Cruise Report 2024-02-ZDLT1

Groundfish survey

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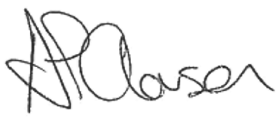

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1. Introduction

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 favours 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, 2022, and 2023). The February groundfish surveys were originally conducted to estimate the biomass of the former index species (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. 2017a; 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., 2020a). The FIFD aims 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, 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 February 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*), and southern blue whiting (*Micromesistius australis*) for histological analysis of maturity stages.
4. To calculate the conversion factor (CF) for driftfish (*Seriolella porosa*).

2. Material and Methods

2.1. Vessel

The February 2024 groundfish survey (2024-02-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 stations of 60 min each, with four trawl stations 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 an individual grid square to ensure coverage of the entire study area.

The February 2024 groundfish survey completed the 84 planned stations that covered the full survey area (Fig. 1) despite experiencing about three rough weather days. The ship departed from Stanley at 20:00 on January 31st 2024. The first trawl station was conducted to the north of East Falkland early in the morning on February 1st 2024, an area where catches are usually small. This allowed the scientific staff, and in particular the new scientific staff, to familiarise with the routine of the survey during the least busy stations to the north of East Falkland. Three to five trawls were conducted per day during the survey. Summer has more daylight hours compared with winter, hence it was possible to conduct up to five trawls per day during daylight. Conducting five trawls during some days allowed anticipating for days with rough weather or when unforeseen vessel technical issues prevented conducting the four planned stations of the day. The oceanographic stations (CTD) preceded or succeeded each trawl depending on logistics. The last trawl of the survey was hauled on February 21st 2024 to the south-west of West Falkland. The ship arrived to Stanley on February 22nd 2024, and the scientific staff 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 83 stations, except for station 3988 when the sensor did not provide net horizontal opening. The duration of each trawl was 60 min on the bottom, and trawling speed varied between 4.0 and 5.1 knots. A total of 84 bottom trawls were conducted with corresponding station numbers ranging from 3962 to 4128 (Table I).

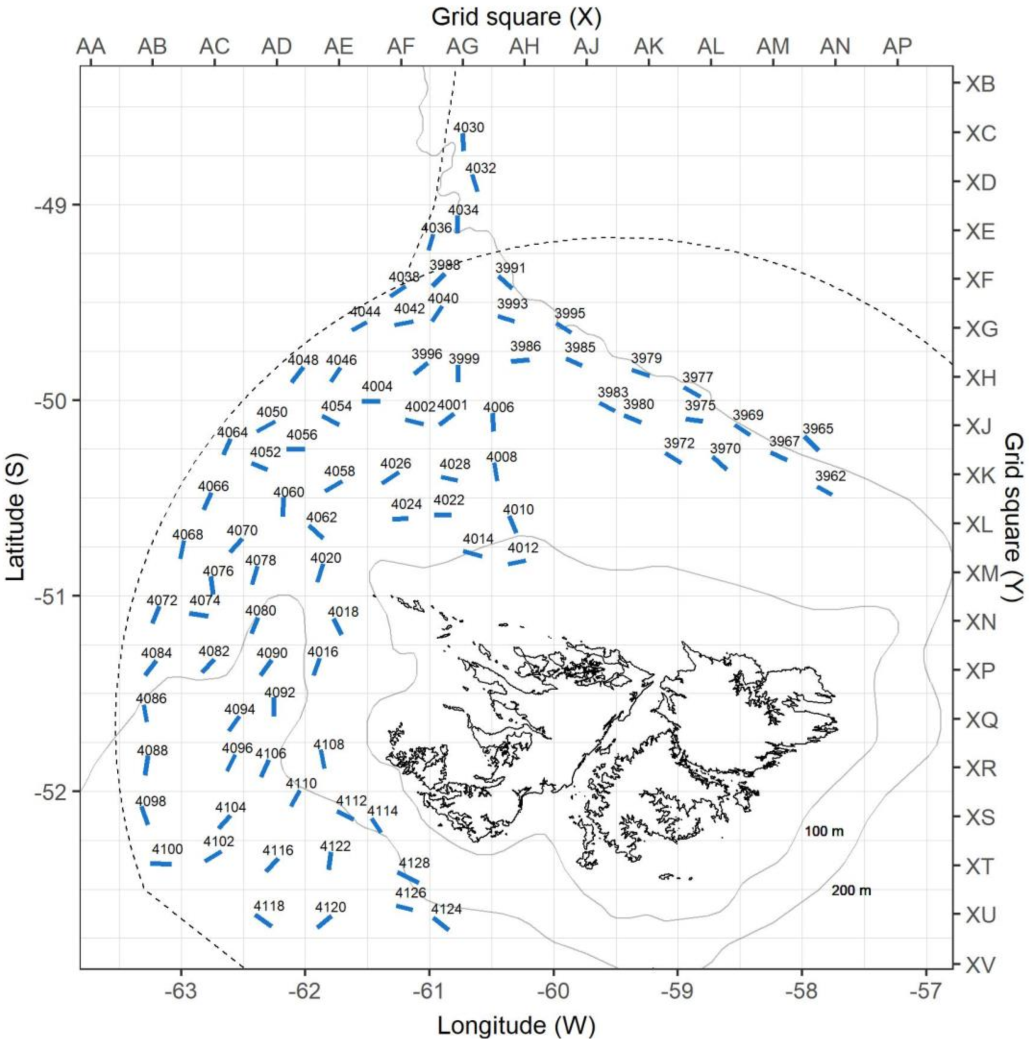

Figure 1. Trawl tracks with station numbers performed during the February 2024 groundfish survey (2024-02-ZDLT1).

2.4. Trawl stations and biological sampling

At each trawl station, the catch was sorted and the total catch was weighed by species with an electronic Marel balance (150 kg capacity). All commercial species and most 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 (*C. fasciatus* and *Macrourus carinatus*). Total length and fork length were recorded for butterfish (*Stromateus brasiliensis*) to the lower cm. Macroscopic assessment of sex and maturity were conducted following an eight-stage maturity scale used at FIFD (Brickle et al. 2005, 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 maturity scale used at FIFD (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 maturity scale used at FIFD (Arkhipkin et al. 2008). For sharks, total length was recorded, and sex and maturity were examined macroscopically using a six-stage maturity scale used at FIFD (Arkhipkin et al. 2008). Skates and sharks were dissected for maturity examination only if they looked in poor shape or if they were going to be processed by the fishing crew, otherwise they were examined externally and released alive immediately; maturity of male skates and sharks was examined externally. Identification of length-groups were based on discrete modal lengths and bell-shaped length frequencies.

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 two additional individuals per species (hake, kingclip, red cod, rock cod and toothfish) were also randomly extracted per station as part of the ROS strategy to increase the spatial coverage of the otoliths collection. 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 (>190 m) and shallow (<170 m) stations, and frozen for statolith extraction at the FIFD laboratory. Several fish specimens were frozen for further analyses ashore. In addition, several fish specimens were frozen for training of scientific observers on maturity stage identification.

Table I. Station data of the February 2024 groundfish survey (2024-02-ZDLT1).

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth (m)
3962	01/02/2024	-50.4838	-57.7593	-50.4418	-57.8805	152
3965	01/02/2024	-50.2578	-57.8637	-50.1845	-57.9808	272
3967	01/02/2024	-50.3073	-58.1225	-50.267	-58.257	156
3969	01/02/2024	-50.1778	-58.4208	-50.1273	-58.5423	167
3970	01/02/2024	-50.2897	-58.7237	-50.3545	-58.6077	145
3972	02/02/2024	-50.3208	-58.9715	-50.2692	-59.1042	149
3975	02/02/2024	-50.0957	-58.94	-50.1072	-58.8	156
3977	02/02/2024	-49.9822	-58.8212	-49.9333	-58.9535	184
3979	02/02/2024	-49.877	-59.2283	-49.8438	-59.3738	188
3980	02/02/2024	-50.078	-59.4373	-50.114	-59.2938	157
3983	03/02/2024	-50.0553	-59.5075	-50.0123	-59.6333	161
3985	03/02/2024	-49.8227	-59.7707	-49.7872	-59.9042	170
3986	03/02/2024	-49.8028	-60.348	-49.7938	-60.1988	168
3988	04/02/2024	-49.4167	-60.9787	-49.3535	-60.8743	169
3991	04/02/2024	-49.3663	-60.4492	-49.4295	-60.3377	197
3993	04/02/2024	-49.5692	-60.4513	-49.5967	-60.3145	172
3995	04/02/2024	-49.6067	-59.9798	-49.656	-59.8575	186
3996	05/02/2024	-49.8678	-61.1262	-49.8082	-61.0165	165
3999	05/02/2024	-49.8198	-60.7703	-49.9083	-60.7697	164
4001	05/02/2024	-50.0685	-60.805	-50.1275	-60.9238	160
4002	05/02/2024	-50.122	-61.0507	-50.0977	-61.1997	160
4004	05/02/2024	-50.0067	-61.3952	-50.0027	-61.5438	159
4006	06/02/2024	-50.0657	-60.4963	-50.1597	-60.4858	158
4008	06/02/2024	-50.3182	-60.4823	-50.4133	-60.4563	154
4010	06/02/2024	-50.5897	-60.3623	-50.6787	-60.304	145
4012	06/02/2024	-50.82	-60.2233	-50.8372	-60.3705	136
4014	06/02/2024	-50.7975	-60.579	-50.7717	-60.729	134
4016	07/02/2024	-51.4057	-61.9352	-51.3177	-61.8847	200
4018	07/02/2024	-51.1978	-61.7102	-51.116	-61.7747	181
4020	07/02/2024	-50.929	-61.9055	-50.8367	-61.858	176
4022	08/02/2024	-50.5855	-60.8215	-50.5873	-60.962	154
4024	08/02/2024	-50.604	-61.1717	-50.6107	-61.3005	153
4026	08/02/2024	-50.427	-61.3882	-50.3692	-61.2487	161
4028	08/02/2024	-50.391	-60.9113	-50.4097	-60.7722	153
4030	09/02/2024	-48.6353	-60.7377	-48.7257	-60.7268	246

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth (m)
4032	09/02/2024	-48.8455	-60.6593	-48.9335	-60.615	242
4034	09/02/2024	-49.0548	-60.776	-49.1478	-60.7757	192
4036	09/02/2024	-49.1522	-60.9712	-49.2337	-61.011	172
4038	09/02/2024	-49.418	-61.1918	-49.4695	-61.3162	162
4040	10/02/2024	-49.5165	-60.8972	-49.5962	-60.983	166
4042	10/02/2024	-49.5987	-61.133	-49.6172	-61.2867	163
4044	10/02/2024	-49.6007	-61.5072	-49.6447	-61.6268	158
4046	10/02/2024	-49.8332	-61.7195	-49.906	-61.7948	157
4048	11/02/2024	-49.8312	-62.0152	-49.9095	-62.1147	148
4050	11/02/2024	-50.1092	-62.2425	-50.1612	-62.3943	149
4052	11/02/2024	-50.3223	-62.4378	-50.3568	-62.3053	154
4054	11/02/2024	-50.0818	-61.8683	-50.1263	-61.7298	157
4056	13/02/2024	-50.2513	-62.1513	-50.253	-62.0032	157
4058	13/02/2024	-50.414	-61.704	-50.466	-61.8418	169
4060	13/02/2024	-50.4967	-62.1765	-50.5955	-62.1838	170
4062	13/02/2024	-50.6393	-61.9758	-50.7082	-61.857	184
4064	14/02/2024	-50.1975	-62.6063	-50.2795	-62.6628	145
4066	14/02/2024	-50.4707	-62.7595	-50.5597	-62.8222	148
4068	14/02/2024	-50.7148	-62.9792	-50.8117	-63.01	154
4070	14/02/2024	-50.7762	-62.6113	-50.7083	-62.5077	166
4072	15/02/2024	-51.1417	-63.2342	-51.0528	-63.1762	154
4074	15/02/2024	-51.0903	-62.936	-51.1047	-62.7818	167
4076	15/02/2024	-50.9957	-62.7418	-50.9005	-62.7625	165
4078	15/02/2024	-50.8468	-62.3855	-50.9415	-62.4328	183
4080	15/02/2024	-51.1098	-62.382	-51.194	-62.4362	189
4082	16/02/2024	-51.325	-62.736	-51.3922	-62.8338	183
4084	16/02/2024	-51.33	-63.1995	-51.406	-63.2945	165
4086	16/02/2024	-51.5565	-63.3043	-51.6452	-63.2783	181
4088	16/02/2024	-51.818	-63.2687	-51.9163	-63.2925	203
4090	17/02/2024	-51.3272	-62.2732	-51.4055	-62.3613	211
4092	17/02/2024	-51.521	-62.255	-51.6183	-62.2587	250
4094	17/02/2024	-51.6153	-62.5325	-51.6922	-62.619	211
4096	17/02/2024	-51.8105	-62.5655	-51.8948	-62.6323	231
4098	18/02/2024	-52.0765	-63.3228	-52.1727	-63.2677	228
4100	18/02/2024	-52.3677	-63.2485	-52.3715	-63.0762	258
4102	18/02/2024	-52.357	-62.811	-52.3053	-62.6773	270
4104	18/02/2024	-52.1905	-62.6983	-52.1233	-62.6047	256
4106	19/02/2024	-51.9253	-62.3572	-51.838	-62.2953	262
4108	19/02/2024	-51.786	-61.8755	-51.8842	-61.8487	184
4110	19/02/2024	-51.9945	-62.048	-52.0763	-62.118	279
4112	19/02/2024	-52.1003	-61.7458	-52.1448	-61.61	260
4114	19/02/2024	-52.1367	-61.4657	-52.2112	-61.3897	190
4116	20/02/2024	-52.342	-62.2178	-52.4085	-62.3223	298
4118	20/02/2024	-52.6285	-62.4052	-52.6908	-62.2743	323
4120	20/02/2024	-52.6973	-61.9055	-52.636	-61.7887	345
4122	20/02/2024	-52.4013	-61.8158	-52.3078	-61.794	321
4124	21/02/2024	-52.7105	-60.8477	-52.6443	-60.9703	374

Station	Date	Latitude start	Longitude start	Latitude finish	Longitude finish	Mean depth (m)
4126	21/02/2024	-52.606	-61.134	-52.5828	-61.269	372
4128	21/02/2024	-52.4132	-61.2587	-52.4662	-61.0867	273

2.5. Finfish gonads sampling for histology

Gonad sampling, including ovaries and testes, was conducted opportunistically for four species: common hake, red cod, rock cod, and southern blue whiting. 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. 2005, modified from Nikolsky 1963). Fresh gonads were photographed for morpho-chromatic analysis, and fixed in 10% neutral buffered formaldehyde for histological examination.

2.6. Conversion factor

Driftfish is a minor species that has been taken in recent years for commercial use in Falkland Islands waters, and a conversion factor (CF) has not previously been established at FIFD for this species (Trevizan et al. 2023). CF was therefore calculated opportunistically in this survey for driftfish; by station, and for the total bulk of individuals collected. First, total weight (green weight) for all individuals – collected randomly – was recorded. Then, head, guts and tail of the fish were removed by the factory crew, and the recovered trunks (HGT: headed, gutted, and tail off) were weighed again. CF was calculated as follows:

$$\mathrm{CF} = \frac{\text{Green weight (kg)}}{\text{HGT weight (kg)}}$$

2.7. Catch density

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

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

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 NHO = net horizontal opening (km) recorded by the MarPort Net Monitoring System.

2.8 Catch-per-unit-effort

Catch-per-unit-effort (CPUE) was calculated as the catch (kg) of the species of interest within the trawl between the duration of the trawl (h):

$$\mathrm{CPUE} = \frac{\text{Catch (kg)}}{\text{Trawl duration (h)}}$$

2.9. Interactions with pinnipeds

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

2.10. Oceanography

A Conductivity, Temperature, Depth instrument (CTD; SBE-25, Sea-Bird Electronics Inc., Bellevue, USA) was used to record oceanographic data in the vicinity of every trawl station. 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 1 m/sec to a maximum depth of 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 instrument calibrated in July 2019. Up-cast data were filtered out. Depth was calculated from pressure. Ocean Data View version 5.15 (Schlitzer, R., Ocean Data View, http://odv.awi.de, 2013) was used to make the plots of chlorophyll, temperature, oxygen, salinity, and density. 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.

3. Results

3.1. Catch composition

Catch weight of all identified species/taxa in the survey are presented in Table II. The most abundant species in terms of catch weight were Argentine shortfin squid (23.1%), rock cod (21.6%), Patagonian squid (11.8%), common hake (8.8%), red cod (8.3%), hoki (7.9%), kingclip (5.7%), and banded whiptail grenadier (5.3%). The rest of the species contributed ≤2% of the total catch. Higher catches occurred to the north-west in the FICZ (Appendix I).

Table II. Catch weight by species/taxon during the February 2024 groundfish survey (2024-02-ZDLT1).

