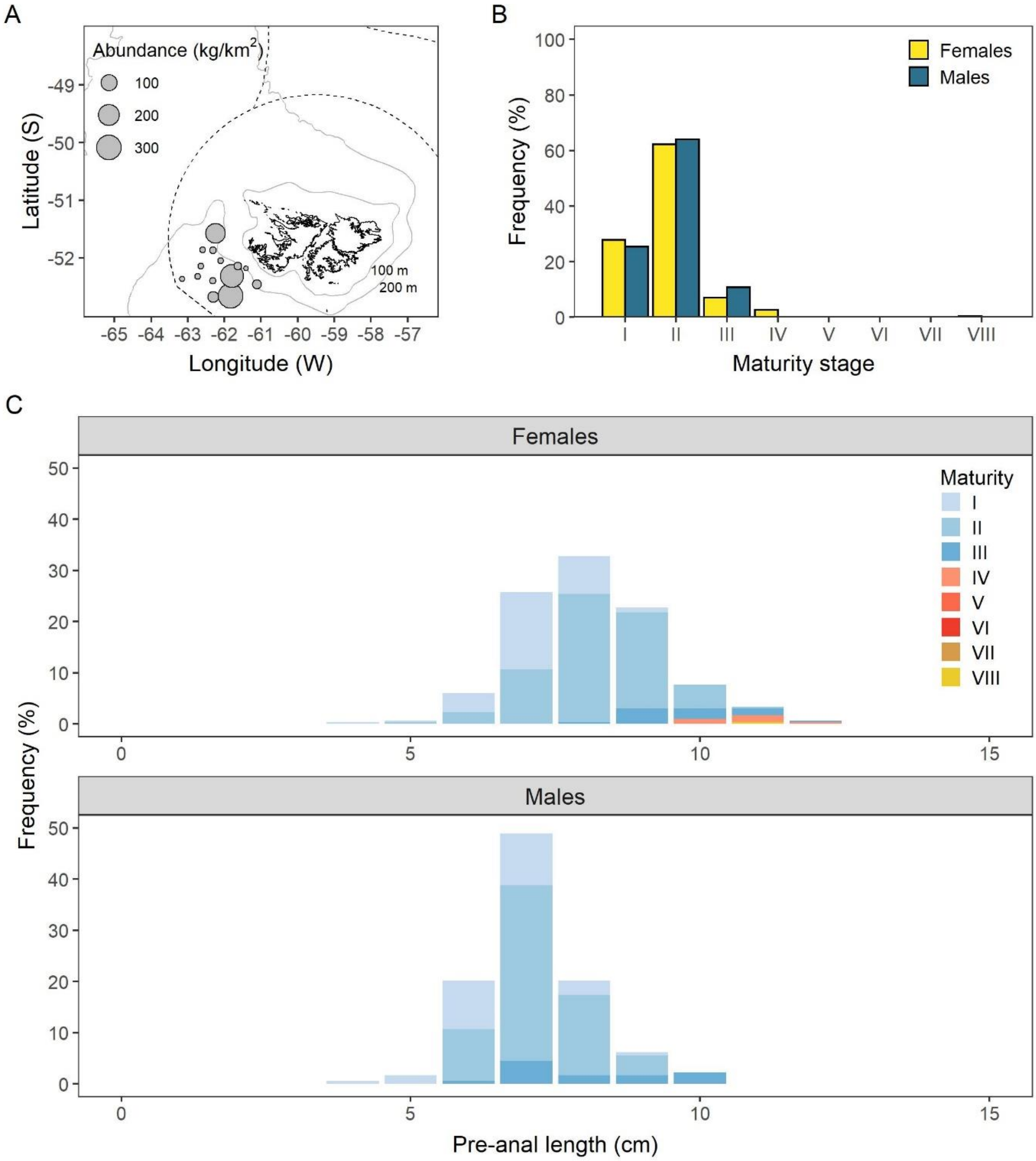

Figure 11. Biological data of *Coelorinchus fasciatus* (Banded whiptail grenadier; GRF). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 299) and male (n = 178) lengths with 1 cm size class.

3.2.11. *Macrourus carinatus* – Ridge scaled rattail

Ridge scaled rattail were caught at 3 of the 76 survey trawl stations. Total catch was 110 kg, and catches ranged from 2 to 68 kg (CPUE: 1.4 kg/h). Densities ranged from 8 to 274 kg/km^2, observed to the south-west in the FICZ (Fig. 12A). Females were mostly at early developing or spent maturity stages (maturity stages III and VII, respectively). Males were mainly at resting or developing maturity stages (maturity stages II–IV; Fig. 12B). Females were 19–28 cm length; males were 17–20 cm length. The length frequency distributions allowed detecting a single length-group with modal length at 23 cm for females (Fig. 12C). The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths for males (Fig. 12C).

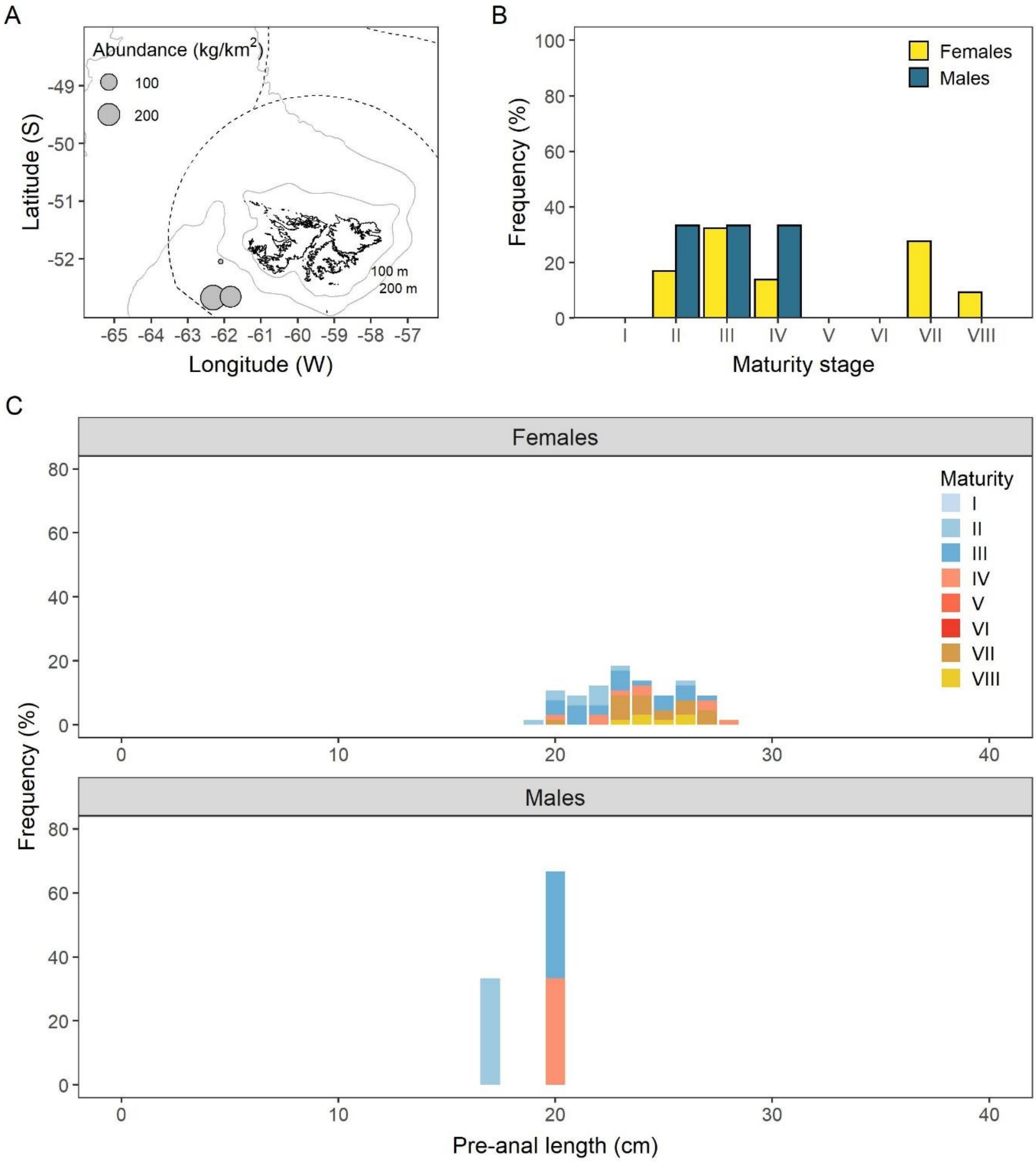

Figure 12. Biological data of *Macrourus carinatus* (Ridge scaled rattail; GRC). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 65) and male (n = 3) lengths with 1 cm size class.

3.2.12. *Seriolella porosa* – Driftfish

Driftfish were caught at 2 of the 76 survey trawl stations. Total catch was 4 kg, and catches ranged from 1.2 to 2.3 kg per trawl (CPUE: 0.1 kg/h). Densities ranged from 6 to 10 kg/km^2, observed mainly to the north-west in the FICZ (Fig. 13A). The two females caught during the survey were at early developing maturity stage (maturity stage III; Fig. 13B), and measured 45 and 52 cm length. No males were caught during the survey. The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 13C).

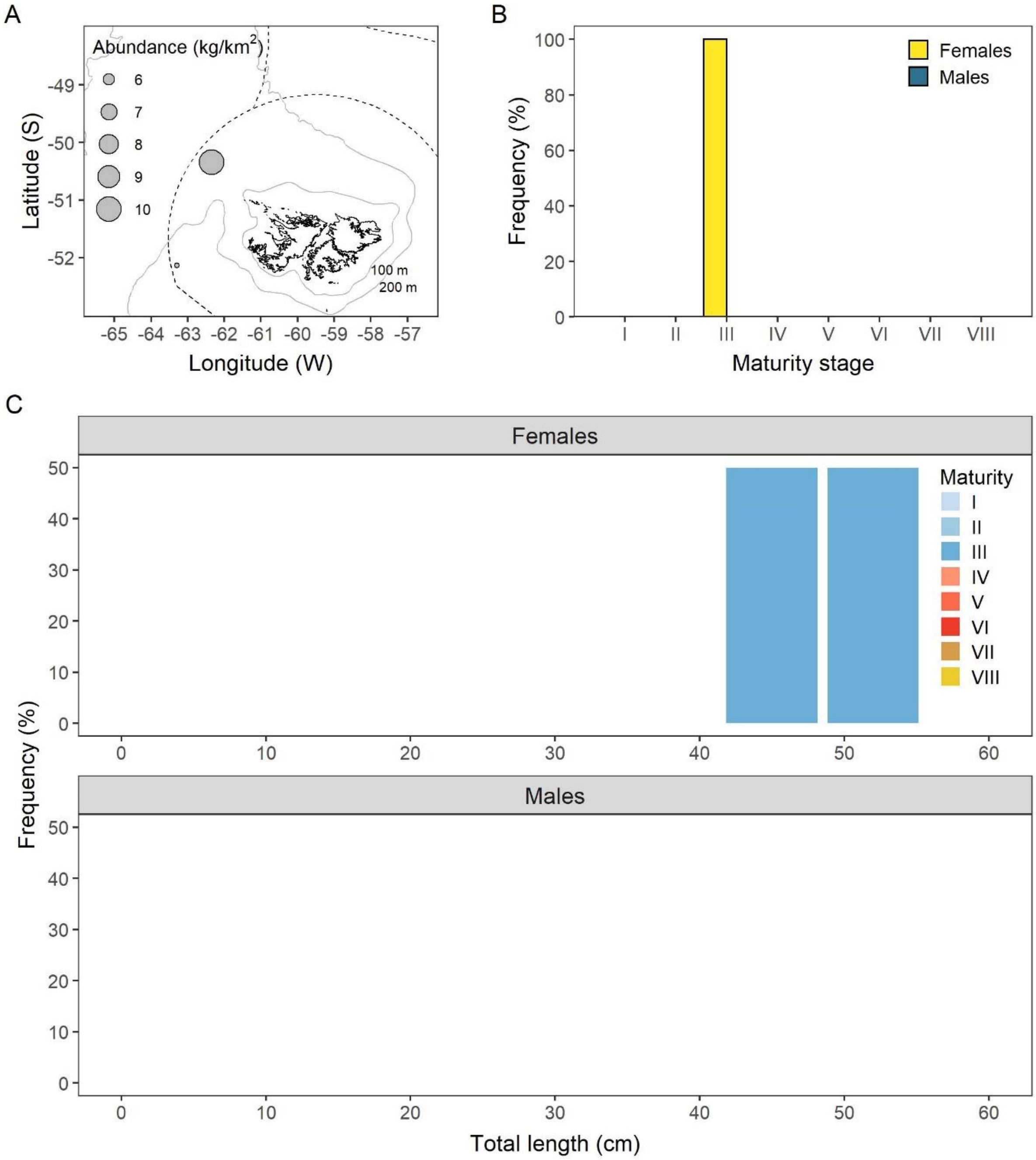

Figure 13. Biological data of *Seriolella porosa* (Driftfish; SEP). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 2) and male (n = 0) lengths with 1 cm size class.