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
ILL	*Illex argentinus*	16018.489	1325.052	1352.704	23.101
PAR	*Patagonotothen ramsayi*	14944.536	790.962	14941.954	21.552
LOL	*Doryteuthis gahi*	8177.011	213.302	261.063	11.792
HAK	*Merluccius hubbsi*	6071.262	1931.846	0.684	8.756
BAC	*Salilota australis*	5777.405	2126.541	46.501	8.332
WHI	*Macruronus magellanicus*	5543.995	955.514	65.915	7.995
KIN	*Genypterus blacodes*	3965.355	2717.135	0.000	5.719
GRF	*Coelorinchus fasciatus*	3680.560	331.978	3680.560	5.308
BLU	*Micromesistius australis*	1450.409	300.284	1450.409	2.092
GRC	*Macrourus carinatus*	732.050	528.810	719.787	1.056
BUT	*Stromateus brasiliensis*	448.636	389.756	448.636	0.647
SEP	*Seriolella porosa*	447.000	344.020	0.000	0.645
TOO	*Dissostichus eleginoides*	366.584	366.578	0.006	0.529
PAT	*Merluccius australis*	270.001	270.001	0.000	0.389
PYM	*Notophycis marginata*	253.562	0.980	253.562	0.366
ALG	Algae	195.085	0.000	195.085	0.281
RGR	*Bathyraja griseocauda*	156.861	156.861	6.429	0.226
CGO	*Cottoperca gobio*	150.162	143.534	150.162	0.217
DGS	*Squalus acanthias*	133.440	133.440	133.440	0.192
PAU	*Patagolycus melastomus*	66.946	0.000	66.946	0.097

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
RBR	*Bathyraja brachyurops*	52.957	46.895	31.560	0.076
DGH	*Schroederichthys bivius*	51.374	51.374	51.374	0.074
ING	*Moroteuthopsis ingens*	50.800	0.000	50.800	0.073
RFL	*Dipturus lamillai*	50.631	49.771	10.578	0.073
COP	*Congiopodus peruvianus*	47.600	0.000	47.600	0.069
SPN	Porifera	37.355	0.000	37.355	0.054
SQT	Ascidiacea	31.425	0.000	31.425	0.045
MED	*Medusa* spp.	24.248	0.000	24.248	0.035
HYD	Hydrozoa	22.159	0.000	22.159	0.032
MUN	*Grimothea gregaria*	13.300	0.000	13.300	0.019
GYM	*Gymnoscopelus* spp.	12.811	0.000	12.811	0.018
RED	*Sebastes oculatus*	10.982	10.982	0.282	0.016
RAL	*Bathyraja albomaculata*	9.886	9.886	5.246	0.014
RAY	Rajiformes	8.103	7.995	0.108	0.012
BRY	Bryozoa	6.801	0.000	6.801	0.010
ILF	*Iluocoetes fimbriatus*	7.090	0.000	7.090	0.010
RMU	*Bathyraja multispinis*	6.200	6.200	0.000	0.009
ZYP	*Zygochlamys patagonica*	4.649	0.000	4.649	0.007
GOC	*Gorgonocephalus chilensis*	4.361	0.000	4.361	0.006
OPV	*Ophiosabine vivipara*	4.052	0.000	4.052	0.006
MUE	*Muusoctopus eureka*	3.401	1.701	3.401	0.005
RMC	*Bathyraja macloviana*	3.162	3.162	3.162	0.005
SHT	Mixed invertebrates	3.712	0.000	3.712	0.005
STA	*Sterechinus agassizii*	2.563	0.000	2.563	0.004
CHE	*Champsocephalus esox*	1.953	1.843	1.953	0.003
CTA	*Ctenodiscus australis*	2.134	0.000	2.134	0.003
MLA	*Muusoctopus longibrachus akambei*	2.280	0.000	2.280	0.003
RBZ	*Bathyraja cousseauae*	1.982	0.342	1.982	0.003
ANM	*Anemonia* spp.	0.737	0.000	0.737	0.001
ASA	*Astrotoma agassizii*	0.736	0.000	0.736	0.001
AST	Asteroidea	0.368	0.000	0.368	0.001
CAS	*Campylonotus semistriatus*	0.874	0.000	0.874	0.001
CIR	Cirripedia	0.400	0.000	0.400	0.001
FLX	*Flabellum* spp.	0.774	0.000	0.774	0.001
FUM	*Fusitriton magellanicus*	0.610	0.000	0.610	0.001
GYN	*Gymnoscopelus nicholsi*	0.971	0.005	0.971	0.001
OPL	*Ophiuroglypha lymani*	0.347	0.000	0.347	0.001
POA	*Glabraster antarctica*	0.486	0.000	0.486	0.001
PYX	Pycnogonida	0.572	0.000	0.572	0.001
RDO	*Amblyraja doellojuradoi*	1.039	1.039	1.039	0.001
SRP	*Semirossia patagonica*	0.634	0.000	0.634	0.001
THO	*Thouarella* spp.	0.636	0.000	0.636	0.001
TRP	*Tripylaster philippii*	0.776	0.000	0.776	0.001
ACS	*Acanthoserolis schythei*	0.001	0.000	0.001	<0.001
ALC	Malacalcyonacea	0.018	0.000	0.018	<0.001

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
ANT	Anthozoa	0.072	0.000	0.072	<0.001
AUC	*Austrocidaris canaliculata*	0.331	0.000	0.331	<0.001
BAL	*Americominella longisetosus*	0.024	0.000	0.024	<0.001
BAO	*Bathybiaster loripes*	0.104	0.000	0.104	<0.001
BRM	*Brucerolis macdonnellae*	0.028	0.000	0.028	<0.001
CAV	*Campylonotus vagans*	0.052	0.000	0.052	<0.001
CAX	*Campylonotus* sp.	0.080	0.000	0.080	<0.001
CAZ	*Calyptraster* sp.	0.238	0.000	0.238	<0.001
CEX	*Ceramaster* sp.	0.098	0.000	0.098	<0.001
COT	*Cottunculus granulosus*	0.288	0.000	0.288	<0.001
CRI	Crinoidea	0.004	0.000	0.004	<0.001
CRY	*Crossaster* sp.	0.048	0.000	0.048	<0.001
CYX	Cycethra sp.	0.037	0.000	0.037	<0.001
EGG	Eggmass	0.131	0.000	0.131	<0.001
EUL	*Eurypodius latreillii*	0.030	0.000	0.030	<0.001
EUO	*Eurypodius longirostris*	0.004	0.000	0.004	<0.001
GON	*Gonatus antarcticus*	0.004	0.004	0.004	<0.001
HEO	*Henricia obesa*	0.010	0.000	0.010	<0.001
HEX	*Henricia* sp.	0.010	0.000	0.010	<0.001
HOL	Holothuroidea	0.296	0.000	0.296	<0.001
ISO	Isopoda	0.232	0.000	0.232	<0.001
LIR	*Limopsis marionensis*	0.066	0.000	0.066	<0.001
MAN	*Mancopsetta* sp.	0.024	0.000	0.024	<0.001
MIR	*Mirostenella* sp.	0.024	0.000	0.024	<0.001
MUG	*Grimothea gregaria*	0.030	0.000	0.030	<0.001
NUD	Nudibranchia	0.102	0.000	0.102	<0.001
NUH	*Nuttallochiton hyadesi*	0.008	0.000	0.008	<0.001
OCM	*Enteroctopus megalocyathus*	0.160	0.000	0.160	<0.001
ODM	*Odontocymbiola magellanica*	0.055	0.000	0.055	<0.001
OIB	*Oidiphorus brevis*	0.006	0.006	0.006	<0.001
OPH	Ophiuroidea	0.007	0.000	0.007	<0.001
OPS	*Ophiactis asperula*	0.007	0.000	0.007	<0.001
PAG	*Paralomis granulosa*	0.006	0.000	0.006	<0.001
PAM	*Pagurus comptus*	0.002	0.000	0.002	<0.001
PES	*Peltarion spinulosum*	0.304	0.000	0.304	<0.001
PLU	Primnoidae	0.047	0.000	0.047	<0.001
POL	Polychaeta	0.016	0.000	0.016	<0.001
PRD	Primnoidae	0.004	0.000	0.004	<0.001
PRI	Priapulida	0.006	0.000	0.006	<0.001
PRX	*Paragorgia* sp.	0.335	0.000	0.335	<0.001
PSX	Psolidae	0.002	0.000	0.002	<0.001
RPX	*Psammobatis* spp.	0.004	0.004	0.004	<0.001
SAL	*Salpa* sp.	0.244	0.000	0.244	<0.001
SAR	*Sprattus fuegensis*	0.176	0.032	0.176	<0.001
SUN	*Labidiaster radiosus*	0.189	0.000	0.189	<0.001

Species Code	Latin name	Total caught (kg)	Total sampled (kg)	Total discarded (kg)	Catch proportion (%)
TED	*Terebratella dorsata*	0.020	0.000	0.020	<0.001
THB	*Thymops birsteini*	0.126	0.000	0.126	<0.001
THN	*Thysanopsetta naresi*	0.085	0.085	0.085	<0.001
WRM	Annelida	0.210	0.000	0.210	<0.001
ZYX	Zygochlamys (dead)	0.002	0.000	0.002	<0.001
XXX	Unidentified animal	0.063	0.000	0.063	<0.001

3.2. Biological information of finfish species

3.2.1. *Salilota australis* – Red cod

Red cod were caught at 57 of the 84 survey trawl stations. Total catch was 5,777 kg, and catches ranged from 0.06 to 1,525 kg per trawl (mean CPUE: 101 kg/h). Densities ranged from 0.29 to 7,035 kg/km^2, with higher densities occurring mostly to the north-west and to the south-west in the FICZ (Fig. 2A). Most females were at resting maturity stage (maturity stage II); males were mainly at resting or developing maturity stages (maturity stages II–IV; Fig. 2B). Females were 16–81 cm, and males were 14–79 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 26 cm, 33 cm, around 44 cm and at 56 cm length (Fig. 2C). Length modes of males were identified at 26 cm, 31 cm, 39 cm, 47 cm, and 56 cm length (Fig. 2C).

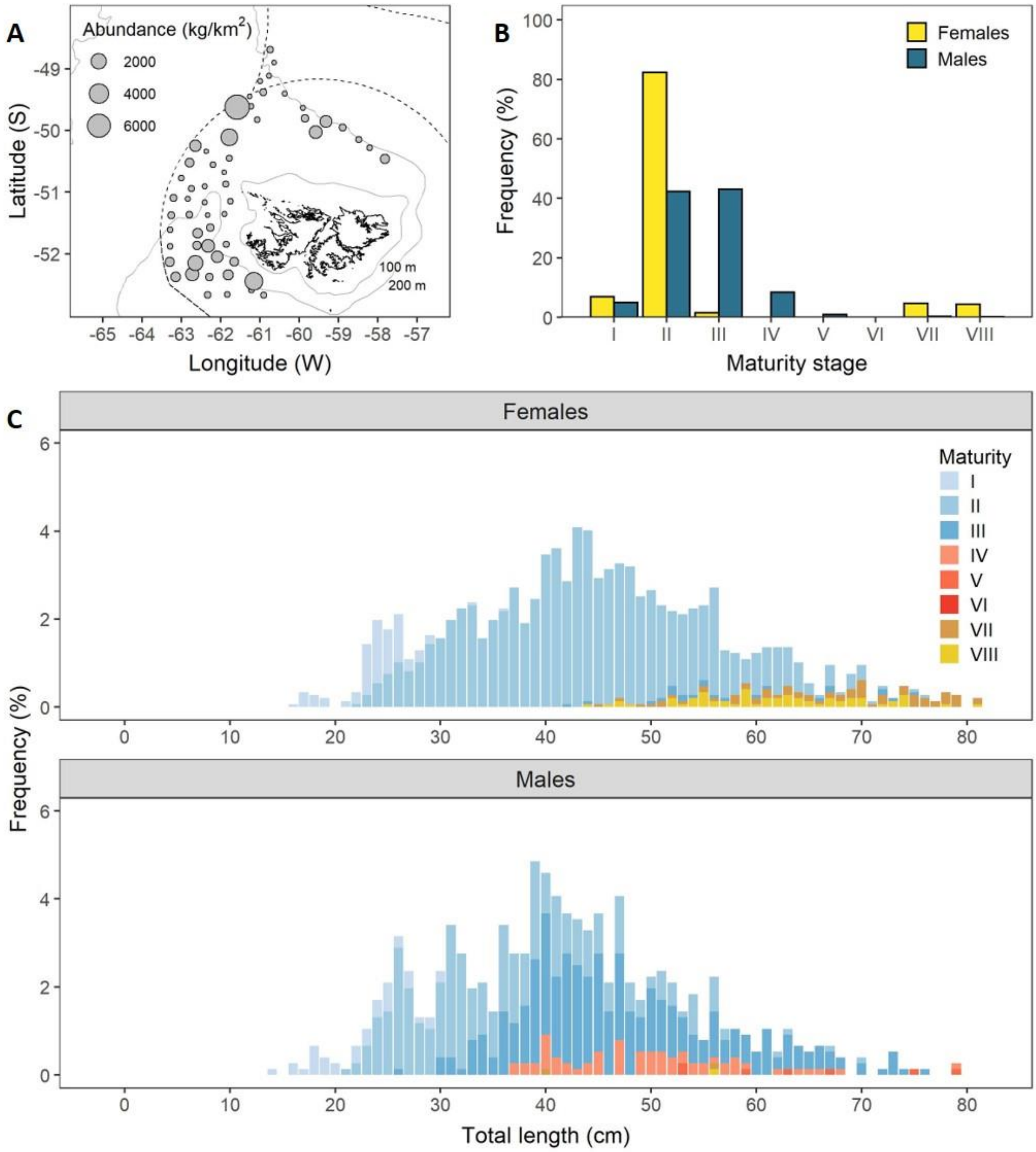

Figure 2. Biological data of *Salilota australis* (Red cod; BAC). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 1,469) and male (n = 762) lengths with 1 cm size class.

3.2.2. *Micromesistius australis* – Southern blue whiting

Southern blue whiting were caught at 41 of the 84 survey trawl stations. Total catch was 1,450 kg, and catches ranged from 0.005 to 635 kg per trawl (mean CPUE: 35 kg/h). Densities ranged from 0.02 to 2,348 kg/km^2, with higher densities to the south-west of West Falkland (Fig. 3A). Females and males were mainly immature (maturity stage I); few individuals were at resting maturity stage (maturity stages II; Fig. 3B). Females were 18–59 cm length (Fig. 3C) and males were 18–61 cm length (Fig. 3C). Several length-groups were detected for both females and males, with the main mode at 23 cm length; other modes were present at around 30 cm and 50 cm length (Fig. 3C).

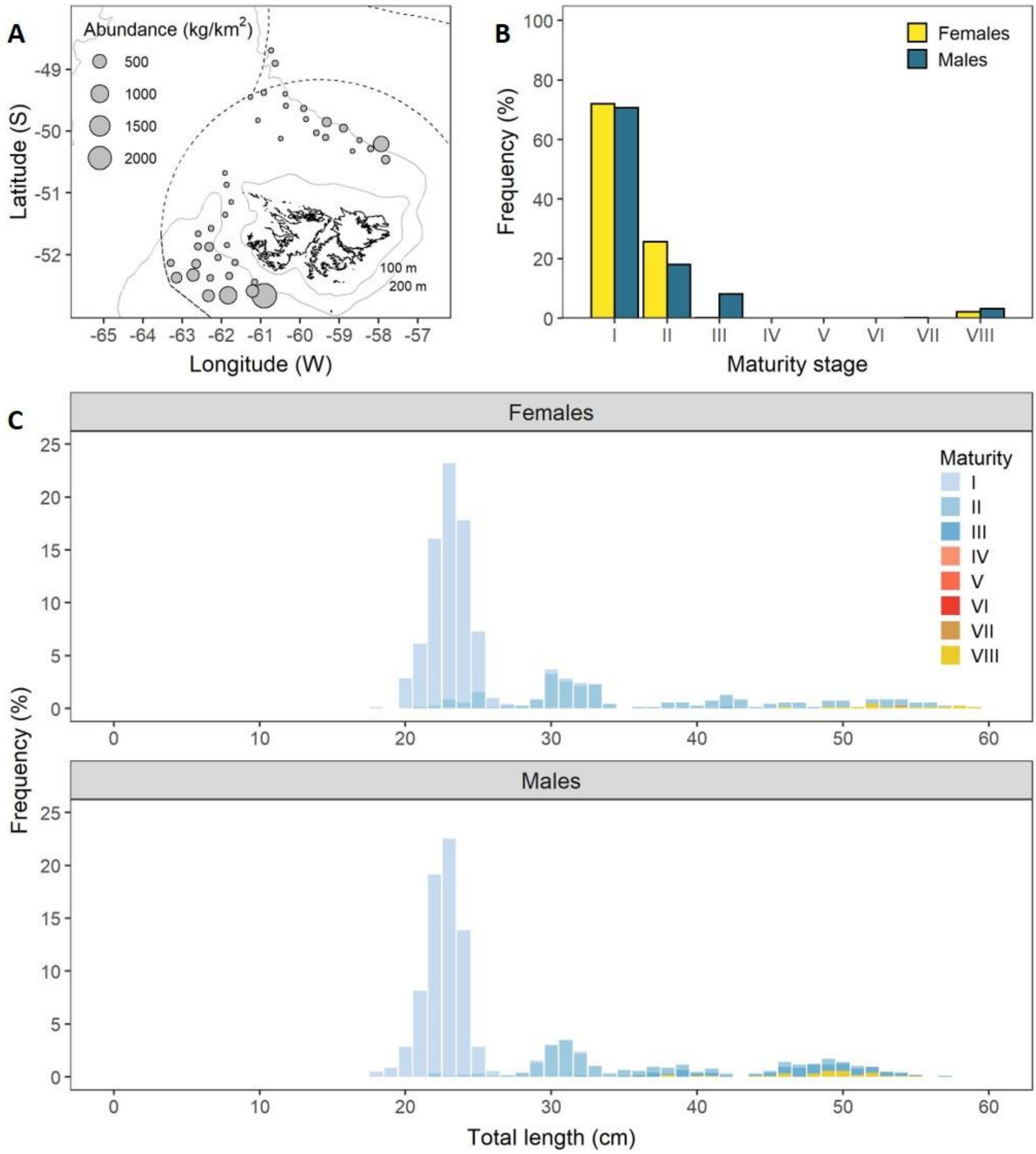

Figure 3. Biological data of *Micromesistius australis* (Southern blue whiting; BLU). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 703) and male (n = 1,061) lengths with 1 cm size class.

3.2.3. *Merluccius hubbsi* – Common hake

Common hake were caught at 54 of the 84 survey trawl stations. Total catch was 6,071 kg, and catches ranged from 0.6 to 886 kg per trawl (mean CPUE: 112 kg/h). Densities ranged from 2.9 to 4,241 kg/km^2, with high densities to the north-west mainly near the limit of the FICZ (Fig. 4A). Most females were at early developing maturity stages (maturity stage III), with minor proportions of resting (maturity stage II), spent (maturity stage VII) and recovering spent (maturity stage VIII) individuals. Most males were at late developing maturity stage (maturity stage IV; Fig. 4B). Females were 32–77 cm length and males were 32–47 cm length. The length frequency histogram allowed identifying at least one length-group with mode at 41 cm length and 38 cm length for females and males, respectively (Fig. 4C).

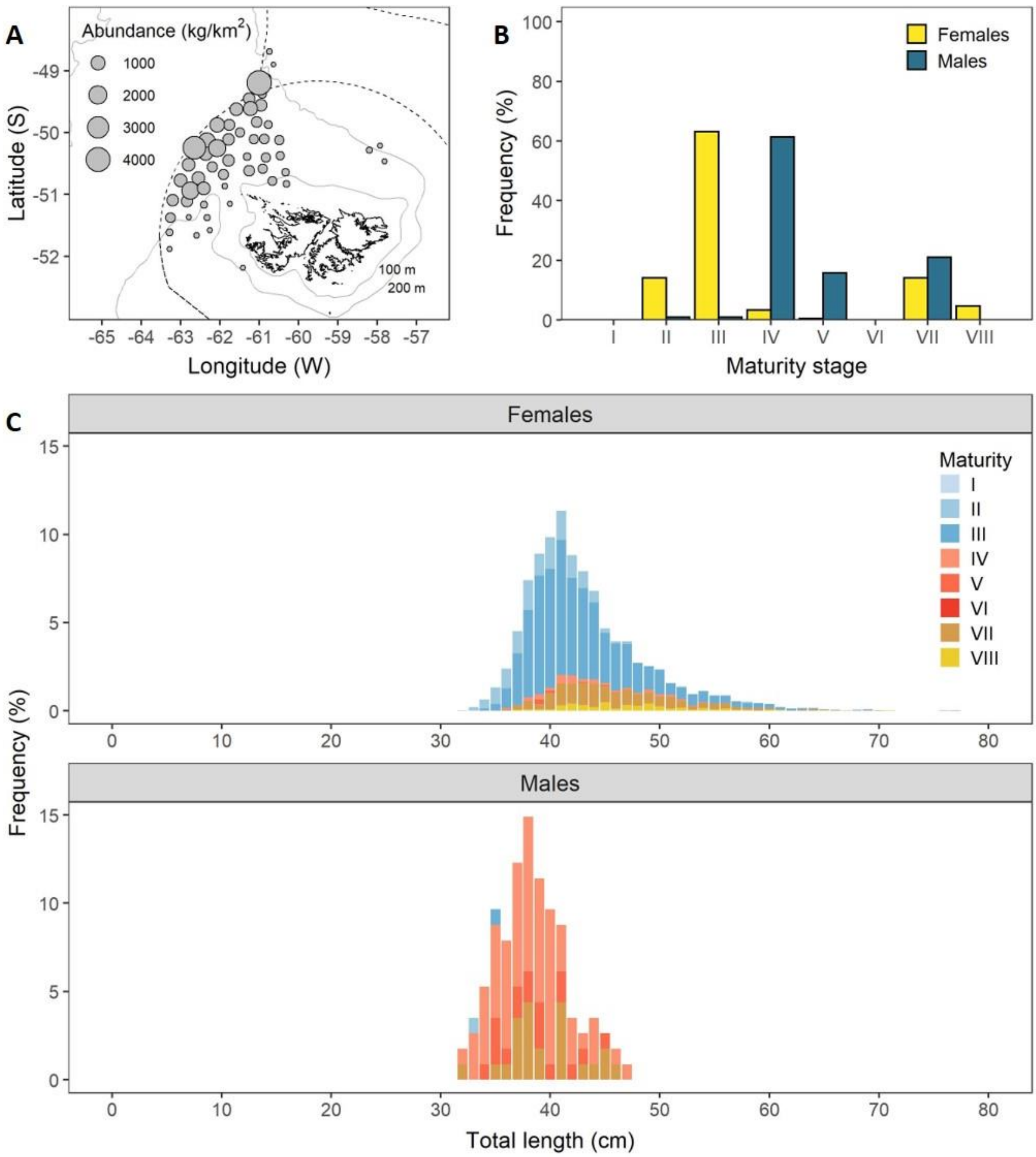

Figure 4. Biological data of *Merluccius hubbsi* (Common hake; HAK). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 3,150) and male (n = 114) lengths with 1 cm size class.

3.2.4. *Genypterus blacodes* – Kingclip

Kingclip were caught at 63 of the 84 survey trawl stations. Total catch was 3,965 kg, and catches ranged from 0.6 to 547 kg per trawl (mean CPUE: 63 kg/h). Densities ranged from 2.3 to 2,525 kg/km^2, with higher densities observed to the north-east, north-west, and south-west in the FICZ (Fig. 5A). Most females and males were at resting maturity stage (maturity stage II) or developing (maturity stages III–IV; Fig. 5B). Females were 42–123 cm length, and males were 45–108 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 84 cm length for females and at 72 cm length for males (Fig. 5C).

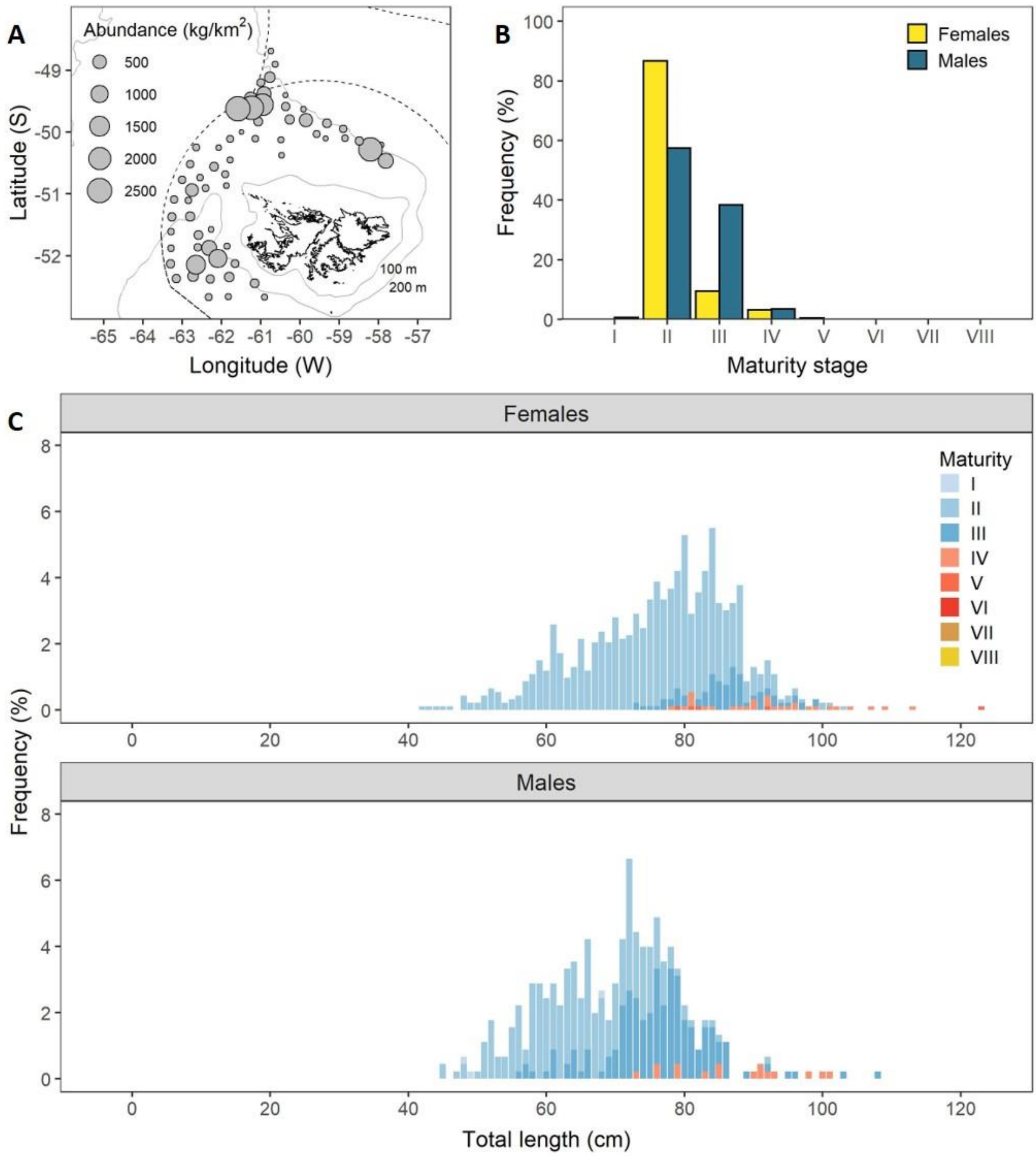

Figure 5. Biological data of *Genypterus blacodes* (Kingclip; KIN). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 927) and male (n = 451) lengths with 1 cm size class.

3.2.5. *Patagonotothen ramsayi* – Common rock cod

Rock cod were caught at all 84 survey trawl stations. Total catch was 14,945 kg, and catches ranged from 3 to 5,192 kg per trawl (mean CPUE: 178 kg/h). Densities ranged from 13 to 21,812 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 ≤III), with resting individuals being predominant; a small proportion of females were spent or recovering spent (maturity stages VII–VIII; Fig. 6B). Females were 9–39 cm length, males were 9–36 cm length, and 8 juveniles were 4–6 cm length. Three length-groups were identified; modal lengths of females were 14 cm, 19 cm and 28 cm for females (Fig. 6C), whereas modal lengths of males were 14 cm, 19 cm, and 29 cm (Fig. 6C). More than three length-groups may exist but these were not detected because of the overlap in lengths.

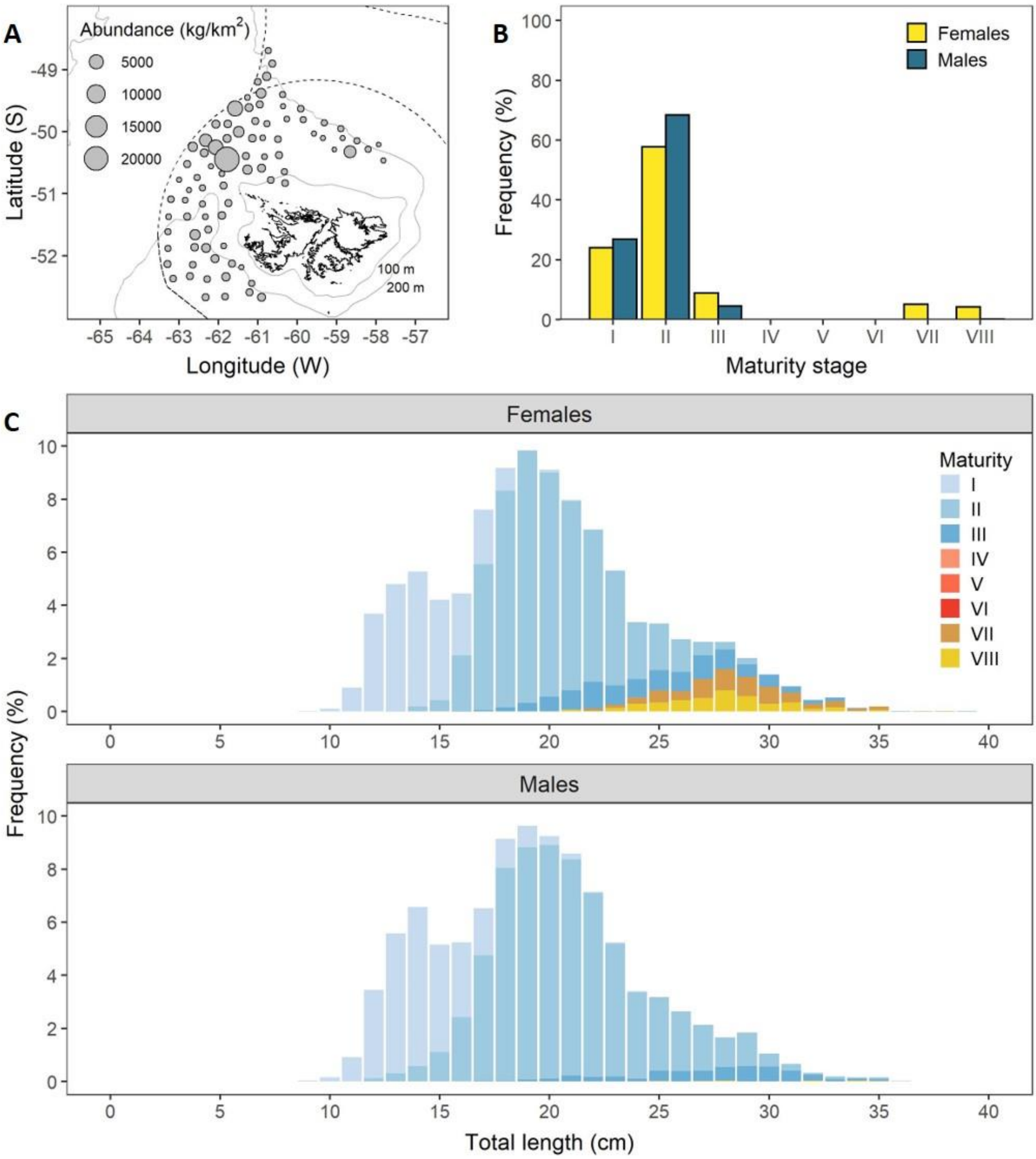

Figure 6. Biological data for *Patagonotothen ramsayi* (Common rock cod; PAR). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 3,773) and male (n = 4,660) lengths with 1 cm size class.

3.2.6. *Merluccius australis* – Southern hake

Southern hake were caught at 18 of the 84 survey trawl stations. Total catch was 270 kg, and catches ranged from 1 to 55 kg per trawl (mean CPUE: 15 kg/h). Densities ranged from 6 to 223 kg/km^2, with higher densities to the south-west in deeper waters (> 200 m depth) where southern hake are more abundant (Fig. 7A). Most females and males were at resting or early developing maturity stages (maturity stages II–III), with minor proportions of post-spawning females (maturity stages VII–VIII; Fig. 7B). Females were 47–93 cm length with mode at 68 cm length (Fig. 7C), and males were 45–76 cm length (Fig. 7C). Southern hake is often misidentified as common hake *M. hubbsi*; therefore, more southern hake could have been present given the large volumes of hake caught during the survey.