3.3. Biological information of squid species

3.3.1. *Illex argentinus* – Argentine shortfin squid

Argentine shortfin squid were caught at 66 of the 76 survey trawl stations. Total catch was 39 kg, and catches ranged from 0.02 to 9 kg per trawl (CPUE: 0.5 kg/h). Densities ranged from 0.07 to 38 kg/km^2, observed through the survey area (Fig. 14A). Most females and males were immature (maturity stages ≤II; Fig. 14B). Females were 6.5–31.0 cm length, and males were 7.0–15.0 cm length. Length frequency distributions allowed detecting modal lengths at 10.5 cm and 10.0 cm for females and males, respectively (Fig. 14C).

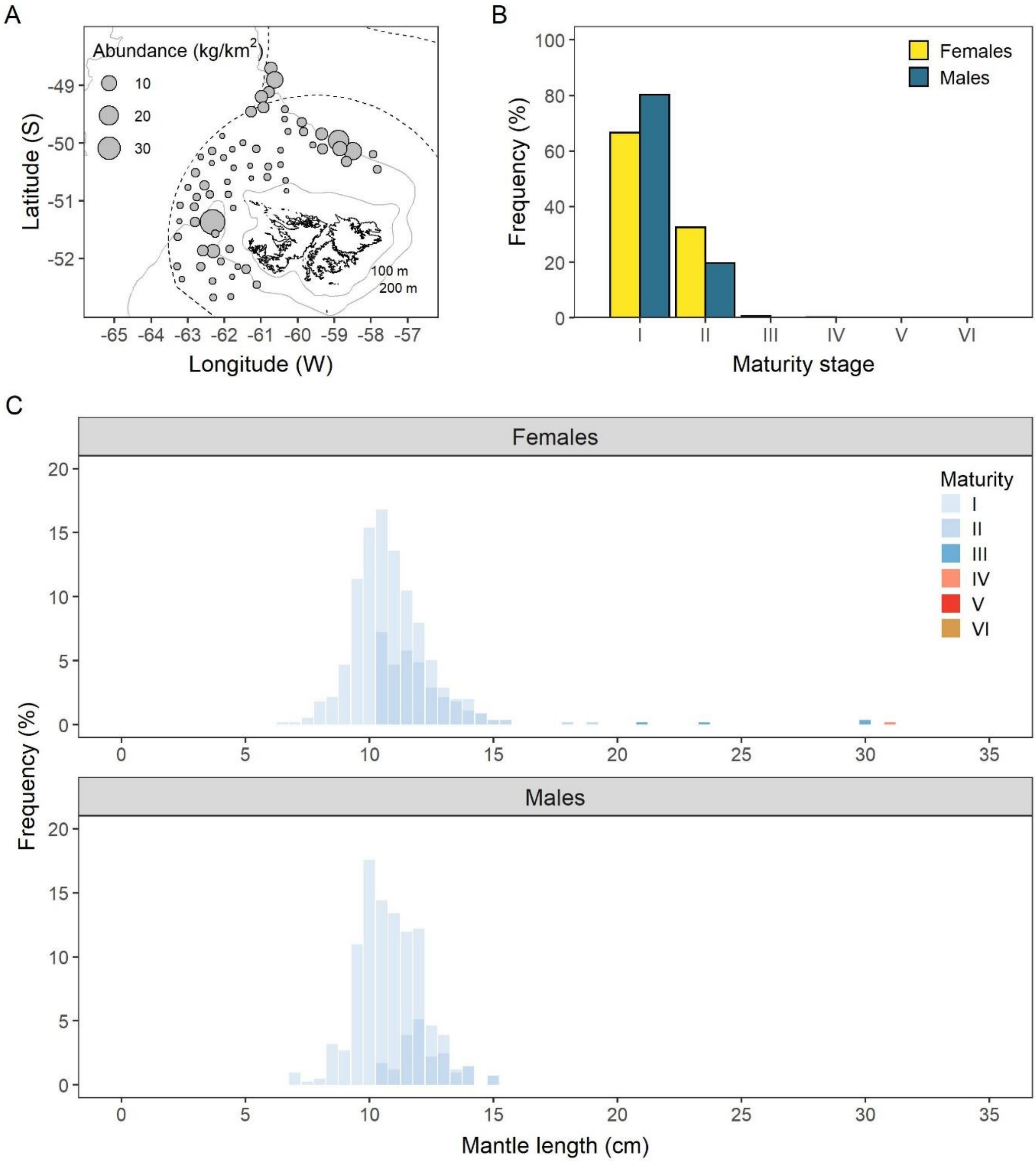

Figure 14. Biological data of *Illex argentinus* (Argentine shortfin squid; ILL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent); C) Relative frequency (%) of female (n = 553) and male (n = 410) lengths with 0.5 cm size class.

3.3.2. *Doryteuthis gahi* – Patagonian squid

Patagonian squid were caught at the 76 survey trawl stations. Total catch was 5,043 kg, and catches ranged from 2 to 442 kg per trawl (CPUE: 66 kg/h). Densities ranged from 8 to 1,892 kg/km^2 along the survey area, with higher densities to the north along the 200 m isobath and to the south-west at stations >200 m deep (Fig. 15A). Most females were immature or preparatory (maturity stages II–III), whereas males were mainly preparatory (maturity stage III), with relatively smaller proportions of immature, maturing and mature individuals (maturity stages II, IV, and V; Fig. 15B). Females were 5.0–22.0 cm length and males were 4.0–35.0 cm length (Fig. 15C). Modal length of females and males were detected at 11.0 cm (Fig. 15C).

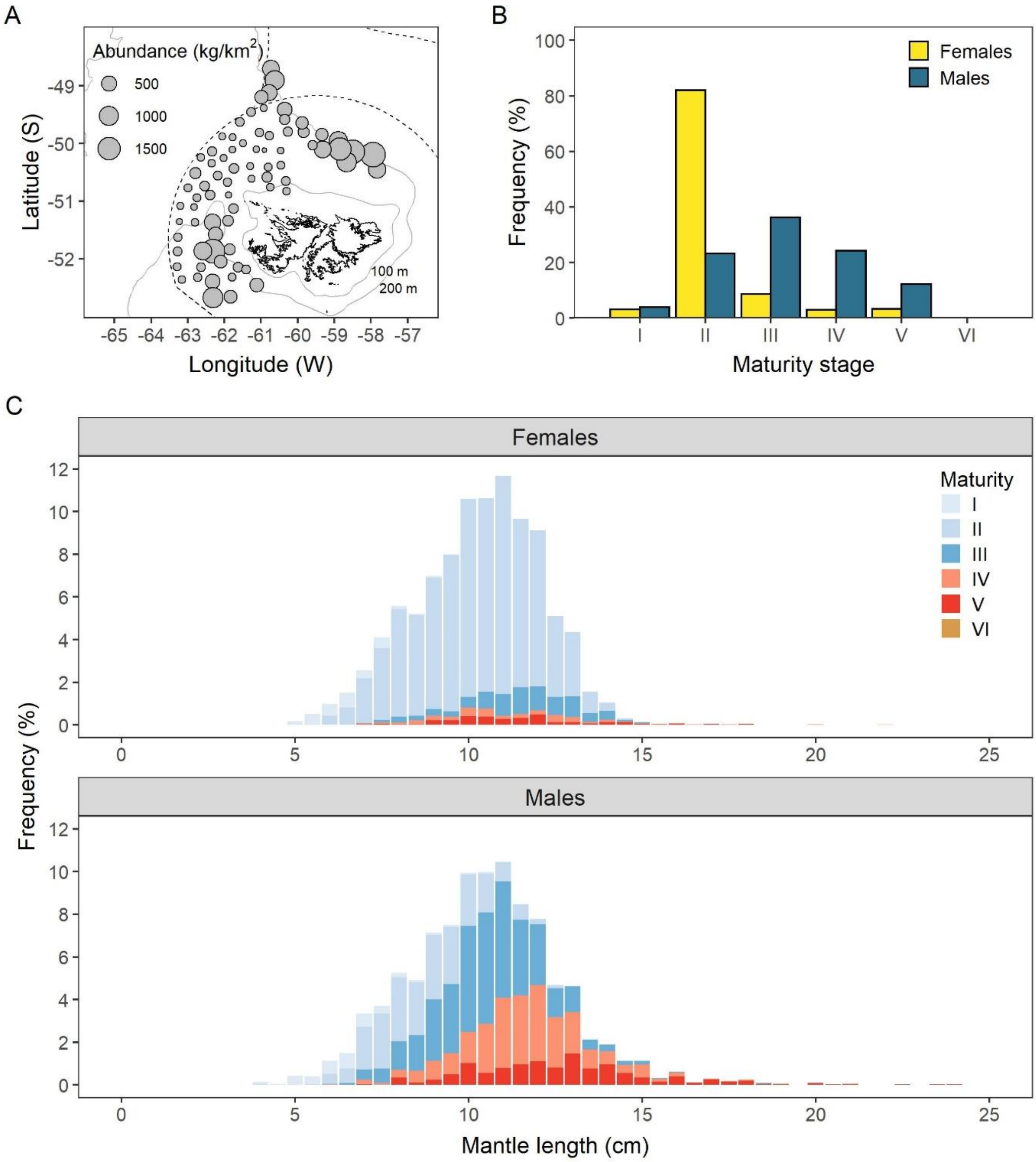

Figure 15. Biological data of *Doryteuthis gahi* (Patagonian squid; LOL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent); C) Relative frequency (%) of female (n = 4,336) and male (n = 3,426) lengths with 0.5 cm size class.

3.4. Biological information of skate species

3.4.1. *Bathyraja albomaculata* – White spotted skate

White spotted skates were caught at 4 of the 76 survey trawl stations. Total catch was 6 kg, and catches ranged from 0.7 to 2 kg per trawl (CPUE: 0.1 kg/h). Densities ranged from 3 to 10 kg/km^2, mainly observed to the north in the FICZ and in the FOCZ (Fig. 16A). One dead female was processed and it was a mature individual (maturity stage IV), the second female was released alive and therefore it was not sexed. One male was developing (maturity stage III) and the other male was mature (maturity stage IV; Fig. 16B). Females were 30–44 cm disc width (Fig. 16C); males were 37 and 42 cm disc width (Fig. 16C). The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 16C).

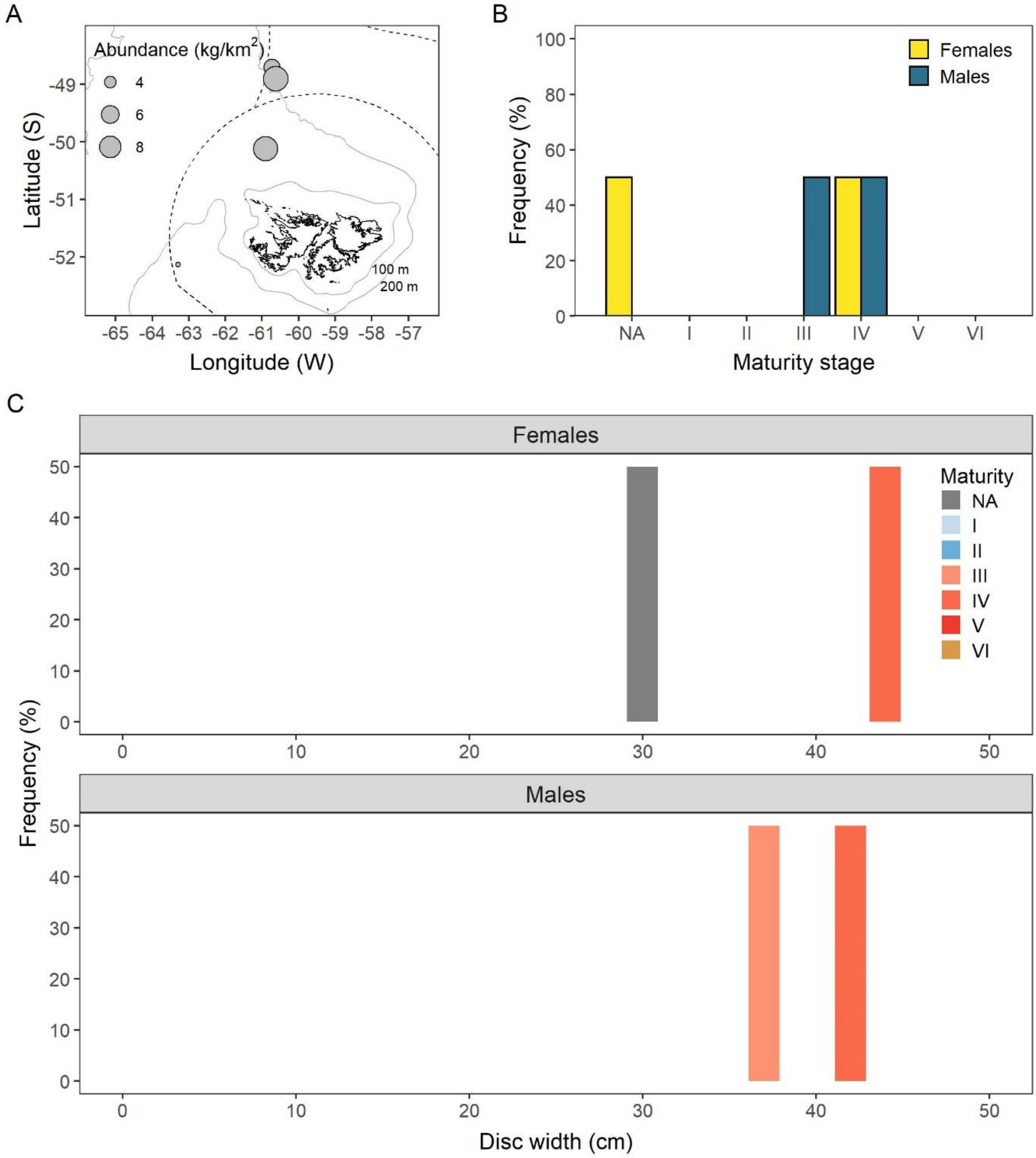

Figure 16. Biological data of *Bathyraja albomaculata* (White spotted skate; RAL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 2) and male (n = 2) lengths with 1 cm size class.

3.4.2. *Bathyraja brachyurops* – Blonde skate

Blonde skates were caught at 14 of the 76 survey trawl stations. Total catch was 50 kg, and catches ranged from 0.04 to 21 kg (CPUE: 0.7 kg/h). Densities ranged from 0.2 to 95 kg/km^2, with patchy distribution to the north and west mainly in the FICZ (Fig. 17A). Alive females (n = 9) were released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. Most females in poor shape or dead (n = 10) were maturing (maturity stage II). Males were mainly juvenile (maturity stage I), with smaller proportions of maturing, developing, mature or running individuals (maturity stages II–V, respectively; Fig. 17B). Females were 11–56 cm disc width and males were 26–51 cm disc width. The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 17C).

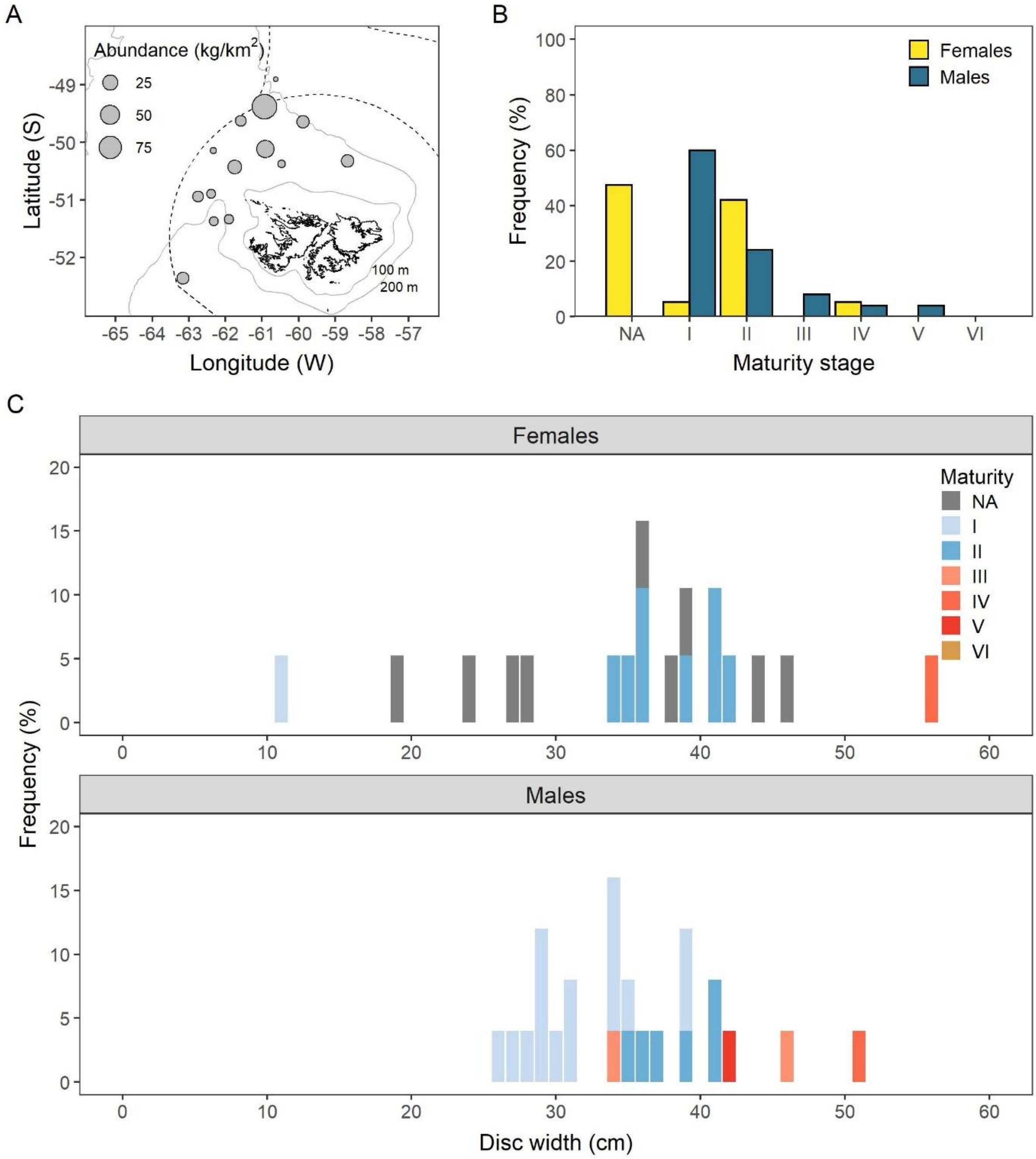

Figure 17. Biological data of *Bathyraja brachyurops* (Blonde skate; RBR). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 19) and male (n = 25) lengths with 1 cm size class.

3.4.3. *Dipturus lamillai* – Warrah skate

Warrah skates were caught at 21 of the 76 survey trawl stations. Total catch was 93 kg, and catches ranged from 0.9 to 19 kg per trawl (CPUE: 1.2 kg/h). Densities ranged from 4 to 83 kg/km^2, with patchy distribution through the survey area (Fig. 18A). Most females were found alive (n = 18) and released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. Most females in poor shape or dead (n = 5) were developing (maturity stage III), while males were mainly maturing, developing or mature (maturity stages II–IV; Fig. 18B). Females were 39–69 cm disc width, and males were 35–63 cm disc width (Fig. 18C); the small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 18C).

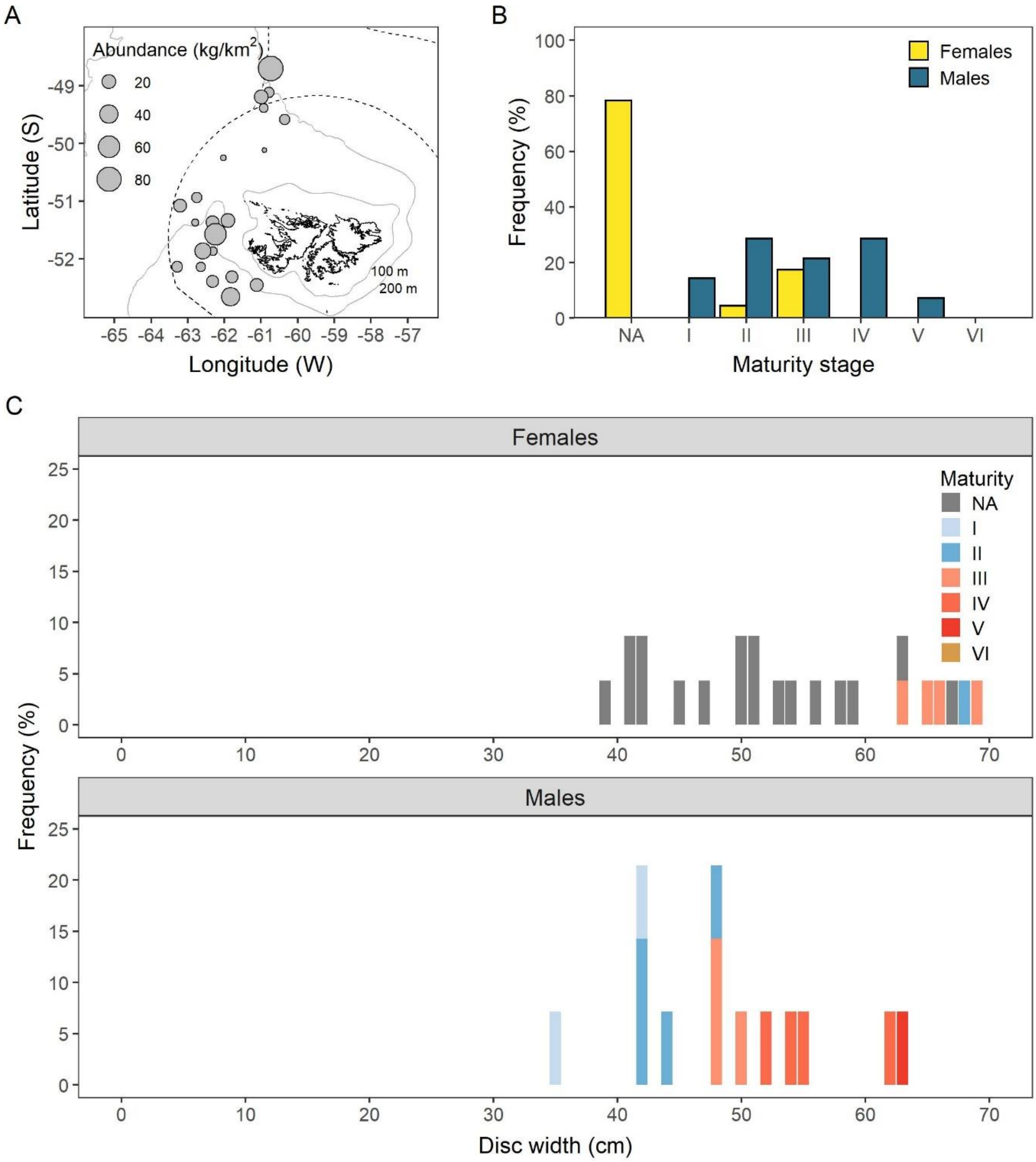

Figure 18. Biological data of *Dipturus lamillai* (Warrah skate; RFL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 23) and male (n = 14) lengths with 1 cm size class.

3.4.4. *Bathyraja griseocauda* – Grey-tailed skate

Grey-tailed skates were caught at 4 of the 76 survey trawl stations. Total catch was 17 kg, and catches ranged from 0.8 to 12 kg per trawl (CPUE: 0.2 kg/h). Densities ranged from 3 to 53 kg/km^2, with higher densities observed to the north in the FOCZ (Fig. 19A). Alive females (n = 3) were released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. Females in poor shape or dead (n = 4) were juvenile, maturing or developing (maturity stages I–III). Most males were juvenile or maturing (maturity stages II–III; Fig. 19B). Females were 23–77 cm disc width, and males were 34–44 cm disc width. The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 19C).