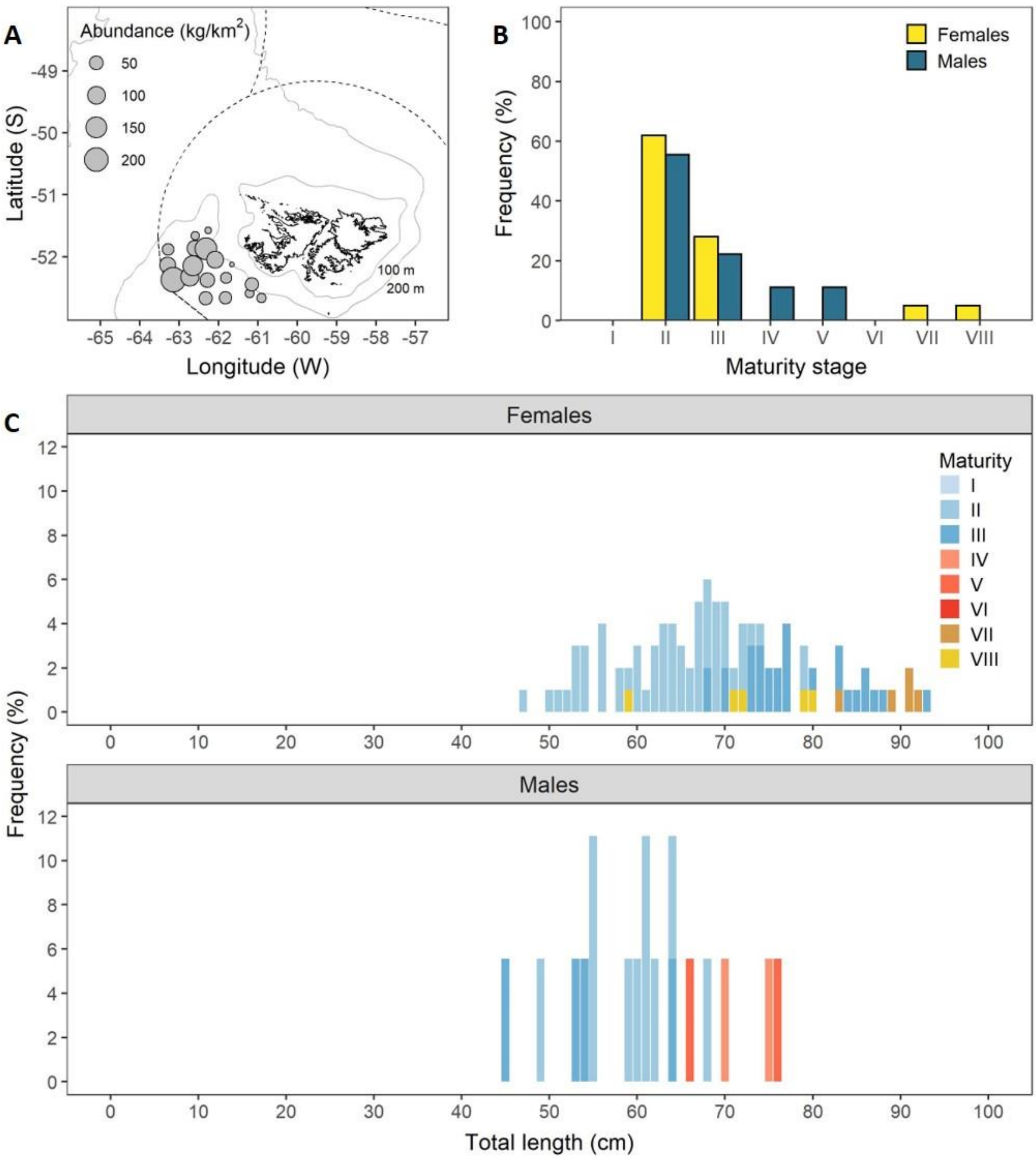

Figure 7. Biological data of *Merluccius australis* (Southern hake; PAT). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 100) and male (n = 18) lengths with 1 cm size class.

3.2.7. *Dissostichus eleginoides* – Patagonian toothfish

Patagonian toothfish were caught at 52 of the 84 survey trawl stations. Total catch was 367 kg, and catches ranged from 0.006 to 35 kg per trawl (mean CPUE: 7 kg/h). Densities ranged from 0.03 to 152 kg/km^2, with higher densities observed mainly to the south-west in the FICZ at stations deeper than 200 m (Fig. 8A). Most individuals were immature or resting (maturity stages ≤II; Fig. 8B). Females were 32–90 cm, males were 33–75 cm. Modal lengths were detected at 47 cm and at 46 cm for females and males, respectively. However, no distinct length-groups were evident in the length frequency distribution due to the overlap of length-groups (Fig. 8C).

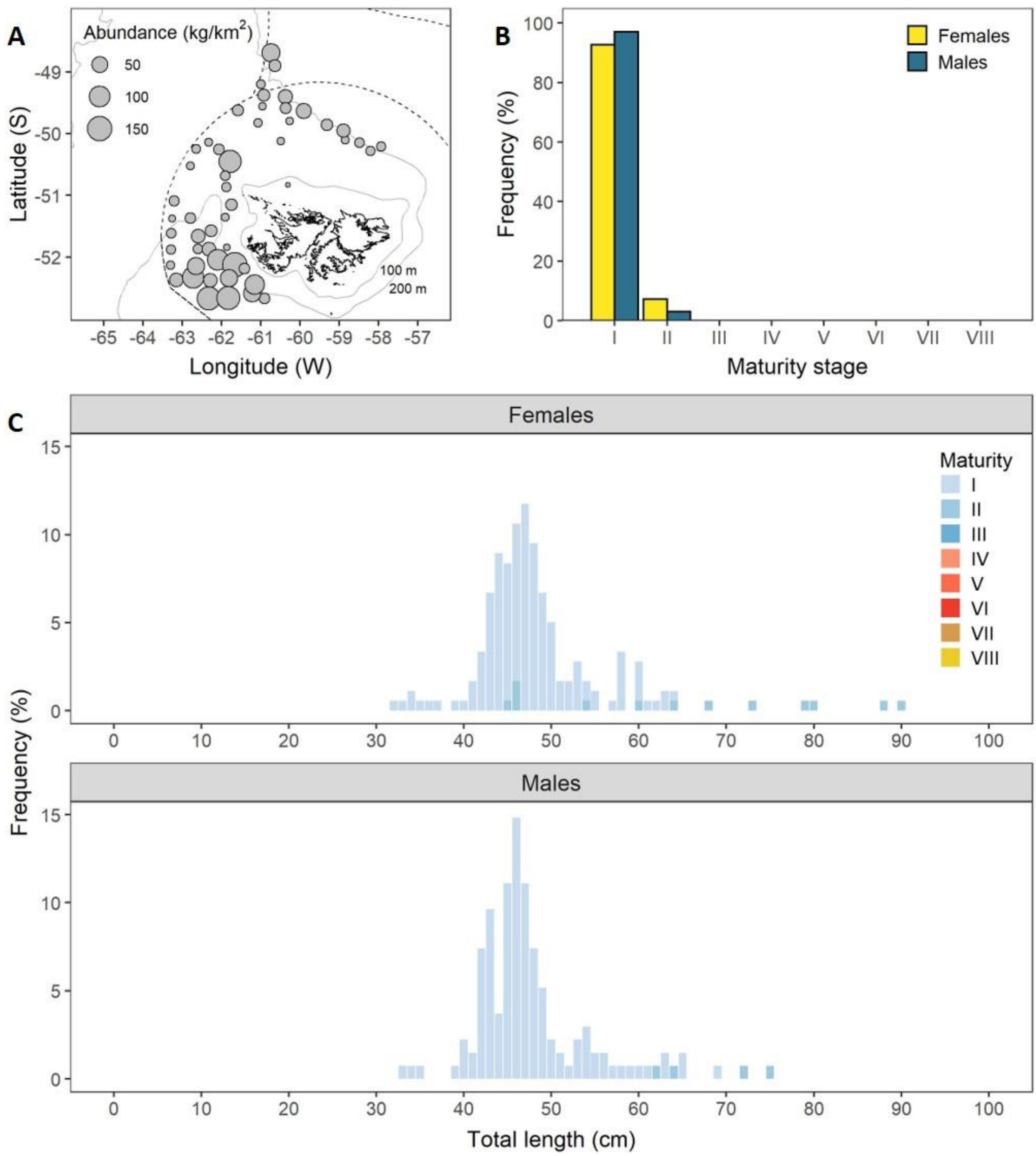

Figure 8. Biological data of *Dissostichus eleginoides* (Patagonian toothfish; TOO). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 180) and male (n = 136) lengths with 1 cm size class.

3.2.8. *Macruronus magellanicus* – Hoki

Hoki were caught at 28 of the 84 survey trawl stations. Total catch was 5,544 kg, and catches ranged from 0.19 to 1,134 kg per trawl (mean CPUE: 198 kg/h). Densities were 1 to 4,796 kg/km^2, with higher densities observed to the south-west in the FICZ (Fig. 9A). Most females and males were at resting or early developing maturity stages (maturity stages II–III; Fig. 9B). Females were 16–38 cm length, and males were 15–32 cm length. Length frequency distributions allowed detecting modal lengths at 19 cm and at 28 cm for females, and at 19 cm and at 27 cm for males (Fig. 9C).

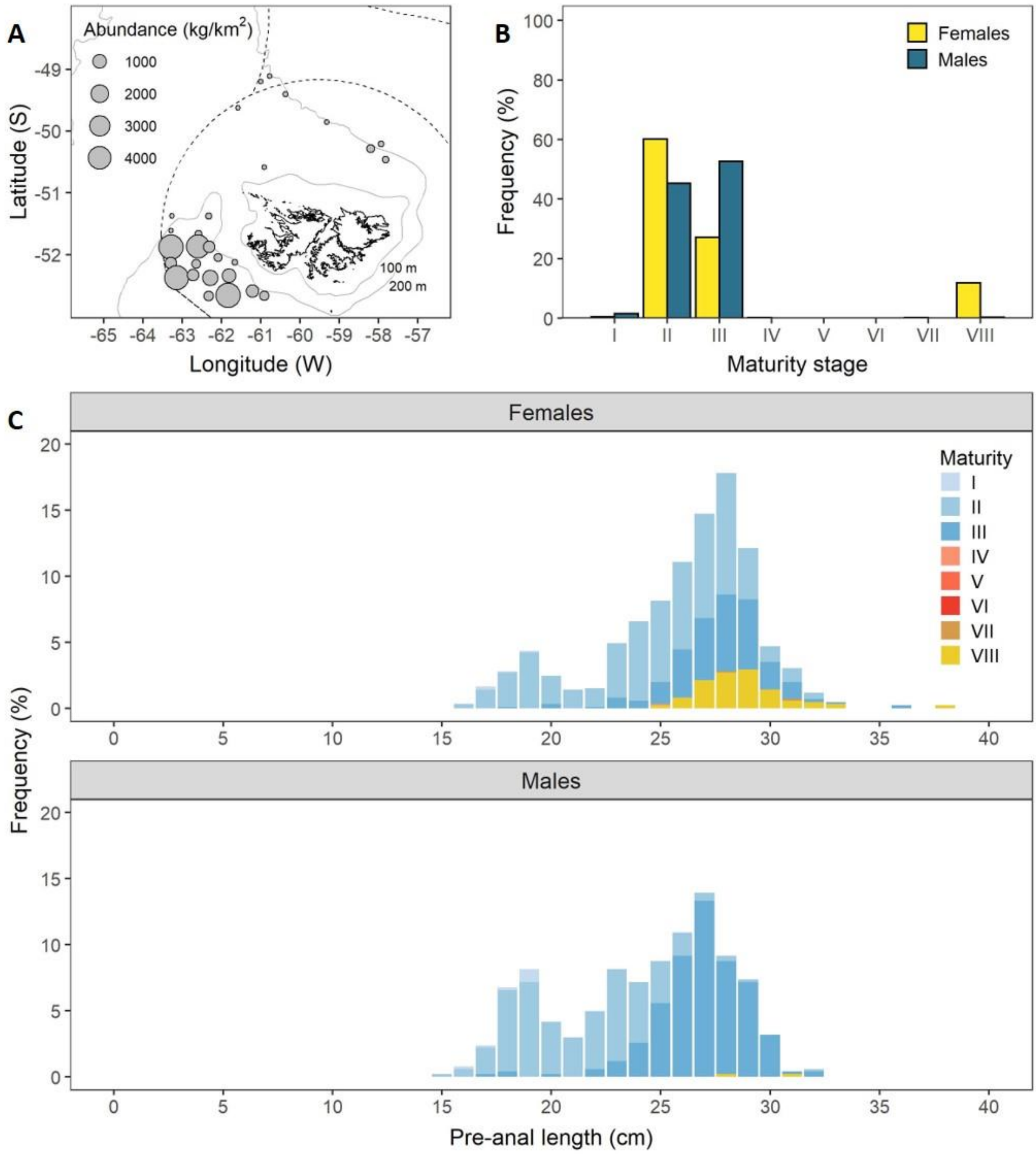

Figure 9. Biological data of *Macruronus magellanicus* (Hoki; WHI). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 848) and male (n = 503) lengths with 1 cm size class.

3.2.9. *Stromateus brasiliensis* – Butterfish

Butterfish were caught at 39 of the 84 survey trawl stations. Total catch was 449 kg, and catches ranged from 0.2 to 71 kg (mean CPUE: 12 kg/h). Densities ranged from 0.7 to 297 kg/km^2, with higher densities to the north and north-west in the FICZ (Fig. 10A). Females were mostly at early developing maturity stage (maturity stage III); minor proportions of late developing females were also observed (maturity stage IV). Males were mainly at resting, early developing, or late developing maturity stages (maturity stage II–IV; Fig. 10B). Females were 22–40 cm length and males were 21–34 cm length. Modal length of females was detected at 27 cm and modal length of males was detected at 26 cm (Fig. 10C).

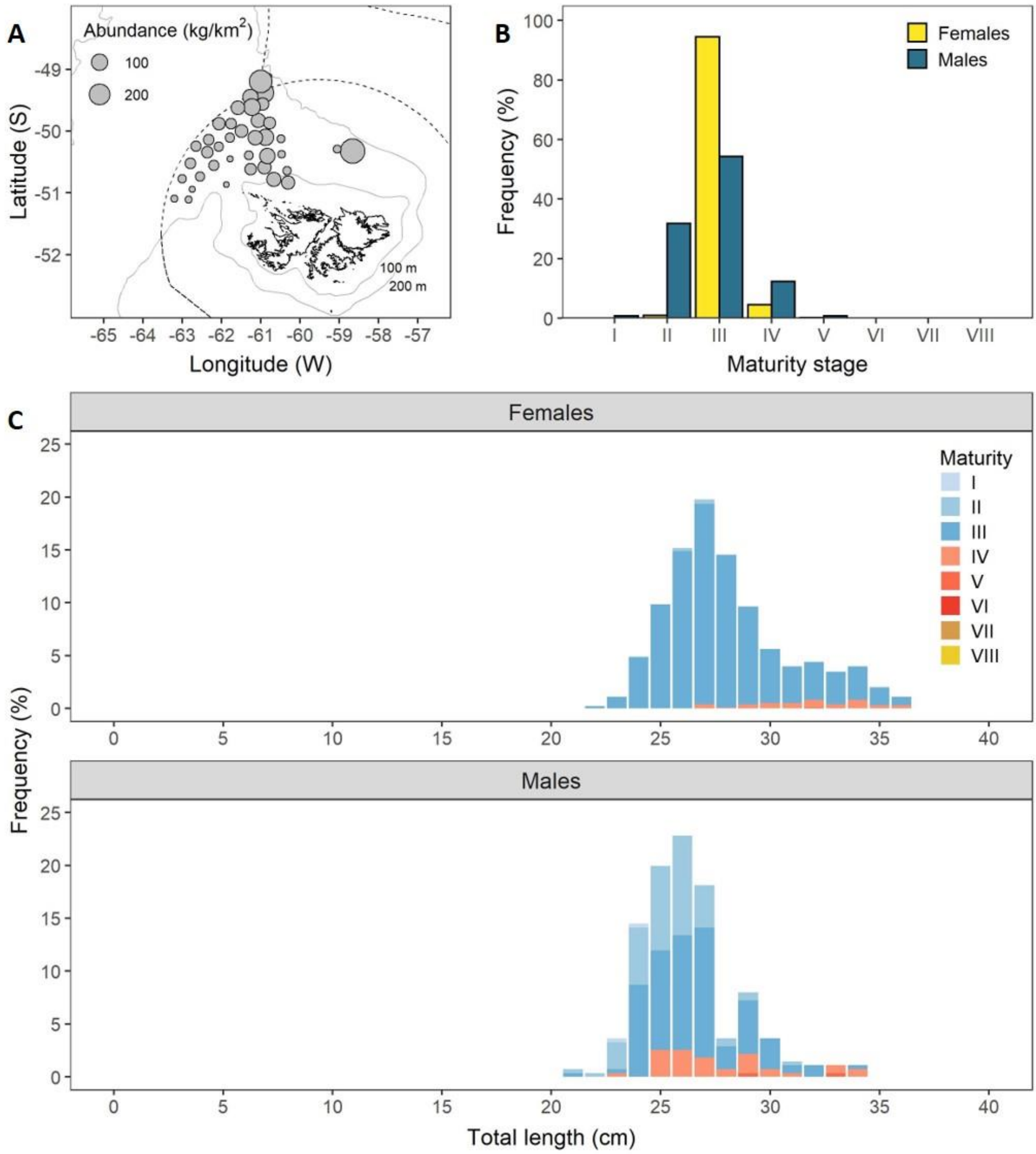

Figure 10. Biological data of *Stromateus brasiliensis* (Butterfish; BUT). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 976) and male (n = 276) lengths with 1 cm size class.

3.2.10. *Coelorinchus fasciatus* – Banded whiptail grenadier

Banded whiptail grenadier were caught at 25 of the 84 survey trawl stations. Total catch was 3,681 kg, and catches ranged from 0.4 to 770 kg (mean CPUE: 147 kg/h). Densities ranged from 2 to 2,846 kg/km^2, observed to the south-west in the FICZ (Fig. 11A). Females and males were mostly at resting or early developing maturity stages (maturity stages II–III); few individuals were immature, spent, or recovering spent (maturity stages I, VII–VIII; Fig. 11B). Females were 3–15 cm length; males were 4–12 cm length. The length frequency distributions allowed detecting a single length-group with modal length at 10 cm for females (Fig. 11C) and at 9 cm for males (Fig. 11C).