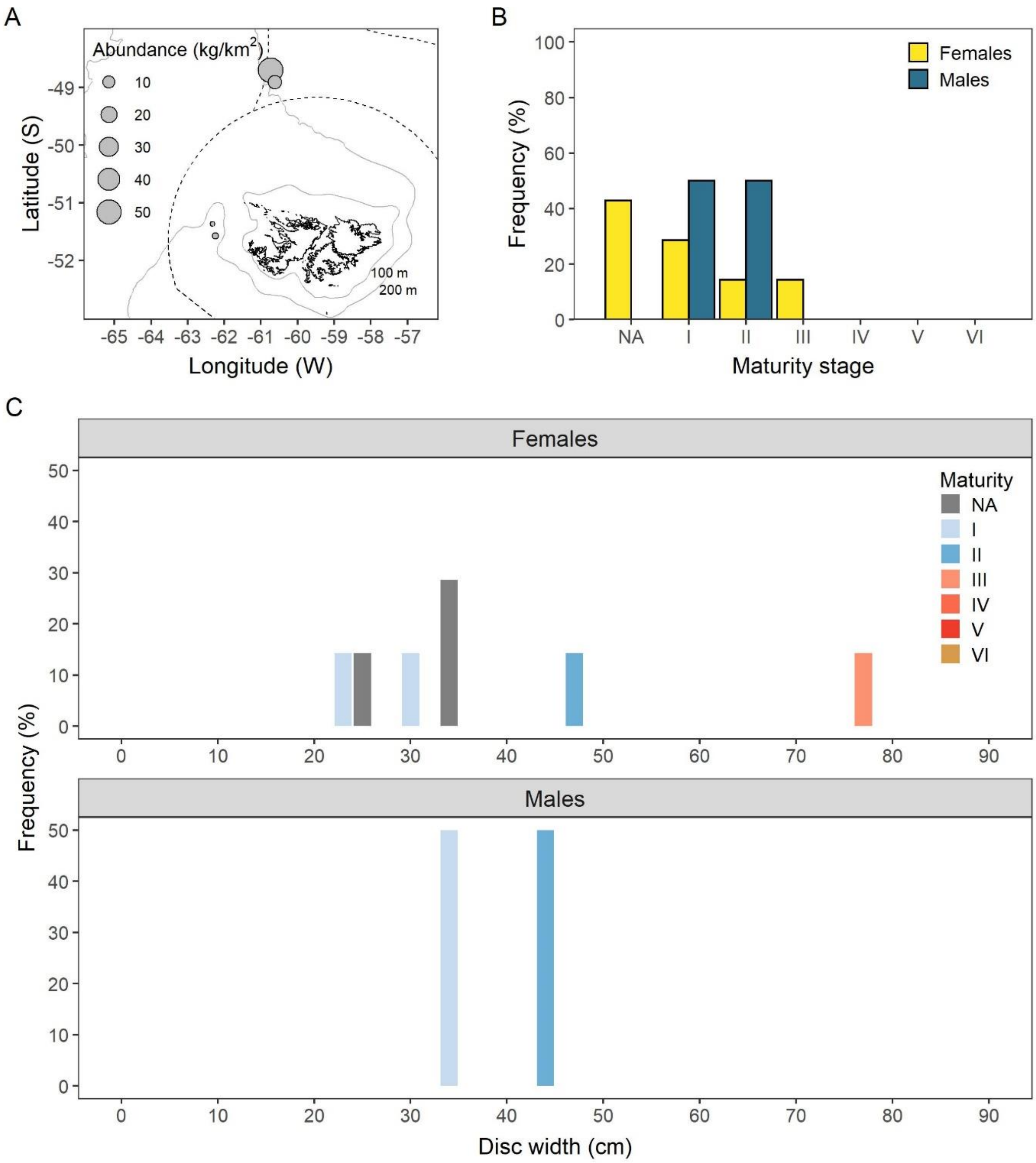

Figure 19. Biological data of *Bathyraja griseocauda* (Grey tailed skate; RGR). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 7) and male (n = 2) lengths with 1 cm size class.

3.4.5. *Amblyraja doellojuradoi* – Starry ray

Starry ray were caught at 2 of the 76 survey trawl stations. Total catch was 2 kg, and catches ranged from 0.9 to 1 kg per trawl (CPUE: 0.02 kg/h). Densities ranged from 3.7 to 4.3 kg/km^2, observed to the north in the FOCZ (Fig. 20A). The only one female caught was alive and released as soon as possible without assessing maturity stage. The maturity stage of this individual was recorded as NA (Fig. 20B), and it measured 34 cm disc width (Fig. 20C). The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths. The only one male caught was at running maturity stage (maturity stage V; Fig. 20B), and it measured 34 cm disc width (Fig. 20C).

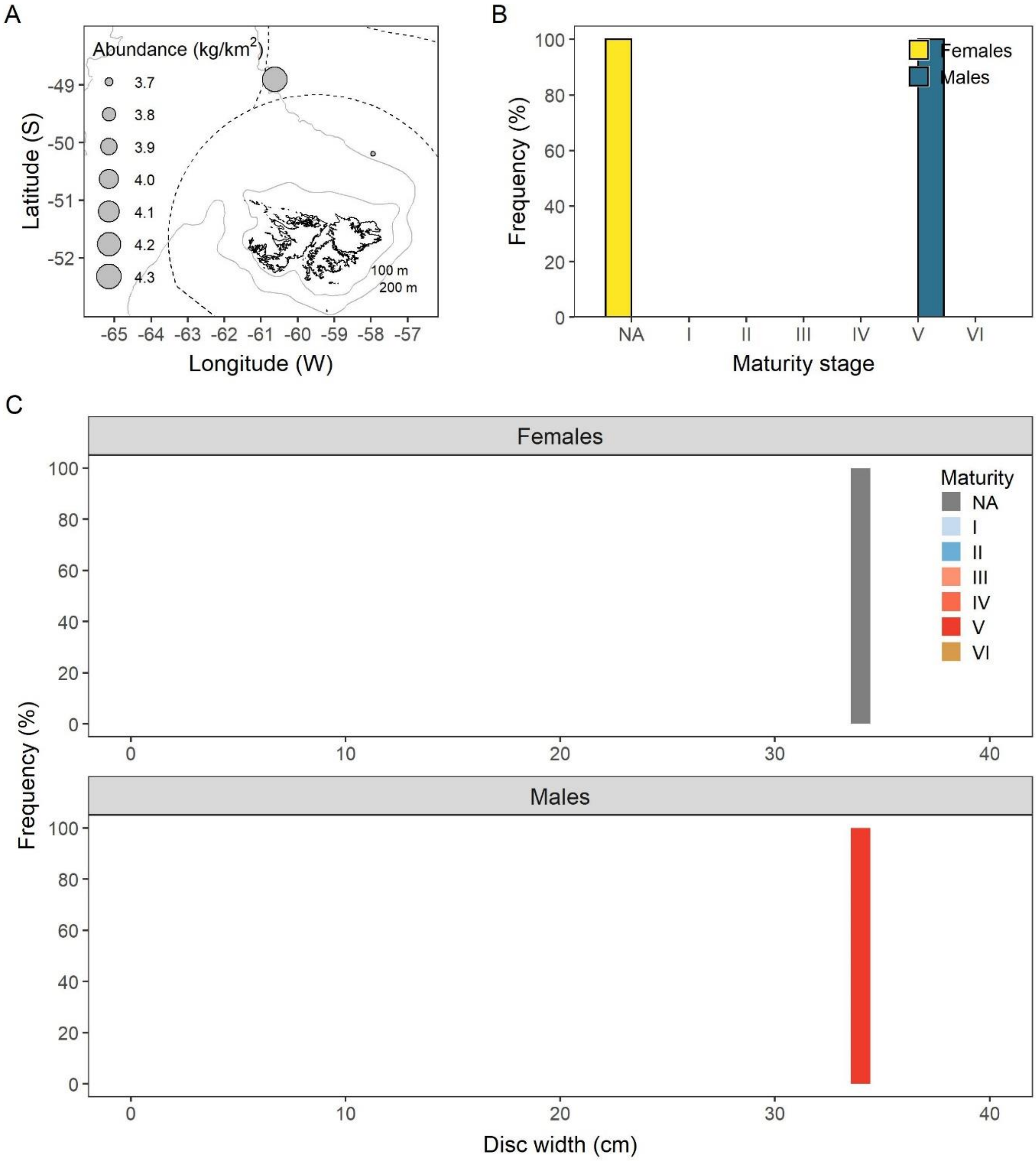

Figure 20. Biological data of *Amblyraja doellojuradoi* (Starry ray; RDO). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 1) and male (n = 1) lengths with 1 cm size class.

3.4.6. *Bathyraja multispinis* – Multispine skate

One multispine skate was caught throughout the survey. Total catch was 2.3 kg (CPUE: 0.03 kg/h). Density was 11 kg/km^2, observed to the west of West Falkland at a station >200 m deep (Fig. 21A). The male caught was mature (maturity stage IV; Fig. 21B), and measured 48 cm disc width (Fig. 21C). The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 21C).

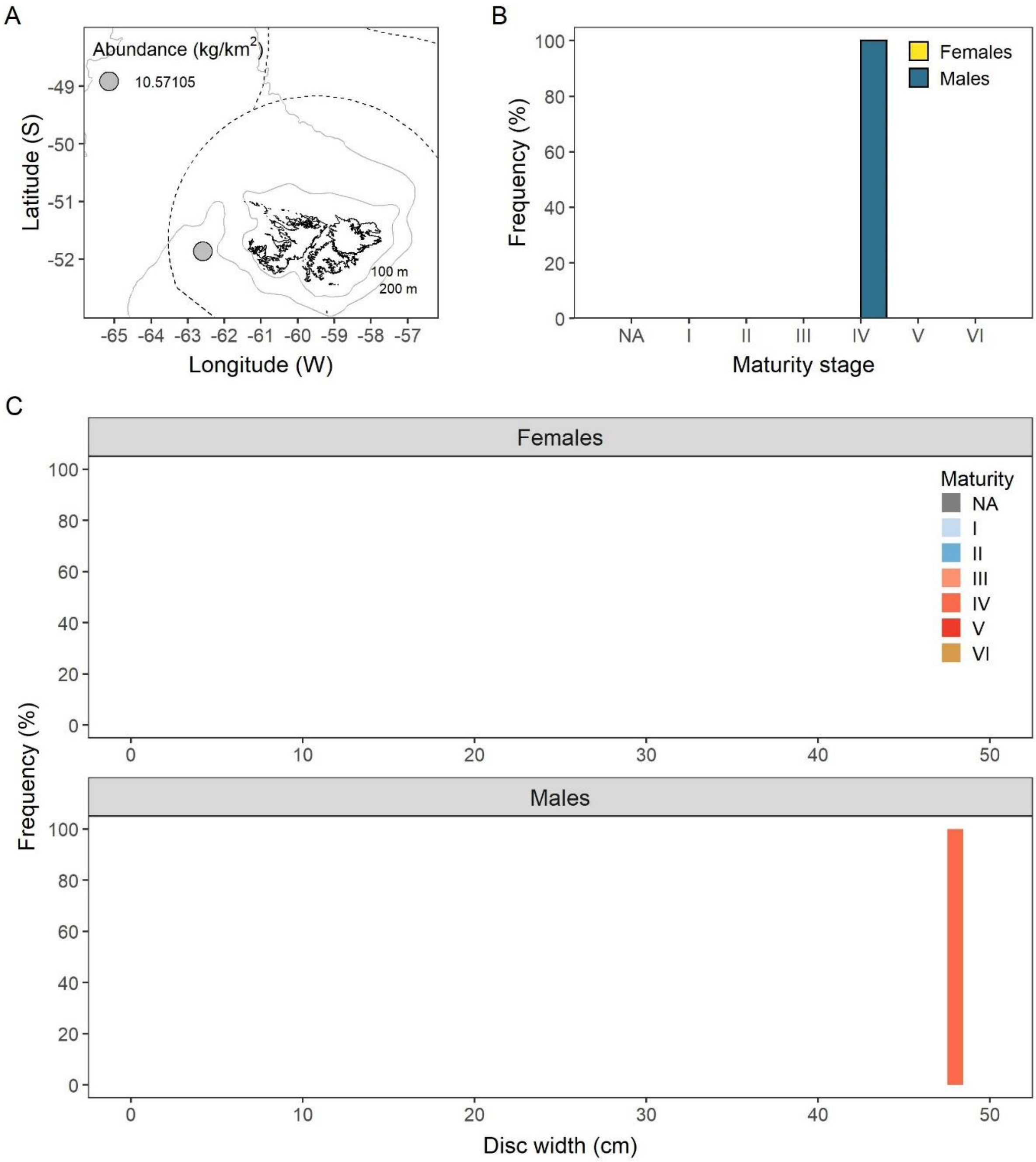

Figure 21. Biological data of *Bathyraja multispinis* (Multispine skate; RMU). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 0) and male (n = 1) lengths with 1 cm size class.

3.4.7. *Bathyraja macloviana* – Falkland skate

One Falkland skate was caught throughout the survey. Total catch was 0.9 kg (CPUE: 0.01 kg/h). Density was 5.8 kg/km^2, observed to the north of West Falkland near the 200 m isobath (Fig. 22A). The male caught was at developing maturity stage (maturity stage III; Fig. 22B), and measured 32 cm disc width (Fig. 22C). The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 22C).

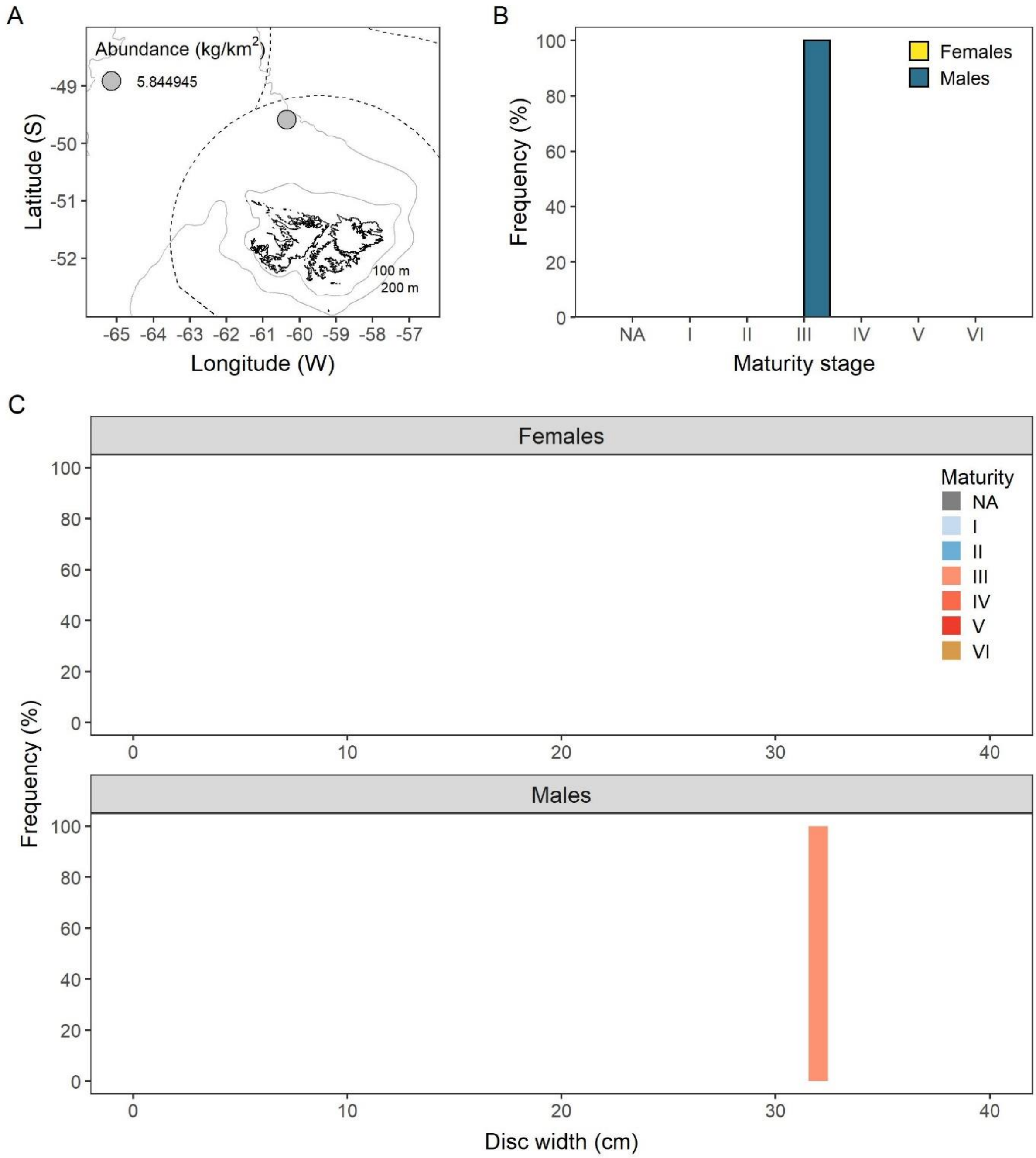

Figure 22. Biological data of *Bathyraja macloviana* (Falkland skate; RMC). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 0) and male (n = 1) lengths with 1 cm size class.

3.5. Biological information of sharks species

3.5.1. *Schroederichthys bivius* – Catshark

Catshark were caught at 52 of the 76 survey trawl stations. Total catch was 161 kg, and catches ranged from 0.1 to 17 kg per trawl (CPUE: 2 kg/h). Densities ranged from 0.5 to 75 kg/km^2, with higher densities observed to the north-west in the FICZ (Fig. 23A). All females were found alive (n = 137) and released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. Most males were mature or developing (maturity stages IV or III, respectively), and juvenile or maturing in smaller proportions (maturity stages I and II; Fig. 23B). Length frequency distributions were multimodal, and overlap of lengths did not allow identifying all the length-groups present. Females were 26–58 cm length, with modes at 45–48 cm length (Fig. 23C). Males were 27–78 cm length, with modes at 53 cm and 63 cm length (Fig. 23C).

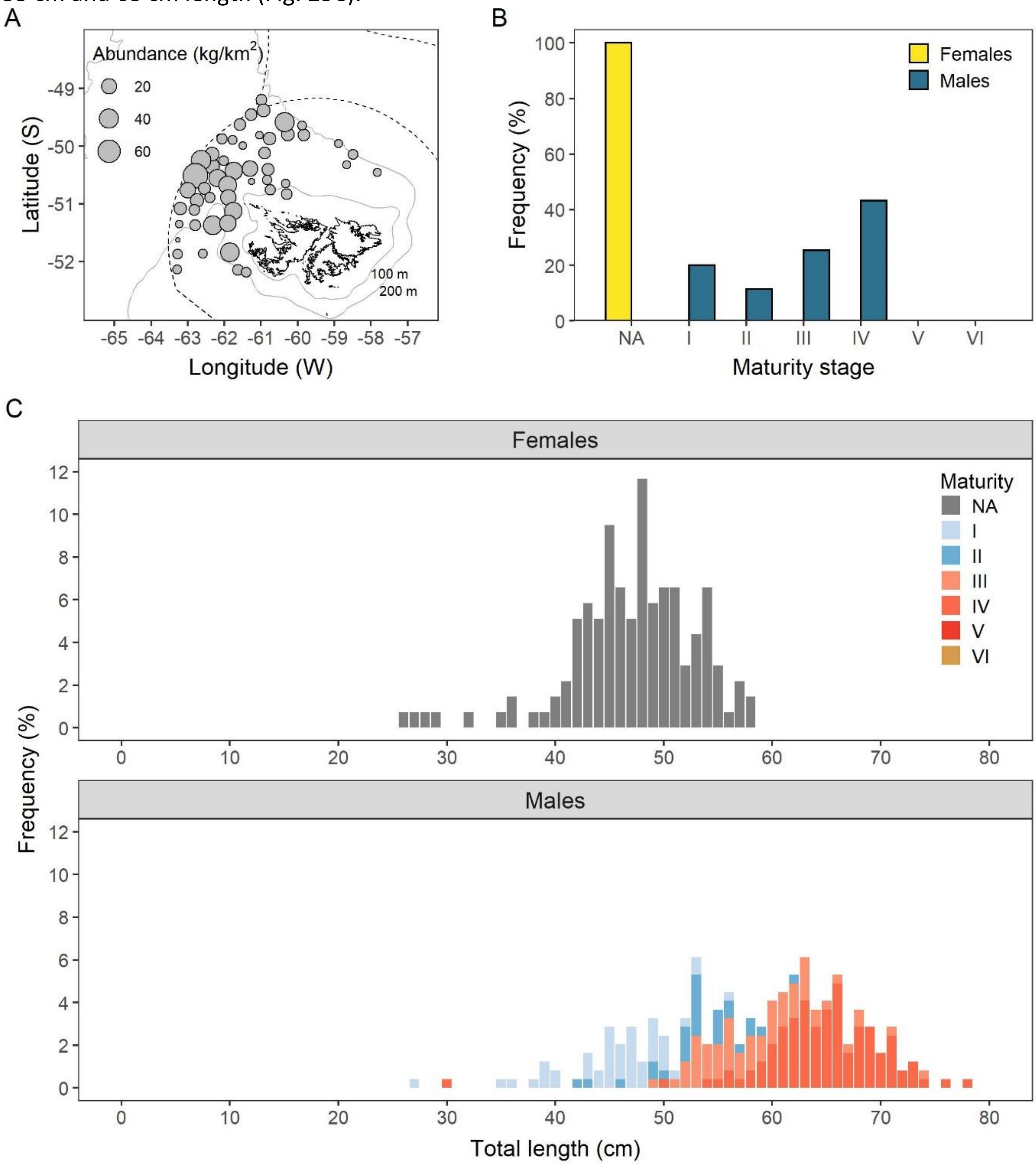

Figure 23. Biological data of *Schroederichthys bivius* (Catshark; DGH); A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 137) and male (n = 245) lengths with 1 cm size class.

3.5.2. *Squalus acanthias* – Dogfish

Dogfish were caught at 18 of the 76 survey trawl stations. Total catch was 178 kg, and catches ranged from 0.5 to 32 kg per trawl (CPUE: 2 kg/h). Densities ranged from 2 to 137 kg/km^2, with higher densities observed to the north-west in the FICZ (Fig. 24A). Most females were found alive (n = 188) and released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. One female was dead and in developing maturity stage III. Most males were juvenile or developing (maturity stages I or III, respectively), with smaller proportions of maturing or mature individuals (maturity stages II or IV, respectively; Fig. 24B). Length frequency distributions were multimodal, and overlap of lengths did not allow identifying all the length-groups present. Females were 45–82 cm length, with the main mode at about 51 cm length (Fig. 24C). Males were 45–85 cm length, with the main mode at 49–53 cm length (Fig. 24C).

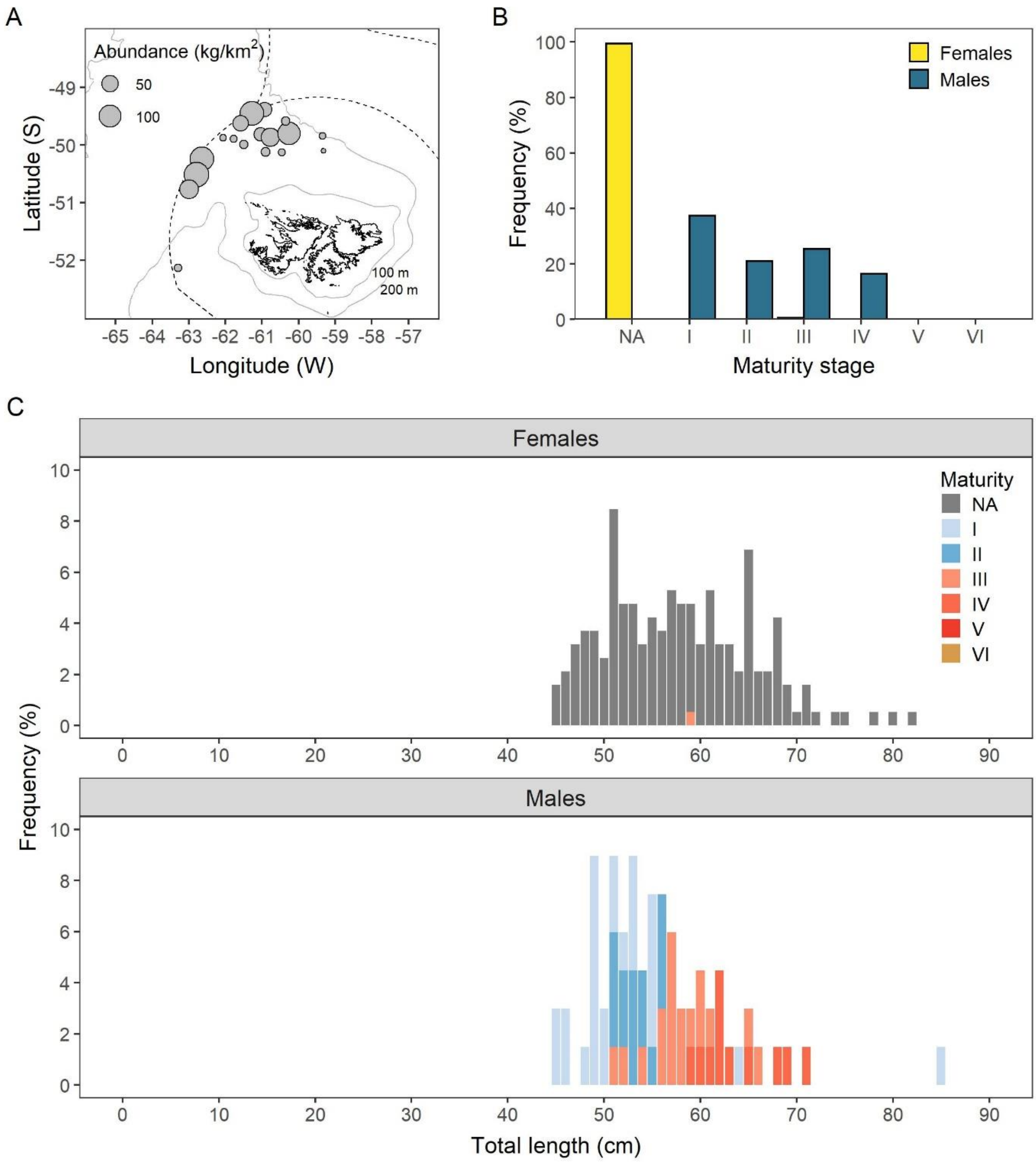

Figure 24. Biological data of *Squalus acanthias* (Dogfish; DGS); A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 189) and male (n = 67) lengths with 1 cm size class.