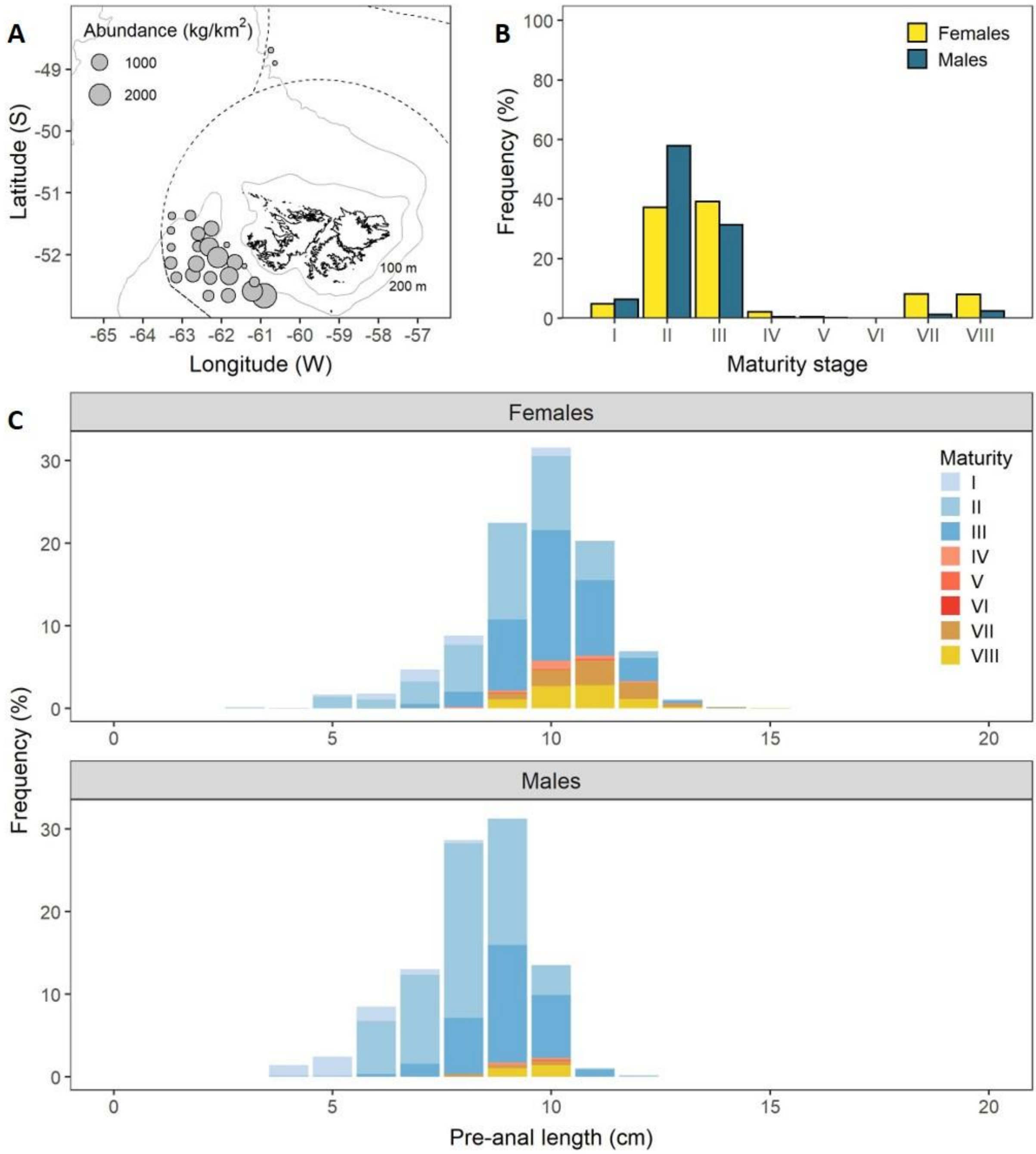

Figure 11. Biological data of *Coelorinchus fasciatus* (Banded whiptail grenadier; GRF). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 1,483) and male (n = 576) lengths with 1 cm size class.

3.2.11. *Macrourus carinatus* – Ridge scaled rattail

Ridge scaled rattail were caught at 9 of the 84 survey trawl stations. Total catch was 732 kg, and catches ranged from 1.3 to 366 kg (mean CPUE: 81 kg/h). Densities ranged from 6 to 1,510 kg/km^2, observed to the south-west in the FICZ (Fig. 12A). Females were mostly at late developing or spent maturity stages (maturity stages IV and VII, respectively). Males were mainly at developing or ripe maturity stages (maturity stages III–V; Fig. 12B). Females were 15–35 cm length; males were 17–24 cm length. The length frequency distributions allowed detecting a single length-group with modal length at 24 cm for females (Fig. 12C) and at 20 cm for males (Fig. 12C).

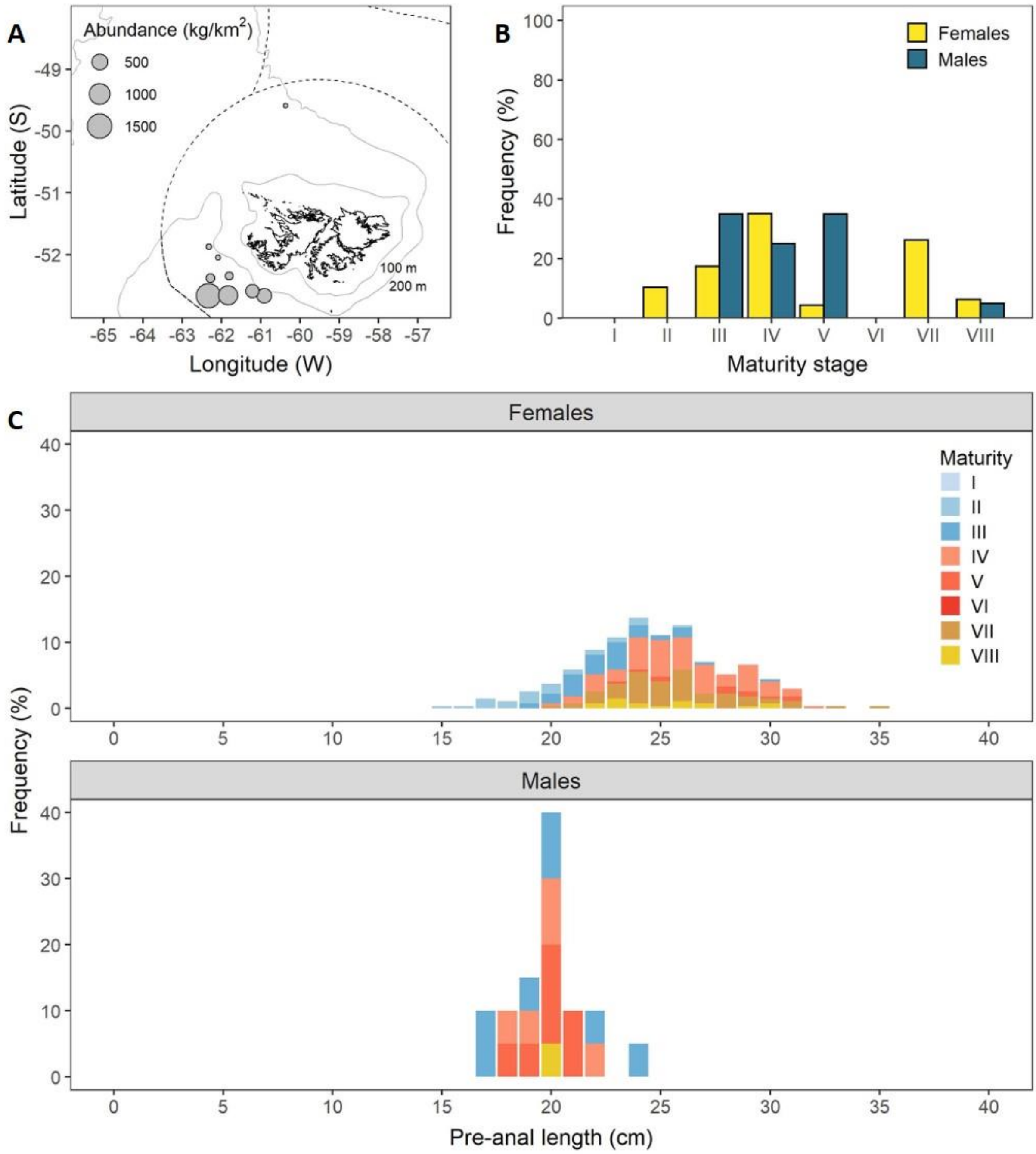

Figure 12. Biological data of *Macrourus carinatus* (Ridge scaled rattail; GRC). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 270) and male (n = 20) lengths with 1 cm size class.

3.2.12. *Seriolella porosa* – Driftfish

Driftfish were caught at 5 of the 84 survey trawl stations. Total catch was 447 kg, and catches ranged from 0.6 to 316 kg (mean CPUE: 89 kg/h). Densities ranged from 2 to 1,285 kg/km^2, observed mainly near the south-west limit of the FICZ (Fig. 13A). Females and males were mainly at spent or recovering spent maturity stages (maturity stages VII–VIII; Fig. 13B). Females were 45–58 cm length with mode at 52 cm length, and males were 36–56 cm length with mode at 51 cm length (Fig. 13C).

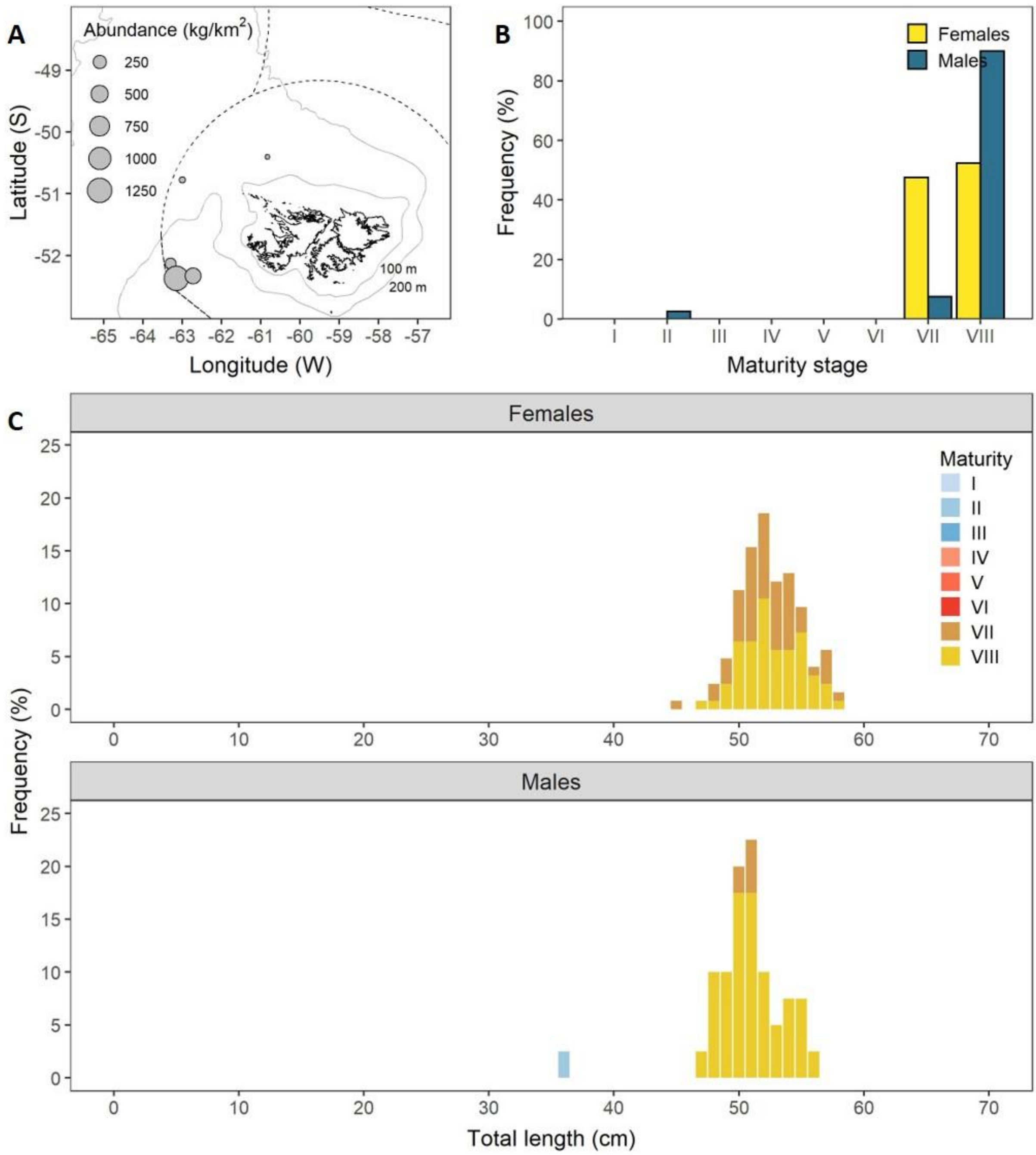

Figure 13. Biological data of *Seriolella porosa* (Driftfish; SEP). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, immature; II, resting; III, early developing; IV, late developing; V, ripe; VI, running; VII, spent; VIII, recovering spent); C) Relative frequency (%) of female (n = 124) and male lengths (n = 40) 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 72 of the 84 survey trawl stations. Total catch was 16,018 kg, and catches ranged from 0.002 to 1,597 kg (mean CPUE: 222 kg/h). Densities ranged from 0.01 to 6,162 kg/km^2, observed to the north-west in the FICZ (Fig. 13A). Most females were immature or preparatory (maturity stages ≤III). Males were mainly mature or maturing (maturity stages V and IV, respectively), with minor proportions of immature or preparatory maturity stages (maturity stages ≤III; Fig. 13B). Females were 7.5–31.0 cm length, and males were 7.5–27.0 cm length. The only juvenile reported was 7.5 cm length. Length frequency distributions allowed detecting modal lengths at 24.0 cm and 23.0 cm for females and males, respectively. However, smaller length-groups were observed (Fig. 13C).

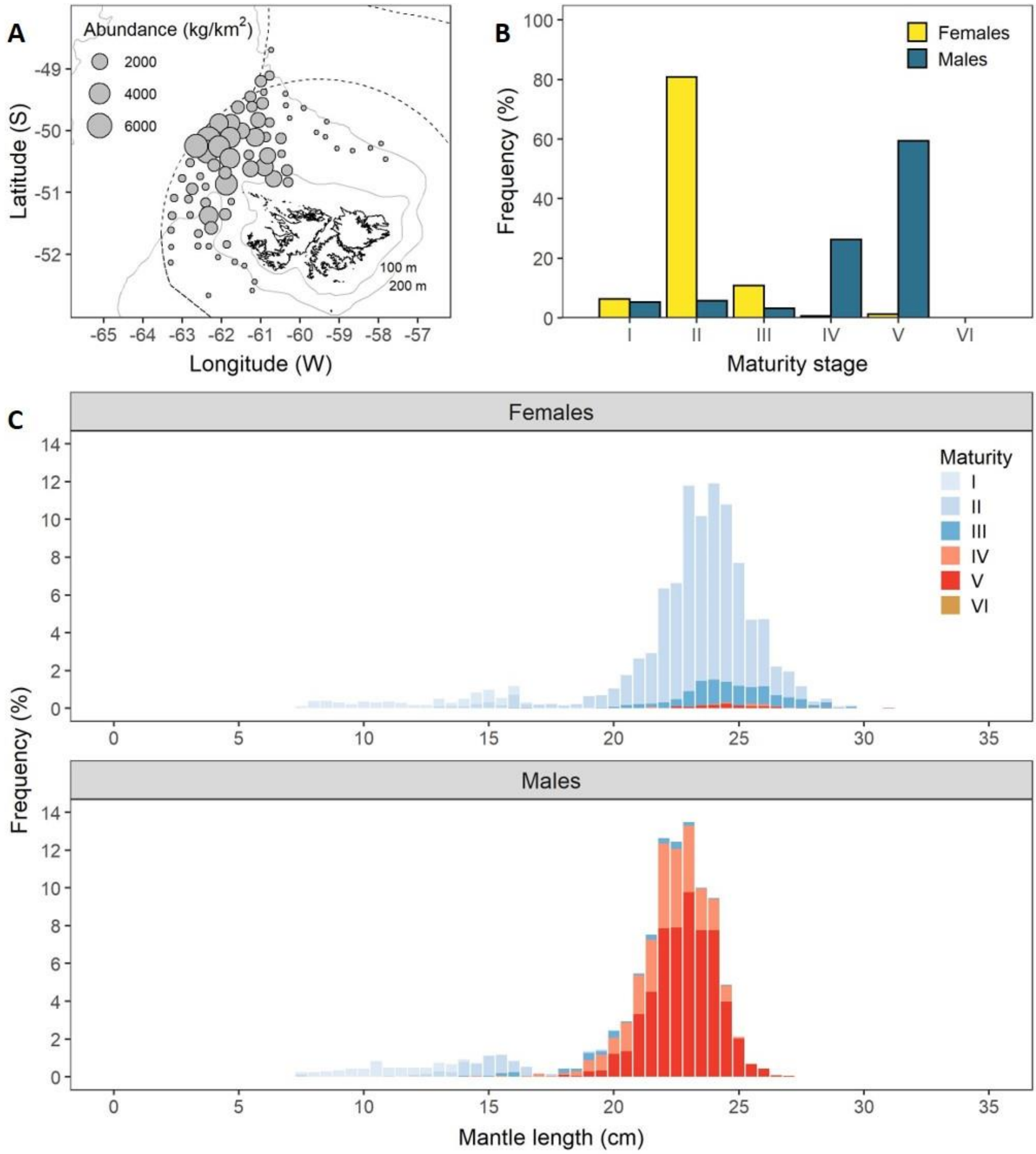

Figure 13. Biological data of *Illex argentinus* (Argentine shortfin squid; ILL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent); C) Relative frequency (%) of female (n = 2,773) and male (n = 2,137) lengths with 0.5 cm size class.