3.6. Finfish gonads sampling for histology

A total of 85 gonads, including 55 ovaries and 30 testes, of the five targeted species (common hake, red cod, rock cod, southern blue whiting, and toothfish) were sampled for histology for validation of maturity stages (Table IV).

Table IV. Samples for histology collected during the July 2024 groundfish survey (2024-07-ZDLT1). *Merluccius hubbsi* (Common hake; HAK), *Salilota australis* (Red cod; BAC), *Patagonotothen ramsayi* (Rock cod; PAR), *Micromesistius australis* (Southern blue whiting; BLU), and toothfish (*Dissostichus eleginoides*).

Species code	Length (mean ± SD)	Ovaries (n)	Testes (n)	Total
Common hake	51.9 ± 15.0	15	8	23
Red cod	46.4 ± 21.7	9	6	15
Rock cod	24.5 ± 5.3	9	2	11
Southern blue whiting	46.2 ± 10.8	5	8	13
Toothfish	54.2 ± 14.8	17	6	23
Total		55	30	85

3.7 Interactions with pinnipeds

Pinnipeds were detected swimming around the vessel during 10 stations out of the 76 stations conducted during the survey (Fig. 25A). There were 7 mortalities of American fur seals (*Arctocephalus australis*) at trawl stations 4171 (n = 1), 4227 (n = 4), 4239 (n = 1), and 4275 (n = 1) to the west of West Falkland and near the limit of the FICZ (Fig. 25B). These were each the first stations conducted of a given day (Table I); the seals were mainly observed while the first CTD station of the day was being conducted, and seemed to disappear immediately after the CTD was back on deck. The Captain would then reposition the vessel and shoot the net, or would wait a few minutes for shooting the net if it was too early for the sunrise. There was no evidence of seals around the vessel after the CTD and before/during net shooting. Still, it was suspected that the seals entered the net during net shooting.

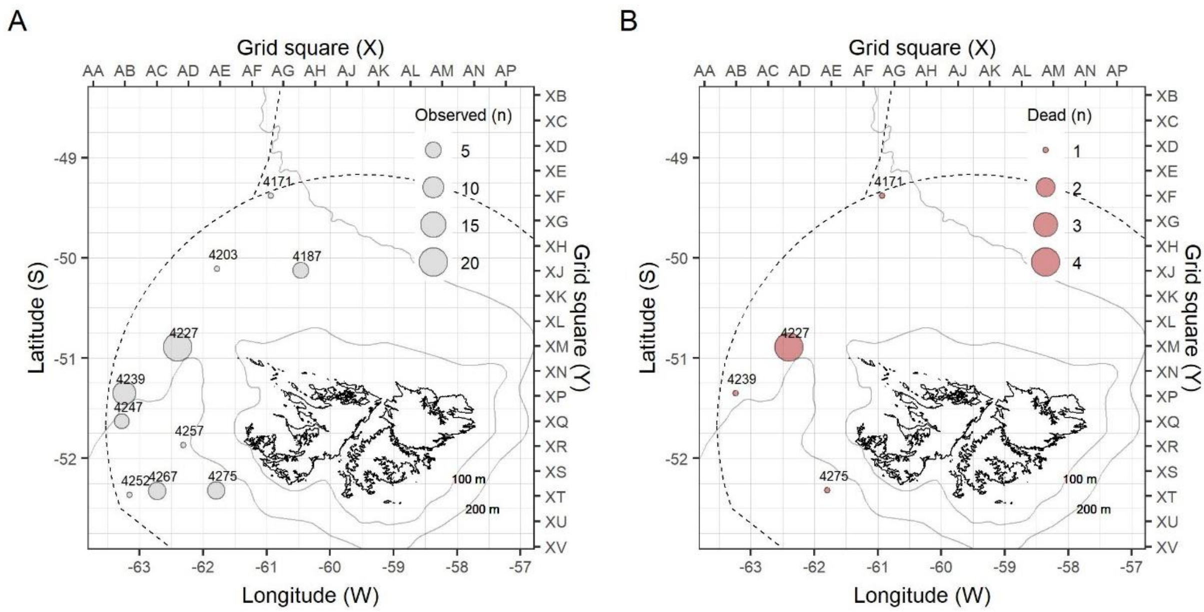

Figure 25. Spatial distribution of the number of pinnipeds A) observed around the vessel and B) dead by incidental bycatch during the July 2024 groundfish survey (2024-07-ZDLT1).

3.8. Oceanography

A total of 76 CTD stations were conducted, of which 72 usable casts were produced. The first three CTD casts of the survey were not usable due to battery failure; new batteries were installed after the third CTD station and the battery did not fail over the subsequent CTD casts. The fourth CTD cast of the survey (CTD station 4137 in the proximity of trawl station 4136) only recorded oceanographic data from the surface to approximately 60 m depth due to winch failure. The shallowest common depth to all stations was 10 m, and this depth was therefore considered a proxy for the surface.

Chlorophyll data were collected but levels are uniformly low at this time of the year. For instance, <0.76 µg of chlorophyll were measured at the surface whereas chlorophyll values around 8.5 µg are measured at the surface during summer (Fig. 26).

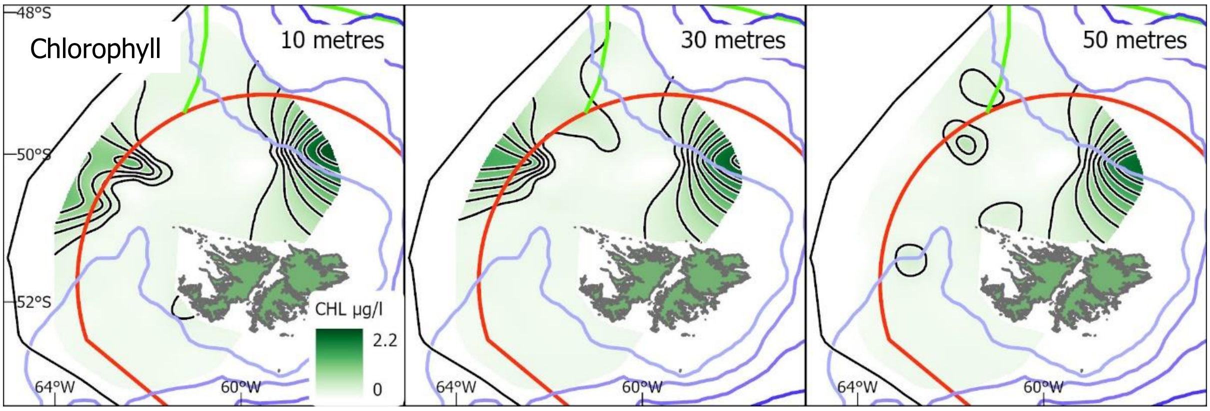

Figure 26. Chlorophyll concentration at surface (10 m), 30 m, and 50 m depths during the July 2024 groundfish survey (2024-07-ZDLT1).

Temperature ranged between 4.9°C at the seabed and 6.4°C at the surface. Temperature was lower to the south-west and to the north-east, and it was higher along the north-west limit of the FICZ. There was little variation over the station profiles, with the maximum difference between surface and seabed being 0.7°C (Fig. 27). This pattern is similar to the July 2023 survey pattern (Ramos et al. 2023); however, water temperature was cooler over the entire survey area during July 2024 (based on surface interpolation; Fig. 28).

Oxygen concentration was higher along the west and to the north-east at 10 m and at 100 m depths. Oxygen concentration also decreased with depth. At 10 m depth, oxygen was mostly >6.5 ml/l across the survey area, with the highest oxygen concentration to the south. At 100 m depth, oxygen concentration pattern was similar to the surface but the oxygen concentration levels were lower. At the seabed, oxygen levels were overall lower compared with the 10 m and 100 m depths, with higher oxygen concentration over the northern shelf and lower oxygen concentration in deeper stations (Fig. 27).

Salinity was higher to the north-east and south-west, and lower along the western limit of the FICZ. Salinity ranged between 33.5 and 33.9 PSU at 10 m depth, between 33.6 to 34 PSU at 100 m, and between 33.5 (33.4 in the interpolated are to the west of the FICZ) and 34.1 PSU at the seabed (Fig. 27; the maps show interpolated values outside the measured range of salinity values). Lower levels of salinity occur generally in the area where the Argentine current enters the FICZ. The Argentine current water-mass is found above the Falklands current water-mass as the Argentine current is less dense than the Falklands current (Arkhipkin et al. 2013).

Density was higher to the south-west and to the north-east, with values from 26.4 to 27.0 sigma t across the survey area. Density was higher with depth, i.e., density was 0.3 sigma-t higher at the seabed than at the surface. At 10 m depth, slightly lower densities (26.4 to 26.6

sigma t) were recorded across the shelf in the FICZ, with higher density above the slope and towards the south where the maximum of 26.6 sigma t was reached. At 100 m depth, density ranged between 26.4 and 26.7 sigma t. At the seabed, density reached 27 sigma t in the south-west (Fig. 27).

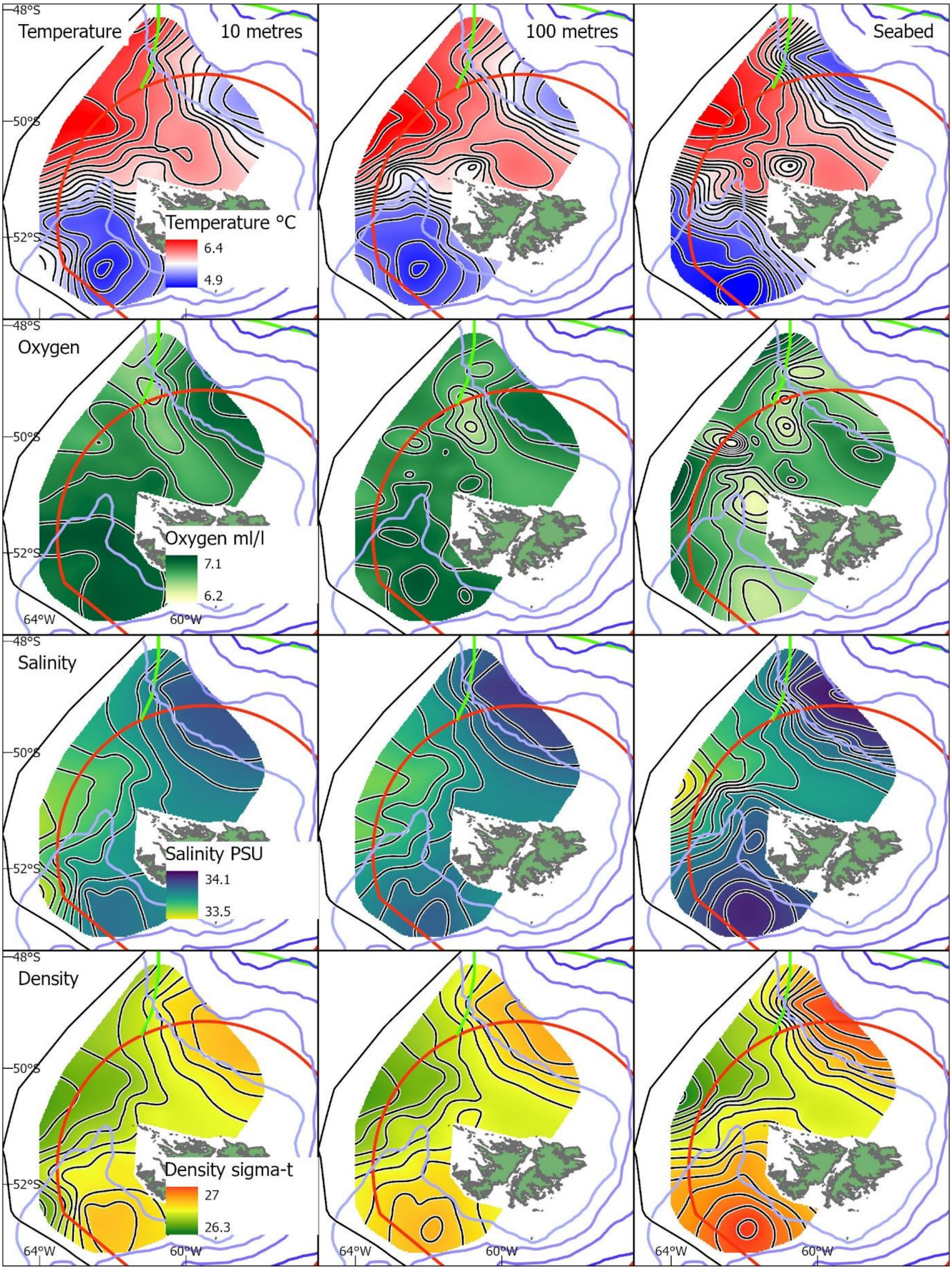

Figure 27. Temperature, oxygen, salinity, and density at 10 m, 100 m, and seabed. Contours at 0.25°C, 0.25 ml/l, 0.1 PSU, and 0.1 sigma t, respectively.