3.3.2. *Doryteuthis gahi* – Patagonian squid

Patagonian squid were caught at the 84 survey trawl stations. Total catch was 8,177 kg, and catches ranged from 0.06 to 779 kg (mean CPUE: 97 kg/h). Densities ranged from 0.3 to 3,480 kg/km^2 along the survey area, with higher densities to the south-west of West Falkland (Fig. 14A). Most females and males were immature (maturity stages I–II), with minor proportions of preparatory to mature individuals (maturity stages ≥III; Fig. 14B). Females were 5.5–16.5 cm length (Fig. 14C), and males were 4.5–19.0 cm length (Fig. 14C). Modal length of females and males were detected at 8.0 cm, respectively.

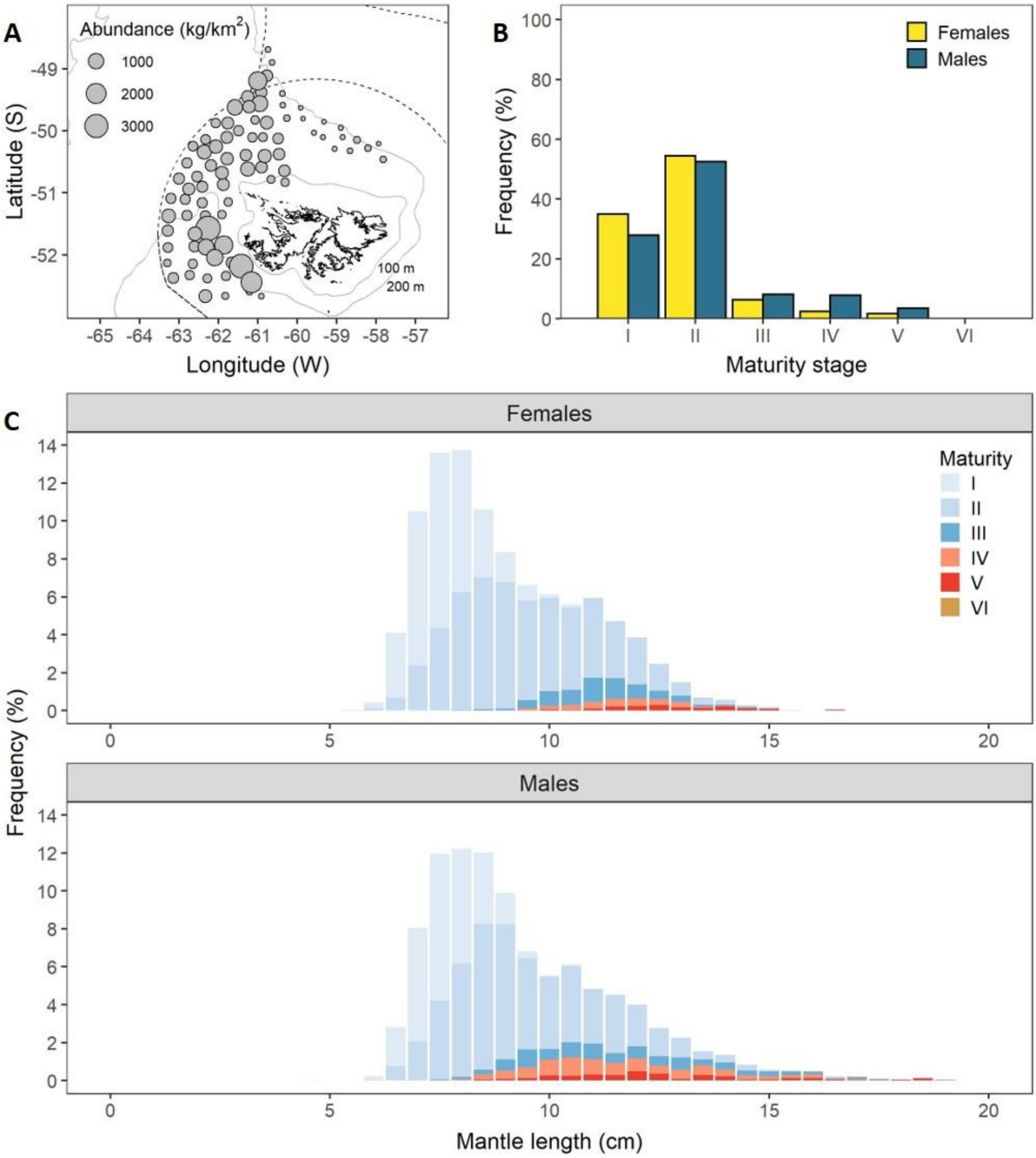

Figure 14. Biological data of *Doryteuthis gahi* (Patagonian squid; LOL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, young; II, immature; III, preparatory; IV, maturing; V, mature; VI, spent); C) Relative frequency (%) of female (n = 4,017) and male (n = 3,776) lengths 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 84 survey trawl stations. Total catch was 10 kg, and catches ranged from 2 to 5 kg (mean CPUE: 2.5 kg/h). Densities ranged from 7 to 19 kg/km^2, observed mainly near the south-west limit of the FICZ (Fig. 15A). The three females sampled were maturing, developing, or mature (maturity stages III–IV), and the two males were mature (maturity stage IV; Fig. 15B). Females were 39–43 cm disc width (Fig. 15C); males were 41–46 cm disc width (Fig. 15C).

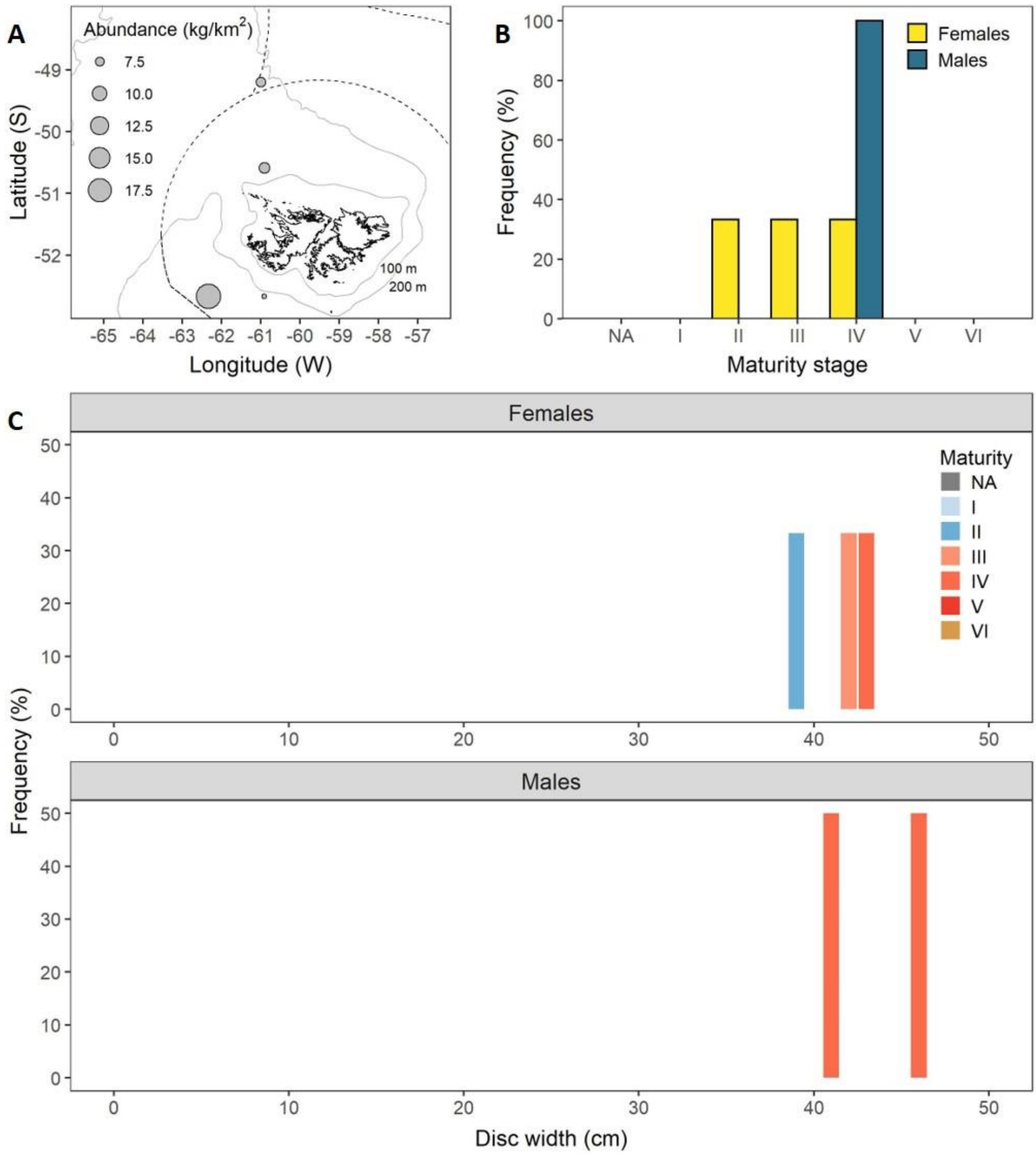

Figure 16. Biological data of *Bathyraja albomaculata* (White spotted skate; RAL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 3) and male (n = 2) lengths with 1 cm size class.

3.4.2. *Bathyraja brachyurops* – Blonde skate

Blonde skates were caught at 19 of the 84 survey trawl stations. Total catch was 53 kg, and catches ranged from 0.1 to 12 kg (mean CPUE: 2.8 kg/h). Densities ranged from 0.4 to 55 kg/km^2, with patchy distribution through the survey area (Fig. 16A). Most females were maturing (maturity stages II); males were mainly maturing or juvenile (maturity stages II or I, respectively). Small proportions of developing or mature individuals (maturity stages III and IV, respectively; Fig. 16B) were also observed. Females were 20–59 cm disc width, and males were 15–54 cm disc width. The small numbers of individuals caught did not allow detecting length-groups nor modal lengths (Fig. 16C).

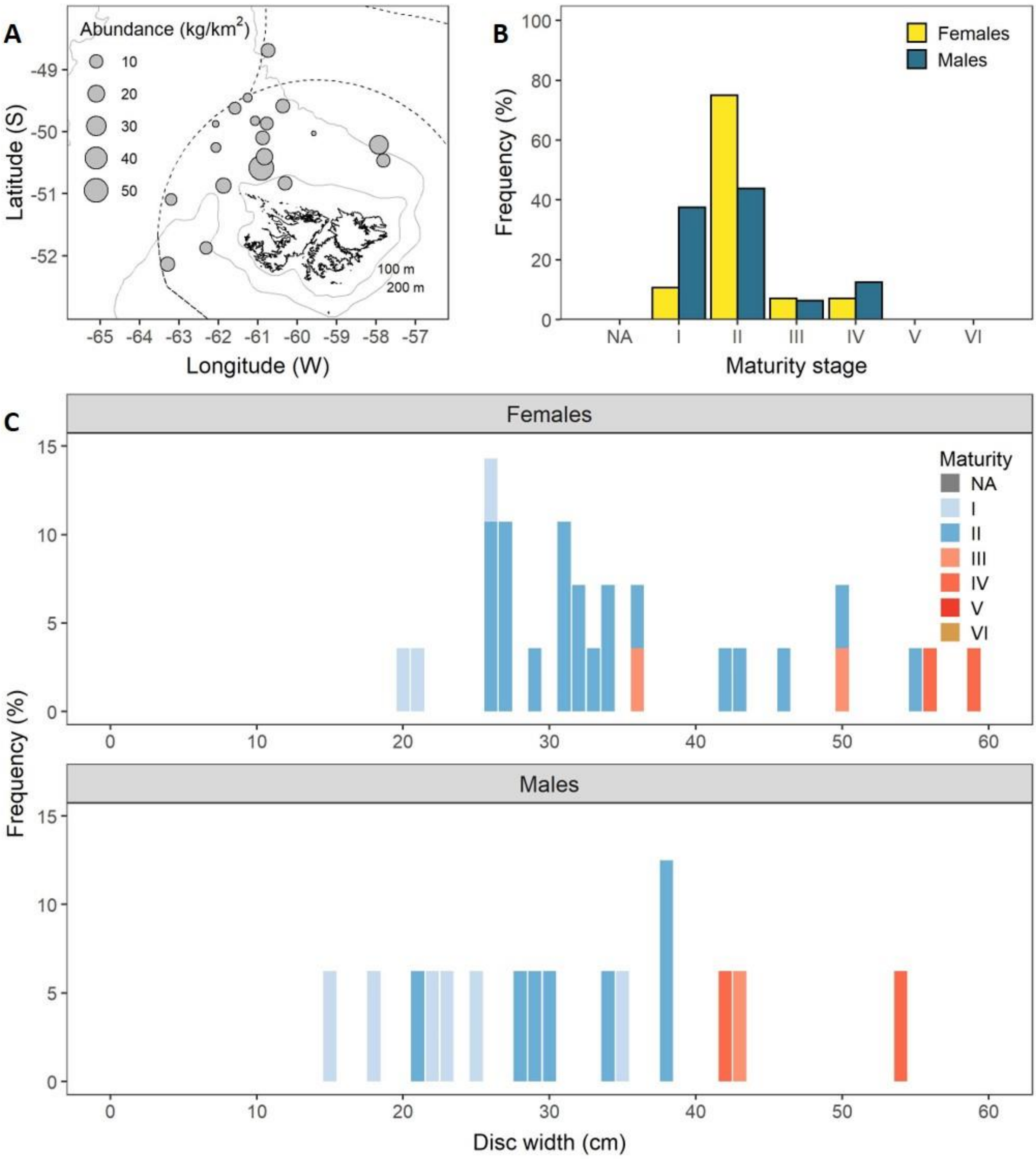

Figure 16. Biological data of *Bathyraja brachyurops* (Blonde skate; RBR). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 28) and male lengths (n = 16) with 1 cm size class.

3.4.3. *Dipturus lamillai* – Warrah skate

Warrah skates were caught at 13 of the 84 survey trawl stations. Total catch was 51 kg, and catches ranged from 0.9 to 12 kg (mean CPUE: 3.8 kg/h). Densities ranged from 4 to 56 kg/km^2, with patchy distribution through the survey area (Fig. 17A). Most females and males were maturing (maturity stage II; Fig. 17B). Females were 33–74 cm disc width, and males were 37–43 cm disc width. The small number of individuals caught during the survey did not allow identifying modal lengths (Fig. 17C).

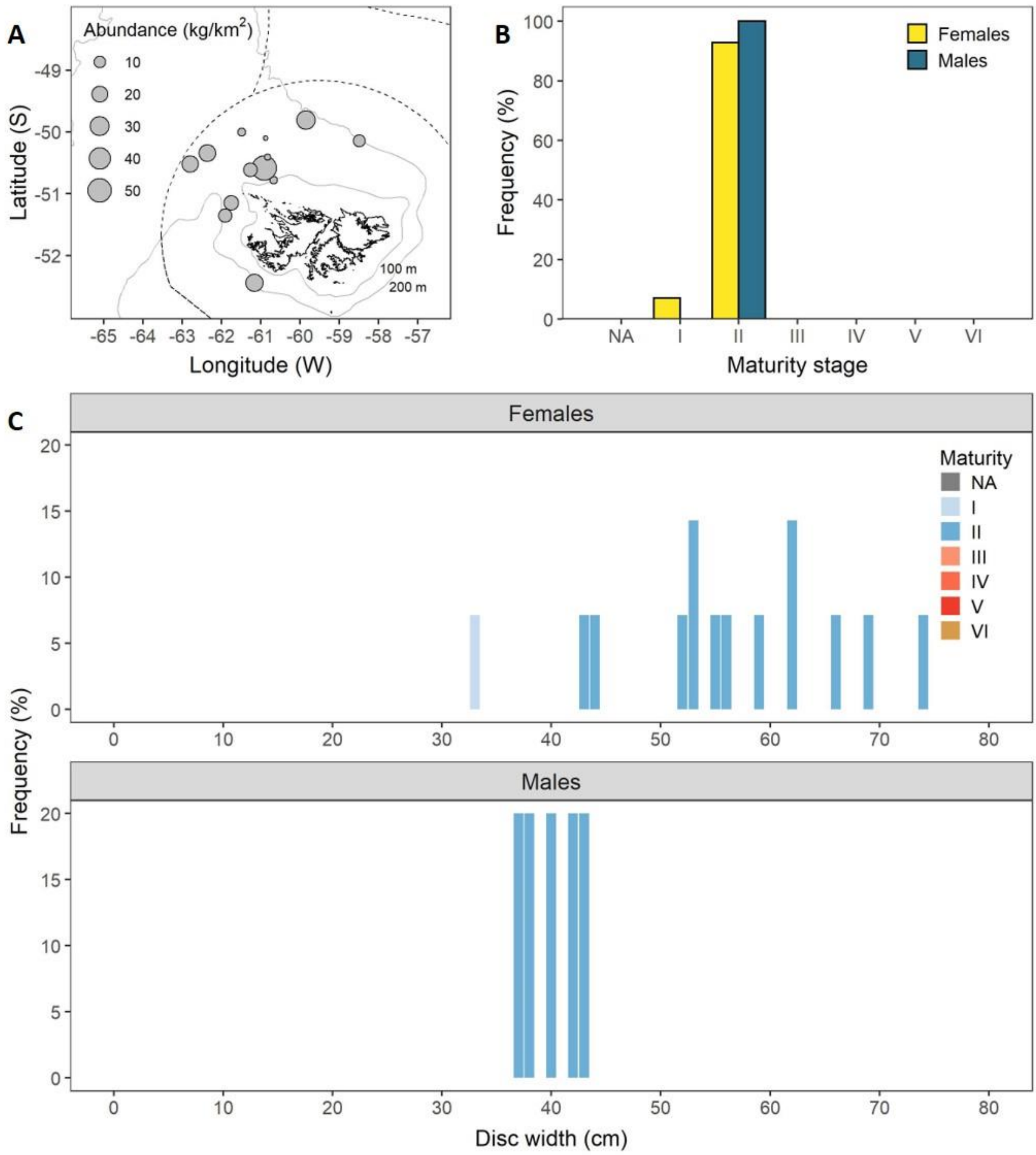

Figure 17. Biological data of *Dipturus lamillai* (Warrah skate; RFL). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 14) and male (n = 5) lengths with 1 cm size class.