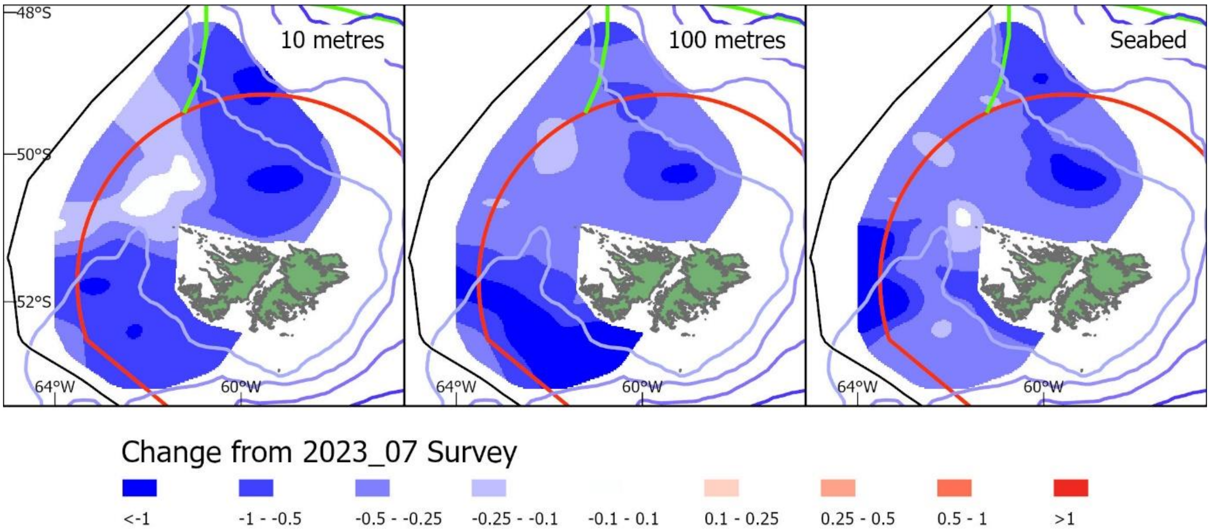

Figure 28. Temperature difference between July 2024 and July 2023, indicated by the gradient of colours from dark blue (maximum decrease in July 2024 compared with July 2023) to dark red (maximum increase in July 2024 compared with July 2023).

4. Discussion

This report summarises the findings of the groundfish survey conducted during July 2024 in the FICZ and FOCZ. The first July groundfish survey of this kind was conducted in 2017 (Gras et al. 2017), the second in 2022 (Lee et al. 2022), and the third in 2023 (Ramos et al. 2023). These surveys follow an array of stations in the FICZ similar to the array of stations of the February groundfish surveys conducted during 2010, 2011, and from 2015 to 2024. The February (summer) and July (winter) fisheries-independent surveys are crucial to better understand the spatial and temporal (seasonal and inter-annual) patterns in species distribution and abundance, and demographic patterns (sex, maturity, and length frequency distributions), in response to environmental, ecological, and anthropogenic factors (e.g., Hilborn & Walters 1992).

The abundance of common hake has increased in the FICZ in recent years (Ramos & Winter 2022a, 2023). Therefore, a hake demography survey was conducted in July 2020 instead of the regular July groundfish survey. The July 2020 hake demography survey followed a different array of stations that covered part of the FICZ, FOCZ, and the high seas to the north of the FOCZ (Randhawa et al. 2020). Hence, of the July 2020 hake demography survey, only those stations that were within the FICZ and FOCZ were considered for comparability to the current report. However, comparability of patterns observed in the July groundfish surveys against the July 2020 hake demography survey should be taken with caution.

Common hake was the main catch (85.8 t; 77%) during the July 2024 groundfish survey, during the previous July groundfish surveys (Gras et al. 2017; Lee et al. 2022; Ramos et al. 2023), and in the hake demography survey (Randhawa et al. 2020). Catch proportion (77%) and CPUE (1,129 kg/h) in the July 2024 groundfish survey were the highest amongst July groundfish surveys (Gras et al. 2017; Lee et al. 2022; Ramos et al. 2023), including the hake demography survey (Randhawa et al. 2020). High densities occurred through the survey area, consistent with high commercial CPUE at this time of the year in the FICZ (Ramos & Winter 2022a). Increasing abundance of common hake has also been detected from February groundfish surveys (Ramos & Winter 2023). Falkland Islands waters are used as feeding ground by this species (Arkhipkin et al. 2003). A pattern of the maturity status of common hake in Falkland Islands waters was described by Arkhipkin et al. (2015): "The post-spawning period runs from March to June, while the resting/feeding period occurs from July to November. The spawning period, when the majority of fish is absent from Falklands waters, is from December to February". During the July 2024 groundfish survey, females were found to be mainly at resting or early developing maturity stages, and males were found mainly at late developing maturity stage, with minor proportions of individuals at early developing maturity stage. These maturity patterns are consistent with the maturity patterns described during the July 2017 survey (for females; Gras et al. 2017), July 2020 hake demography survey (Randhawa et al. 2020) and the July 2023 survey (Ramos et al. 2023) but differ from the maturity patterns described during the July 2022 surveys. During July 2017, males were described as spent, with minor proportions as immature, resting, early developing, or recovering spent (Gras et al. 2017). During July 2022, females were described as resting, spent, or recovering spent, and males were described mainly as spent or recovering spent (Lee et al. 2022). These contrasting maturity patterns may be due to alterations in reproductive phenology associated with environmental variability (Pörtner & Farrell 2008; Alix et al. 2020; Elisio et al. 2020), or may be an artefact caused by the misidentification of maturity stages as noted during the July 2023 survey (Ramos et al. 2023).

Common hake was in the range of sizes between 28 cm and 77 cm length, and modal length at about 41 cm during the July 2024 groundfish survey, similar to July 2023 (Ramos et al. 2023). A wider range of sizes were recorded in the July 2017 survey (19–90 cm length; Gras et al. 2017). Small individuals were also detected during the July 2020 survey (<30 cm length; Randhawa et al. 2020). Individuals >80 cm length have not been reported since the July 2020 survey (Randhawa et al. 2020; Lee et al. 2022). The decline in the frequency of >80 cm length individuals is consistent with the decline in modal length of females from 60 cm in 2012 to 40 cm in 2021, based on commercial and survey data during June and July (Ramos & Winter 2022a).

Rock cod was the second highest catch (8.9 t; 8%) during the survey and it was caught through the survey area, with denser aggregations to the north-west in the FICZ. In previous July groundfish surveys, rock cod total catches were in the range from 330 kg to 6.2 t (0.9–8.3%), and the distribution of the catch varied across surveys. The abundance of rock cod is usually low from July to November (Ramos & Winter 2023), as this species emigrates from Falkland Islands waters and remains in low abundances during winter (July to September) (Arkhipkin et al. 2012). Nevertheless, the CPUE of rock cod (117 kg/h) was the highest in the July 2024 groundfish survey compared with previous July groundfish surveys (27 kg/h, Gras et al. 2017; 10 kg/h, Randhawa et al. 2020; 100 kg/h, Lee et al. 2022; 88 kg/h, Ramos et al. 2023). Immature, resting and developing maturity stages were observed, as rock cod prepare for spawning at the end of autumn and in part of winter at the shelf break in Falkland Islands waters (Ekau 1982; Brickle et al. 2006). Length frequency distributions allowed detecting two length-groups. The absence of the smaller length-group (<10 cm) was noted, as in the July 2022 survey (Lee et al. 2022).

Kingclip was the third highest catch (6 t; 5.5%) during the survey; this was the highest catch and CPUE (80 kg/h) of kingclip in July groundfish surveys (1.7–4.5 t; 2.1–9.1%; 28–64 kg/h). Individuals were consistently at resting and at early developing maturity stages across July groundfish surveys (Gras et al. 2017; Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023). Kingclip migrate in autumn (April to June) from Argentine waters into Falkland Islands waters, and remain abundant in feeding grounds to the north, north-west, and west of the Falkland Islands during winter (July to September) and spring (October to December) (Ramos & Winter 2022c; Falkland Islands Government 2023). An increasing trend in modal length was observed from July 2017 to July 2024, with relatively small individuals (mode at 46 cm length) being dominant during July 2017 (Gras et al. 2017). Modal lengths were observed at 53–55 cm during July 2020 and July 2022 (Randhawa et al. 2020; Lee et al. 2022). From July 2022, larger modal lengths (>65 cm) were also observed (Lee et al. 2022; Ramos et al. 2023).

The Patagonian squid *D. gahi* comprised the fourth highest catch (5 t; 4.5%) during the survey; it was distributed across the survey area, and the largest densities were found to the north along the 200 m isobath and to the south-west in stations >200 m deep. This species has been in the top three catches of the July groundfish surveys, with catches that were in the range of 4.7 to 6.5 t (4.5–12.4%) per survey, and patterns of distribution were similar across surveys (Gras et al. 2017; Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023). Consistent with previous surveys, most females were immature; males had a higher proportion of preparatory individuals, followed by relatively similar proportions of immature and maturing individuals. Length frequency distributions showed similar patterns across surveys; however, modal lengths for females and males (11 cm) were relatively higher in July 2024 than in previous surveys (8.5–10 cm; Gras et al. 2017; Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023).

Red cod was the fifth highest catch (2.9 t; 2.7% of the total survey catch) during the July 2024 groundfish survey. This is the second highest red cod catch in July groundfish surveys, only below the July 2023 survey (8.5 t; 11.5% of the total survey catch). In July 2024, higher densities of red cod were reported mainly from five stations located to the south-west in the FICZ, an area where relatively higher densities of red cod were observed in previous July groundfish surveys (Gras et al. 2017; Randhawa et al. 2020; Lee et al. 2022). Resting or immature individuals were frequent, also consistent with previous July groundfish surveys (Gras et al. 2017; Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023), as red cod starts the maturation process to spawn typically between August and October to the south and south-west of West Falkland (Arkhipkin et al. 2010; Brickle et al. 2011). A survey conducted in late September 2022 found low biomass of spawning red cod, and concluded that this stock has decreased in the Falkland Islands fishing area (Arkhipkin et al. 2022), which is consistent with low CPUE in recent years calculated from commercial fishery data (Ramos & Winter 2022b). The length-group of <20 cm animals was represented in lower numbers since the July 2020 survey (Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023) compared with the July 2017 survey (Gras et al. 2017).

Hoki catch during the July 2024 survey was relatively small (345 kg; 0.3%) and most catches were from stations >200 m deep to the south-west in the FICZ, as described in previous July groundfish surveys (Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023). It must be noted that the July 2017 survey had the highest hoki catch (6.5 t; 14.4%) (Gras et al. 2017), comparatively higher than in more recent surveys. Females and males were mainly at resting maturity stage. The maturity status observed during the July groundfish surveys was expected considering that spawning occurs during winter outside of Falkland Islands waters (Brickle et al. 2009; Arkhipkin et al. 2012). Hoki was in the range of 15–24 cm during July 2024, with mode at 20 cm length. This is higher than the modal lengths found in July 2017 (Gras et al. (2017) and July 2023 (Ramos et al. 2023), when the mode was found at 16 cm length (13–23 cm). In contrast, the July 2020 and July 2022 surveys reported a wider range of lengths (14–32 cm) and multiple modes at 16 cm, 21–22 cm, and 28 cm length (Randhawa et al. 2020; Lee et al. 2022).