3.4.4. *Bathyraja griseocauda* – Grey-tailed skate

Grey-tailed skates were caught at 8 of the 84 survey trawl stations. Total catch was 157 kg, and catches ranged from 0.6 to 39 kg (mean CPUE: 20 kg/h). Densities ranged from 3 to 162 kg/km^2, with higher densities observed to the south-west in the FICZ (Fig. 18A). Most females were juvenile (maturity stage I), and smaller proportions of maturing, developing and mature females were also reported (maturity stages II–IV); males were mainly mature (maturity stage IV), and a smaller proportion of males were also juveniles or at resting maturity stage (maturity stages I–II; Fig. 18B). Females were 16–97 cm disc width, and males were 31–90 cm disc width. The small number of individuals caught during the survey did not allow identifying length-groups nor modal lengths (Fig. 18C).

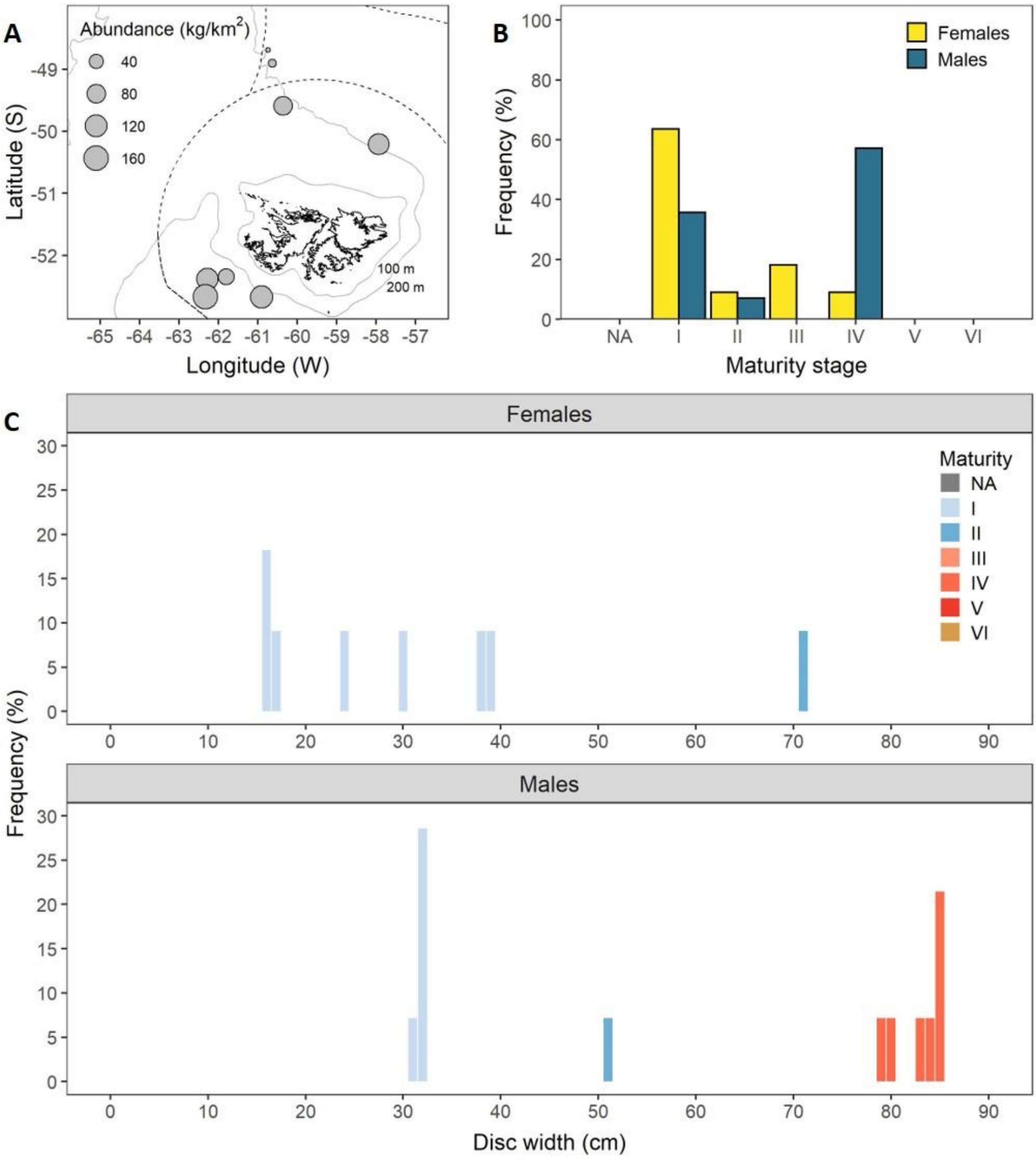

Figure 18. Biological data of *Bathyraja griseocauda* (Grey tailed skate; RGR). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 11) and male (n = 14) lengths with 1 cm size class.

3.4.5. *Bathyraja macloviana* – Falkland skate

Falkland skates were caught at 4 of the 84 survey trawl stations. Total catch was 3 kg, and catches ranged from 0.05 to 1.3 kg (mean CPUE: 0.8 kg/h). Densities ranged from 0.2 to 6 kg/km^2, observed to the north and south-west of West Falkland (Fig. 19A). The four females caught were from juvenile to mature (maturity stages I–IV; Fig. 19B), and measured 12–35 cm disc width (Fig. 19C). No males were caught during the survey (Fig. 19B–19C).

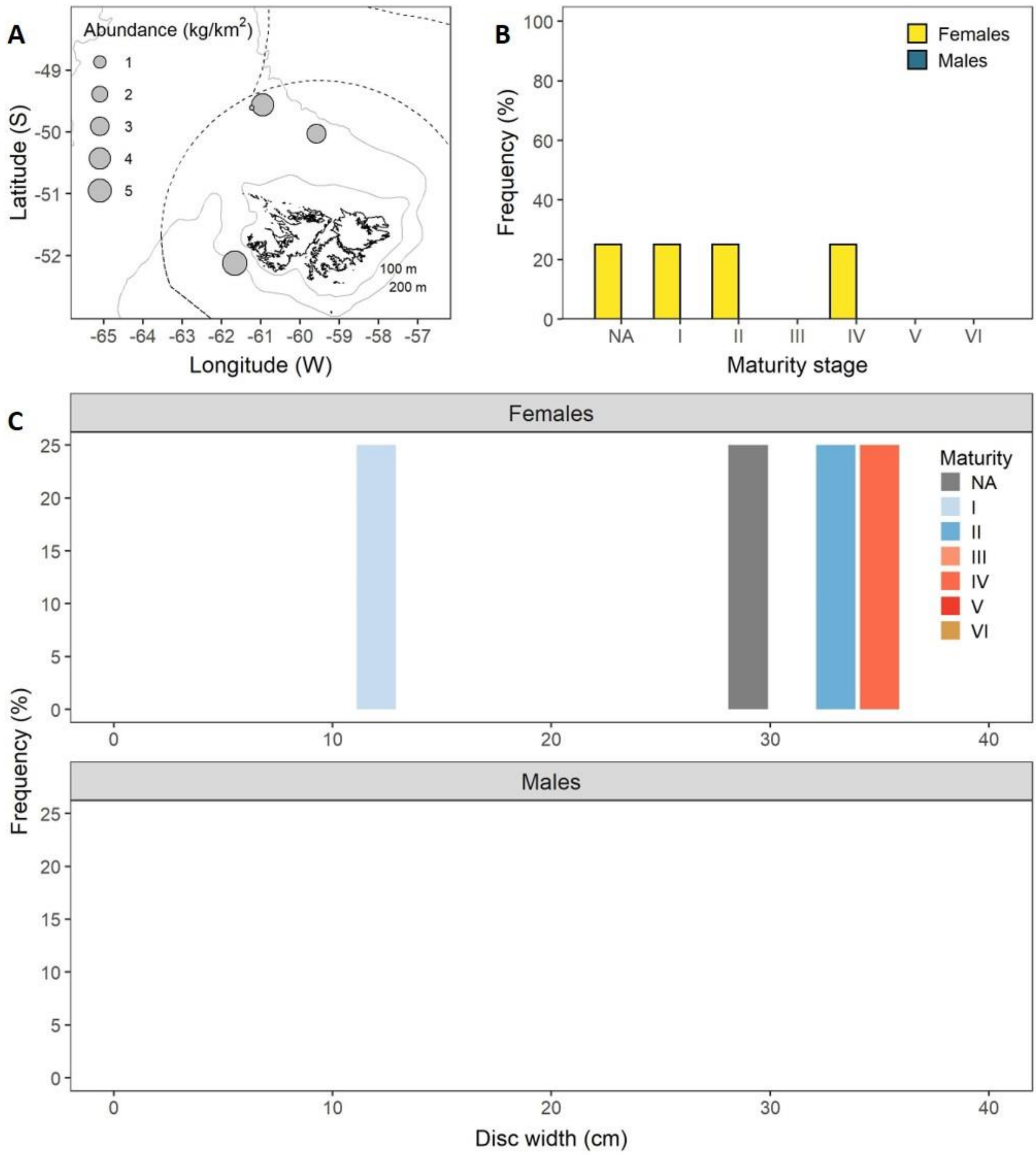

Figure 19. Biological data of *Bathyraja macloviana* (Falkland skate; RMC). A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 4) and male (n = 0) lengths with 1 cm size class.

3.5. Biological information of sharks species

3.5.1. *Schroederichthys bivius* – Catshark

Catshark were caught at 30 of the 84 survey trawl stations. Total catch was 51 kg, and catches ranged from 0.08 to 12 kg (mean CPUE: 2 kg/h). Densities ranged from 0.4 to 50 kg/km^2, with higher densities observed to the north-west in the FICZ (Fig. 20A). Most females were found alive and released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. Most males were juvenile (maturity stage I), mature (maturity stage IV), maturing or developing (maturity stages II–III; Fig. 20B). Length frequency distributions were multimodal, and overlap of lengths did not allow identifying all the length-groups present. Females were 33–62 cm length, with mode at 52 cm length (Fig. 20C). Males were 29–72 cm length (Fig. 20C).

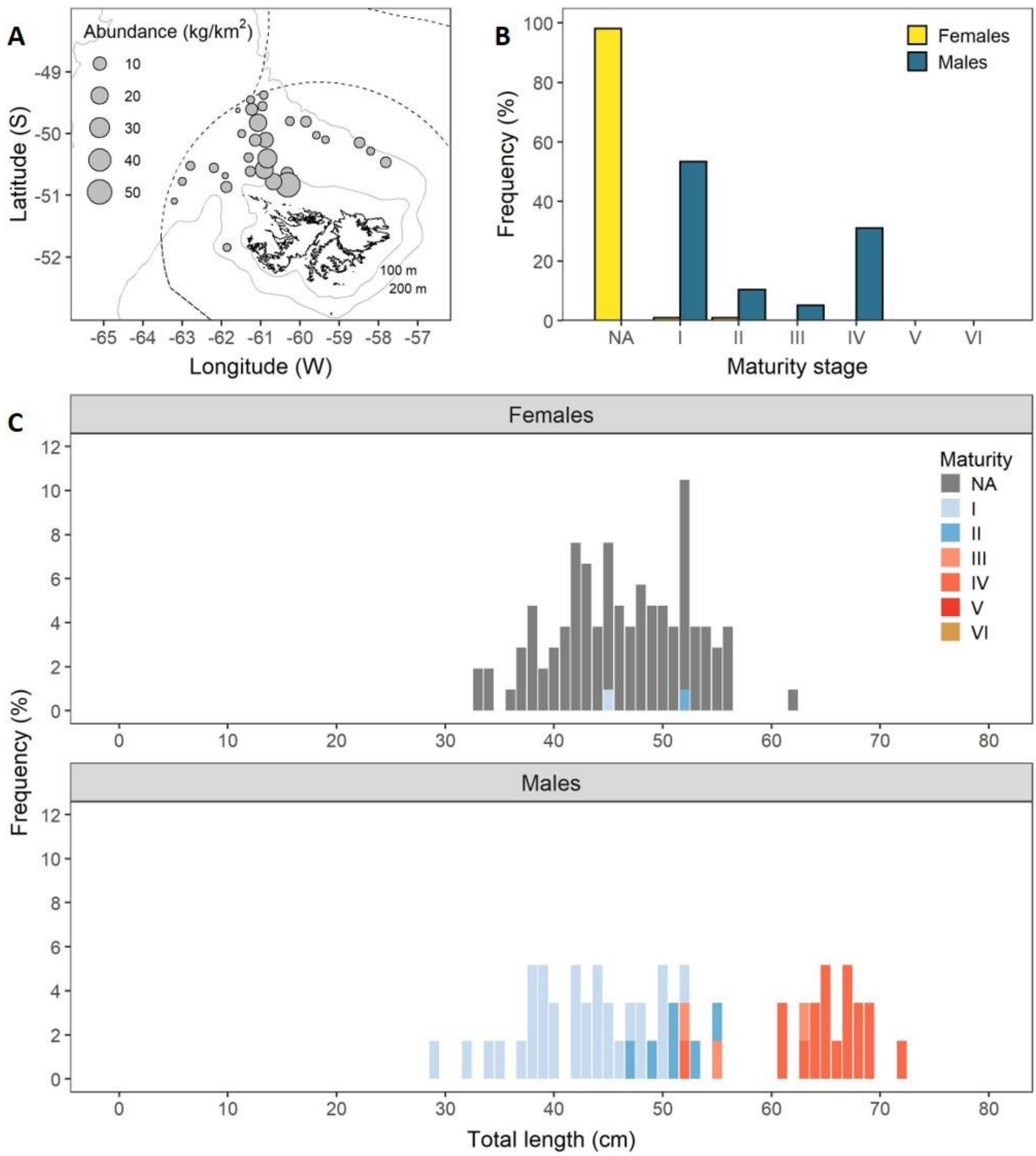

Figure 20. Biological data of *Schroederichthys bivius* (Catshark; DGH); A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 105) and male (n = 58) lengths with 1 cm size class.

3.5.2. *Squalus acanthias* – Dogfish

Dogfish were caught at 33 of the 84 survey trawl stations. Total catch was 133 kg, and catches ranged from 0.7 to 17 kg (mean CPUE: 4 kg/h). Densities ranged from 3 to 75 kg/km^2, with higher densities through the north in the FICZ, along the 200 m isobath (Fig. 21A). Most females were found alive and released as soon as possible without assessing maturity stage, and their maturity stage was recorded as NA. Most males were mature (maturity stage IV), with smaller proportions of juvenile, maturing, or developing individuals (maturity stages I–III; Fig. 21B). Length frequency distributions were multimodal, and overlap of lengths did not allow identifying all the length-groups present. Females were 50–86 cm length, with the main mode at 63 cm length (Fig. 21C). Males were 51–79 cm length, with the main mode at 69 cm length (Fig. 21C).