Toothfish was a minor catch (191 kg; 0.17%) during the survey, where relatively small individuals at immature or resting maturity stages were caught at stations >200 m deep to the south-west in the FICZ. This is the second highest catch of toothfish in July groundfish surveys (122 kg, 0.3% in July 2017, Gras et al. 2017; 468 kg, 1.2% in July 2020, Randhawa et al. 2022; 105 kg, 0.1% in July 2022, Lee et al. 2022; 46 kg, 0.06 kg/h; Ramos et al. 2023) and represents an increase in toothfish catch compared with the July 2022 and 2023 surveys. However, adult toothfish are caught mainly using longline; therefore, the information provided in this report is not representative of the adult portion of the toothfish population.

Southern blue whiting represented a minor catch (26 kg; 0.02%) during the survey, and were mainly caught at stations >200 m deep to the south-west and to the north in the FICZ and in the FOCZ. This was the lowest catch across July groundfish surveys (126 kg, 0.3% in July 2017, Grass et al. 2017; 606 kg, 1.6% in July 2020, Randhawa et al. 2022; 23 kg, 0.03% in July 2022, Lee et al. 2022; 41 kg, 0.06% in July 2023, Ramos et al. 2023). The majority of individuals were of small size (<25 cm length), and identified as sexually immature males. However, it is noted that some females may have been misidentified as males considering that only 2 females of 18 cm length were reported, whereas 76 males between 14 and 21 cm were reported. Animals >25 cm length have been infrequent during the July groundfish surveys, except for the July 2020 survey (Randhawa et al. 2022). Large and developing individuals are expected during July in preparation for spawning that takes place during September and October to the south of West Falkland (Macchi et al. 2005; Arkhipkin et al. 2022).

Argentine shortfin squid, banded whiptail grenadier, butterfish, driftfish, and southern hake contributed minor catches (<180 kg each) during the survey, some of which were amongst the lowest catches across July groundfish surveys (Gras et al. 2017; Randhawa et al. 2022; Lee et al. 2022; Ramos et al. 2023).

Skates had minor CPUE (≤1.2 kg/h each species), with the starry ray, the Warrah skate, the Falkland skate and the sand ray having the lowest CPUEs across July groundfish surveys. The white spotted skate, the blonde skate, the joined-fins skate, the grey tailed skate, and the multispine skate had the second lowest CPUEs across July groundfish surveys (Gras et al. 2017; Randhawa et al. 2020; Lee et al. 2022; Ramos et al. 2023). Skates discards in the Falkland Islands fishery increased considerably in the late 1990s and again in 2017, with average levels from 2018 to 2021 (Parkyn et al. 2021). Some skate species caught in Falkland Islands waters are classified as endangered (i.e., grey tailed skate; Pollom et al. 2020a), vulnerable (i.e., white spotted skate; Pollom et al. 2020b) or near threatened (i.e., blonde skate, Pollom et al. 2020c; multispine skate, Pollom et al. 2020d; and Falkland skate, Pollom et al. 2020e) by

IUCN. Catshark and dogfish were caught in relatively small amounts, i.e., 161 kg and 178 kg, respectively, with the lowest and second lowest CPUEs across July groundfish surveys, respectively. The highest catches of these species were reported during the July 2017 groundfish survey (Gras et al. 2017). The dogfish is classified as vulnerable by the IUCN (Finucci et al. 2020).

5. Conclusions

1. The most abundant species in terms of catch proportion were common hake (77%), rock cod (8%), kingclip (5%), Patagonian squid (5%), and red cod (3%).
2. CPUE of common hake (1,129 kg/h), kingclip (80 kg/h), and rock cod (117 kg/h) in the July 2024 groundfish survey were the highest for these species across July groundfish surveys.
3. CPUE of *D. gahi* (66 kg/h) in the July 2024 groundfish survey was the second lowest across July groundfish surveys.
4. Dogfish, catshark, and several skates showed lower catches and CPUE in the July 2024 groundfish survey compared with previous July groundfish surveys.
5. A total of 85 gonads of common hake, red cod, rock cod, southern blue whiting, and toothfish were collected for histology, for validation of maturity stages.
6. A total of 7 mortalities of American fur seals occurred during the survey.
7. Temperature was lower to the north-east and to the south-west in the survey area, and it was lower in July 2024 compared with July 2023. Chlorophyll concentration was relatively low, with higher values to the north-east and to the north-west. Overall, oxygen, salinity, and density were higher to the north-east and to the south-west.

6. Recommendations

1. Given the increasing abundance of common hake in Falkland waters, studies are currently being conducted to better understand the drivers of its distribution and abundance, and its ecological effects on other commercially important stocks such as *D. gahi*.
2. The causes of the low abundance of *D. gahi* are being investigated, with suspected combined effects of oceanographic conditions (Arkhipkin et al. 2006), predation by multiple species, i.e., common hake, kingclip, sharks, skates, seabirds, and marine mammals (Büring et al. 2024), and fishing pressure.
3. The generally low productivity of chondrichthyes (Cailliet et al. 2005), and the poor conservation status of some skates and sharks (described by IUCN) that occur in Falkland Islands waters pinpoint the need for research on these species to better understand their distribution, abundance, biology, and the effects of the fisheries on their populations.
4. Operational delays should be minimized so that the survey schedule and the number of stations is consistent across groundfish surveys. Changes in the number of stations from one year to the next reduces comparability of distribution, abundance, and other demographic patterns through time, limiting our capacity to examine the state and trends of the fisheries stocks.
5. The eight-stages sexual maturity scale modified from Nikolsky (1963) and used for fishes at the FIFD is a broad maturity scale. A detailed description of this scale is recommended for each individual species according to their gonads' macroscopic features validated with histology. This should facilitate the identification of maturity stages for each species and minimize subjectivity in the interpretation of the scale by different scientific staff. The histology project aimed at validating the maturity stages of different finfish species started in February 2024 and will continue until the required samples are collected.
6. The identification of maturity stages of some species during the groundfish surveys, i.e., butterfish, may require the use of stereomicroscope or magnifier spectacles, which are available at FIFD. Pertinent arrangements should be made to facilitate the use of these equipment during the groundfish survey.

7. Measures to prevent pinniped mortalities during groundfish surveys should be investigated. It is suspected that pinnipeds entered the net during net shooting, right after the CTD station was conducted. Implementation of a seal exclusion device (SED; Iriarte & Zawadowski 2019) may be possible provided it will not compromise the catch and further biomass calculations. Alternatively, steaming for 1–2 nm at full speed before net shooting (Iriarte et al. 2020) (during the groundfish survey it would be between the CTD station and net shooting), may allow leaving pinnipeds behind reducing incidental bycatch during net shooting.
8. Oceanographic data provides valuable insights towards understanding the distribution, abundance, and other demographic patterns of the stocks, and should be recorded and described for every survey. The FIFD CTD was serviced *in house* before the July 2024 groundfish survey, and spare accessories in working condition were provided for the survey (CTD cable and adaptor to laptop). A laptop (asset number: 0005439) with the required software is designated for the CTD and is available upon request to the FIFD oceanographic data analyst.
9. At the start of the survey, batteries already installed in the CTD indicated 11.7 v, which is above the recommended lower limit (10.5 v) required for correct functioning. However, the first three CTD casts had battery fail. It's therefore recommended to install new batteries before the first station of the survey, and to corroborate correct functionality of this equipment as soon as the batteries are near 11.7 v.

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Appendix I. Master list of fixed stations for groundfish surveys. Specific survey station number will be different from the master list fixed station number. Positions 1 and 2 refer to the initial and final coordinates of the trawl; it's at the Captain's discretion to decide whether to start each trawl at position 1 or 2. The start of each trawl corresponds to net deployment.

Station	Latitude 1	Longitude 1	Latitude 2	Longitude 2	Course (°)	Mean depth (m)
5	52.702	60.874	52.644	60.980	320	378
6	52.425	61.199	52.477	61.053	123	279
7	52.122	61.456	52.217	61.393	166	187
8	52.288	61.779	52.386	61.823	205	320
9	52.363	62.248	52.426	62.380	235	296
10	52.161	61.584	52.114	61.709	309	254
11	52.006	62.066	52.046	62.098	211	288
12	51.811	61.866	51.915	61.846	155	190
13	51.919	62.351	51.817	62.280	25	262
14	51.816	62.559	51.905	62.640	215	230
15	51.621	62.549	51.652	62.581	220	211
16	52.191	62.700	52.113	62.588	33	256
17	52.359	62.806	52.289	62.655	53	272
18	52.372	63.232	52.363	63.048	85	256
19	52.088	63.262	52.187	63.272	185	226
20	51.830	63.271	51.918	63.298	190	203
21	51.573	63.308	51.617	63.290	195	183
22	51.329	63.206	51.401	63.299	230	165
23	51.038	63.180	51.134	63.255	235	153
24	51.115	62.749	51.096	62.912	290	170
25	51.407	62.859	51.336	62.758	40	184
26	51.194	62.443	51.152	62.375	47	190
27	51.413	62.384	51.334	62.280	39	211
28	51.633	62.268	51.530	62.237	360	249
29	51.296	61.875	51.394	61.924	205	200
30	51.092	61.783	51.192	61.700	152	181
31	50.845	61.860	50.943	61.906	200	170
32	50.644	61.971	50.713	61.860	125	181
33	50.765	62.573	50.678	62.498	32	166
34	50.933	62.439	50.839	62.356	5	183
35	50.886	62.767	50.984	62.737	175	166
36	50.715	62.985	50.815	63.003	192	152
37	50.473	62.759	50.577	62.830	200	149
38	50.506	62.197	50.604	62.185	177	167
39	50.332	62.430	50.356	62.261	90	152
40	50.207	62.622	50.298	62.681	191	146
41	50.120	62.258	50.152	62.406	252	147
42	50.256	61.963	50.254	62.125	270	158
43	49.832	62.008	49.912	62.105	220	147
44	49.921	61.820	49.833	61.703	34	157
45	50.127	61.732	50.084	61.863	290	158
46	49.997	61.417	49.996	61.572	270	157
47	50.121	61.063	50.085	61.215	285	160
48	50.419	61.700	50.460	61.858	252	168
49	50.375	61.259	50.421	61.405	243	160
50	50.418	60.750	50.392	60.891	280	153

Station	Latitude 1	Longitude 1	Latitude 2	Longitude 2	Course (°)	Mean depth (m)
51	50.592	60.919	50.583	60.749	85	152
52	50.620	61.357	50.613	61.200	85	151
53	50.792	60.618	50.749	60.833	282	133
54	50.828	60.216	50.833	60.384	261	136
55	50.597	60.358	50.695	60.288	158	146
56	50.333	60.478	50.422	60.447	170	154
57	50.077	60.470	50.172	60.458	177	158
58	50.086	60.821	50.146	60.960	222	160
59	49.812	60.770	49.923	60.778	168	164
60	49.865	61.134	49.790	61.013	40	163
61	49.618	61.280	49.603	61.128	80	161
62	49.654	61.648	49.602	61.513	173	158
63	49.430	61.206	49.488	61.351	236	162
64	49.518	60.904	49.607	61.001	220	167
65	49.342	60.875	49.418	60.966	190	168
66	49.145	60.980	49.238	61.018	200	174
67	49.062	60.788	49.158	60.780	160	193
68	48.855	60.657	48.965	60.593	159	242
69	48.635	60.747	48.742	60.725	167	242
70	49.437	60.292	49.380	60.425	300	197
71	49.592	60.302	49.580	60.477	277	173
72	49.665	59.822	49.607	59.960	300	186
73	49.797	60.372	49.793	60.197	92	168
74	49.810	59.938	49.810	59.792	98	168
75	49.875	59.247	49.832	59.392	295	190
76	50.055	59.528	50.015	59.662	291	162
77	50.115	59.248	50.088	59.407	278	158
78	50.315	59.008	50.273	59.160	295	149
79	50.118	58.778	50.082	58.932	286	156
80	49.965	58.852	49.918	58.993	321	187
81	50.358	58.592	50.305	58.727	309	144
82	50.167	58.433	50.107	58.583	307	168
83	50.318	58.088	50.265	58.243	285	165
84	50.173	57.998	50.230	57.878	130	274
91	52.603	61.151	52.578	61.293		371
92	52.700	61.891	52.630	61.770		345
93	52.642	62.404	52.698	62.263		324
94	50.446	57.866	50.490	57.746		154

Appendix II. Spatial distribution of total catch in July groundfish surveys.