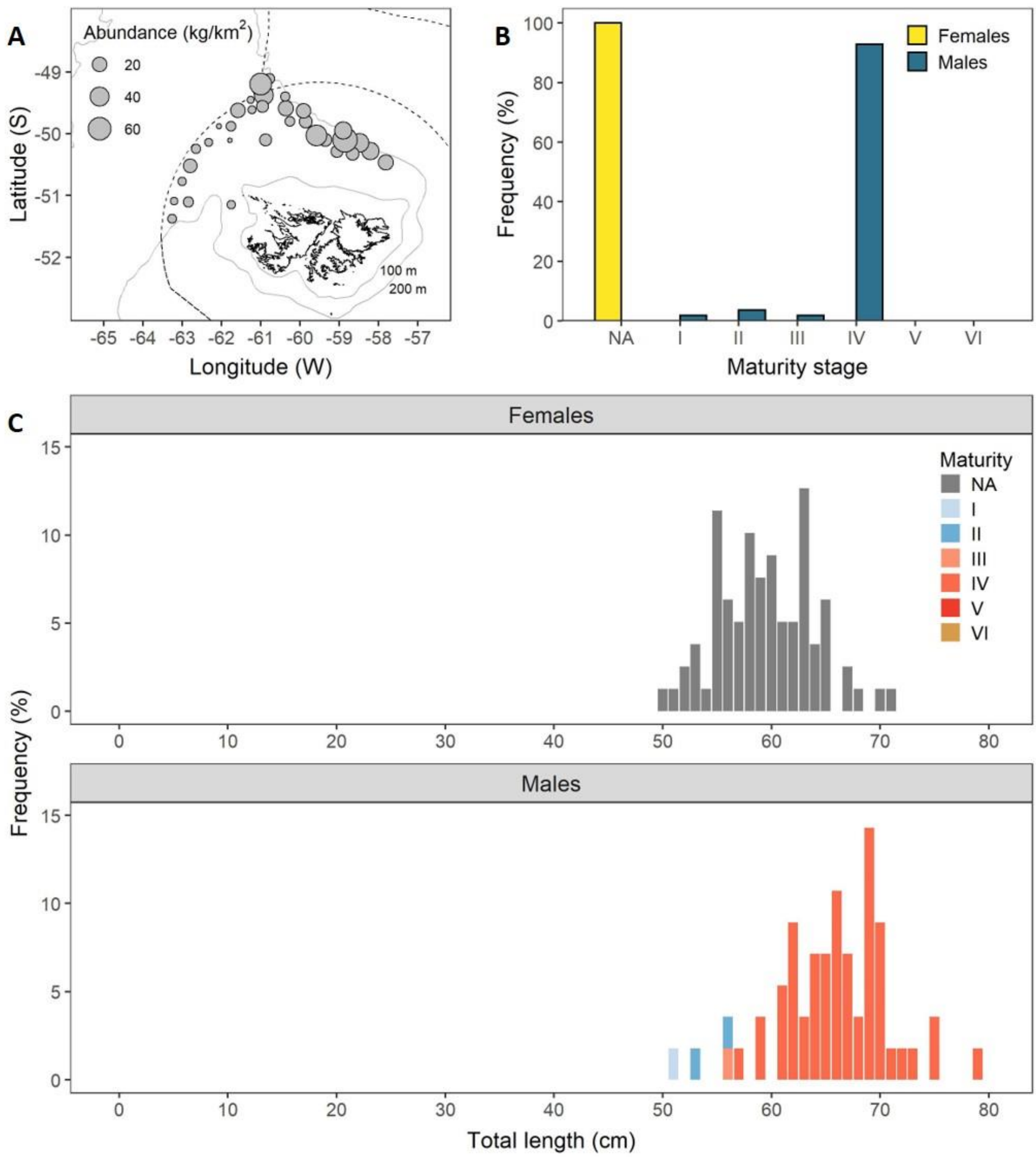

Figure 21. Biological data of *Squalus acanthias* (Dogfish; DGS); A) Map of densities in kg/km^2; B) Relative frequency (%) per maturity stage (I, juvenile; II, adolescent maturing; III, adult developing; IV, adult mature; V, adult laying/running; VI, adult resting); C) Relative frequency (%) of female (n = 209) and male (n = 77) lengths with 1 cm size class.

3.6. Finfish gonads sampling for histology

A total of 189 gonads, including ovaries and testes, of the four target species (common hake, red cod, rock cod, and southern blue whiting) were sampled for histology in 29 stations (Fig. 22). Additionally, 29 gonads of six other species (banded whiptail grenadier, butterfish, frogmouth, hoki, kingclip, ridge scaled rattail, and southern hake) were sampled for histology during the survey. On average, 10 pictures were taken per gonad sample, resulting in a photographic reference material of 2,168 high-quality images (Table III). Among the target species, common hake ovaries (n = 89) accounted for 41% of the gonads sampled, and exhibited the highest variation in shape, size, colour, and turgor (Fig. 23).

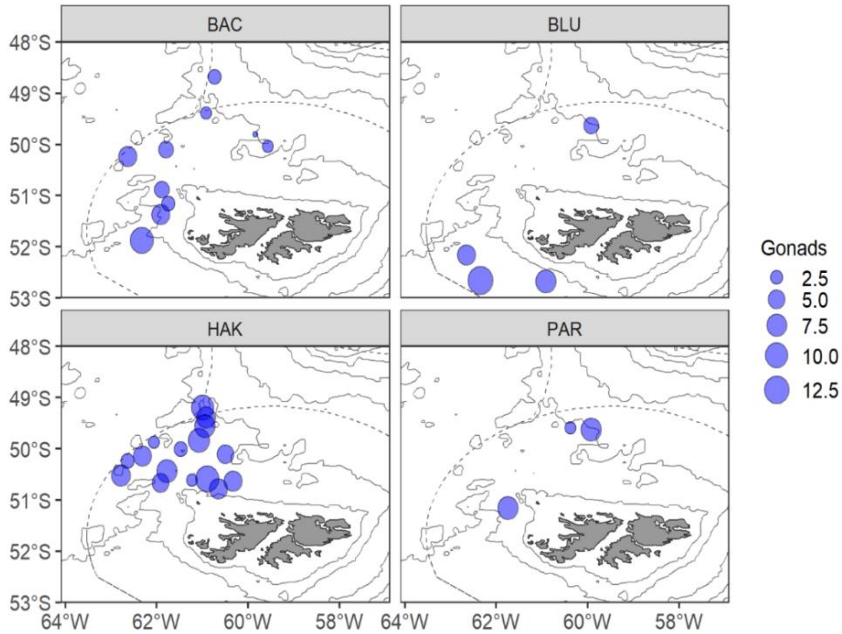

Figure 22. Distribution of *Salilota australis* (Red cod; BAC), *Micromesistius australis* (Southern blue whiting; BLU), *Merluccius hubbsi* (Common hake; HAK), and *Patagonotothen ramsayi* (Rock cod; PAR) gonads sampled for histology during the February 2024 groundfish survey (2024-02-ZDLT1). Symbol size corresponds to the number of gonads sampled at each station.

Table III. Mean fish length ± standard deviation (SD), number of ovaries, testes, and pictures taken per species during the February 2024 groundfish survey (2024-02-ZDLT1). *Merluccius hubbsi* (Common hake; HAK), *Salilota australis* (Red cod; BAC), *Micromesistius australis* (Southern blue whiting; BLU), *Patagonotothen ramsayi* (Rock cod; PAR), *Genypterus blacodes* (Kingclip; KIN), *Macrourus carinatus* (Ridge scaled rattail; GRC), *Merluccius australis* (Southern hake; PAT), *Cottoperca gobio* (Frogmouth; CGO), *Stromateus brasiliensis* (Butterfish; BUT), *Macruronus magellanicus* (Hoki; WHI), *Coelorinchus fasciatus* (Banded whiptail grenadier; GRF).

Species code	Length (mean ± SD)	Ovaries (n)	Testes (n)	Pictures (n)
Common hake	46.71 ± 9.19	89	9	1,036
Red cod	40.59 ± 17.96	28	14	384
Southern blue whiting	39.51 ± 10.76	22	9	284
Rock cod	24.38 ± 5.12	14	4	138
Kingclip	67.81 ± 19.18	7	4	126
Ridge scaled rattail	23.75 ± 3.57	7	1	101
Southern hake	80.5 ± 9.57	3	1	40
Frogmouth	46 ± 4.24	1	1	17
Butterfish	29	1	0	11
Hoki	17	1	0	8
Grenadier	9 ± 0	0	2	23
Total		173	45	2,168

Figure 23. Ovaries of *Merluccius hubbsi* (Common hake; HAK) sampled for histological analysis during the February 2024 groundfish survey (2024-02-ZDLT1). Note the wide diversity of developmental stages.

3.7. Conversion factor

CF was contrasting between the stations with smaller number of samples (< 45 individuals; CF = 1.64 at station 4098, and CF = 1.67 at station 4102) and the station with a larger number of samples (station 4100; n = 101; green weight = 315.72 kg; HGT weight = 123.18 kg; CF = 2.56). It's suspected that a number of trunks were not weighed at station 4100, resulting in a higher CF. Trevizan et al. (2023) calculated a CF of 1.64 for driftfish, which is consistent with our CF calculations at stations 4098 and 4102. Therefore, only data of these two stations were considered for the calculation of total CF, and resulted in a CF for driftfish of 1.66 (Table IV).

Table IV. Conversion factor for *Seriolella porosa* (Driftfish; SEP) HGT product conducted during the February 2024 groundfish survey (2024-02-ZDLT1). n) Number of individuals; Green) Whole animal; HGT) Headed, gutted, and tail off; CF) Conversion factor. * Not considered for the calculation of total CF.

Station	N, green	Weight, green (kg)	n, HGT	Weight, HGT (kg)	CF
4098	17	32.96	17	20.14	1.64
4100*	101	315.72	NA	123.18	2.56
4102	44	95.8	44	57.3	1.67
Total	61	128.76	61	77.44	1.66

3.8 Interactions with pinnipeds

Pinnipeds were detected around the vessel during shooting, trawling, and/or hauling at two of the 84 trawl stations conducted during the survey, respectively; these were the stations 4028 (n = 4) and 4042 (n = 1). No pinnipeds were caught in the net during the survey (Fig. 24).

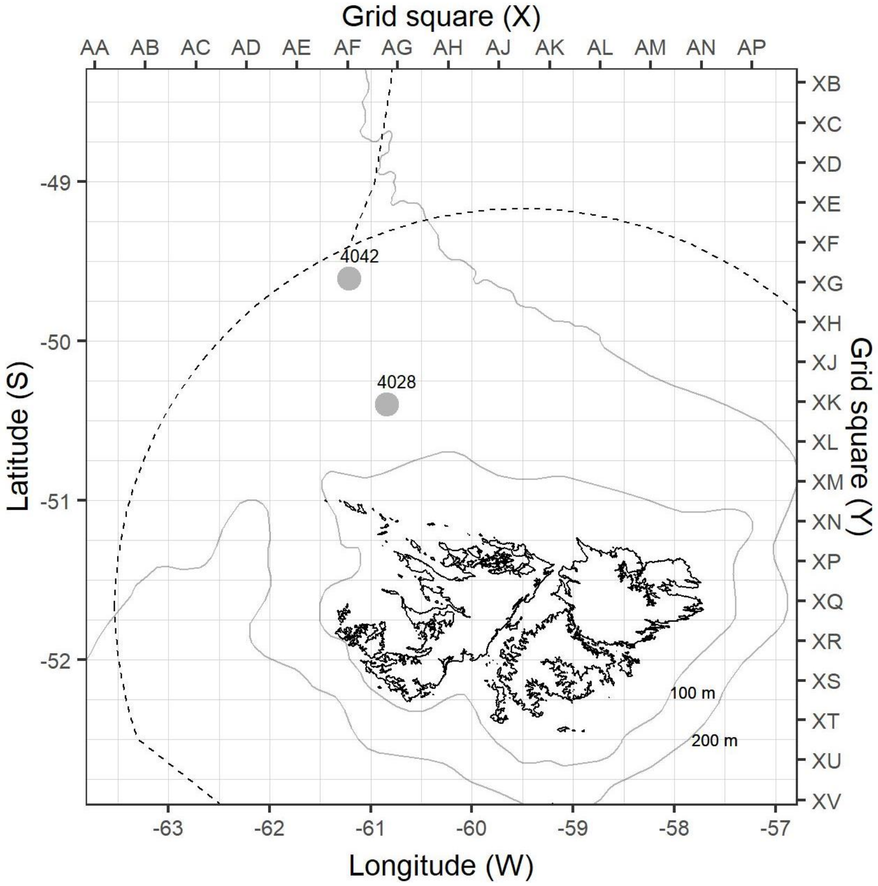

Figure 24. Presence (grey circles) of pinnipeds during the February 2024 groundfish survey (2024-02-ZDLT1).

3.9. Oceanography

Oceanographic data were collected from 84 stations during the survey, producing 81 usable casts. The CTD battery failed at stations 3982, 3984, and 3989, which corresponded to the bottom trawl stations 3983, 3985, and 3988, respectively. The shallowest common depth to all stations was 14 m, which has only a minor bearing on the majority of sensors; however, at a number of stations the peak fluorescence was above 14 m depth. Therefore, oceanographic data from the 15 m depth layer were used as a proxy for oceanographic conditions at the surface. Oceanographic data at 100 m depth layer and at the seabed were used as a proxy for oceanographic conditions were demersal-pelagic species, and were demersal species occur, respectively.

Chlorophyll levels ranged from <1 µg/l to ~ 8.5 µg/l at different depths in the first 50 m of the water column. The highest concentrations of chlorophyll were observed at the surface (15 m depth) over the shelf. Lower levels of chlorophyll were associated with cooler waters at the shelf edge, and with depth. At 50 m depth, <1µg/l of chlorophyll was detected at 65 stations; stations with >1µg/l were to the west and south (Fig. 25).

At 15 m depth, temperature ranged between 9.6 °C to the south of 52°S and 12.3 °C to the north of 51°30'S. Temperature was lower to the south-west and to the north-east, and it was higher on the western limit of the FICZ and to the north of the Falklands along the shelf break. At 100 m depth, temperature was lower on the shelf and to the north, with the lowest temperatures to the north (5.5 °C) of 51°30'S. At the seabed, temperature was lower (~5 °C) to the south-west and to the north-east, positively correlated with depth, and with temperatures ~6.5 °C from the central north to the north-west in the FICZ (Fig. 26).

At 15 m depth, oxygen was above 6.5 ml/l across the survey area. At 100 m depth and at the seabed, oxygen levels were higher (~ 6.8 ml/l) to the south-west and to the north, and lower (~ 5.3 ml/l) over the northern part of the shelf and to the north-west (Fig. 26). The spatial distribution of high levels of oxygen match the branches of the Falklands Current.

At 15 m depth, measured salinity ranged between 33.5 and 33.9 PSU, with higher values to the south-west in the FICZ. At 100 m depth and at the seabed, higher values of salinity occurred to the south-west and to the north, average values were found along the north-west, and lower values were detected along the west limit of the FICZ. At the seabed, salinity ranged between 33.5 and 34.1 PSU. The maps show interpolated values outside the measured range of salinity values (Fig. 26). Lower levels of salinity occur generally in the area where the Argentine current enters the FICZ, and as the Argentine Current is less dense than the Falklands current (Arkhipkin et al. 2013) the Argentine Current water-mass is found above the Falklands current water-mass.

Density was in a range of values from 25.6 to 27 sigma t, with lower values towards the surface. At 15 m depth, slightly lower densities (25.5 to 26 sigma t) were recorded across the shelf in the FICZ, and higher density above the slope; maximum density (26.7 sigma t) was recorded towards the south. Similar densities were measured at 100 m depth and at the seabed. At the seabed, density reached 27 sigma t in the south-west; at the seabed, density was 0.8 sigma-t higher and matched the distribution pattern at the surface (Fig. 26).

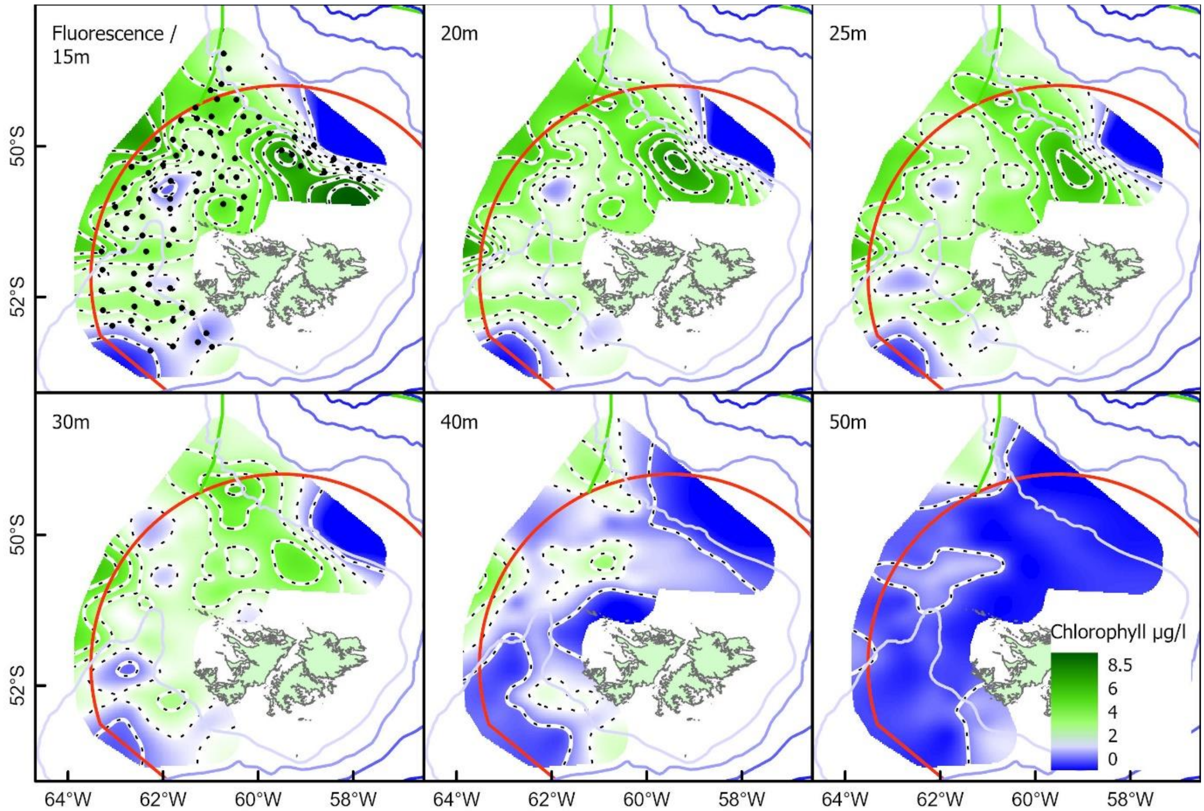

Figure 25. Chlorophyl levels (µg/l) at surface (15 m), 20 m, 25 m, 30 m, 40, and 50 m during the February 2024 groundfish survey (2024-02-ZDLT1).

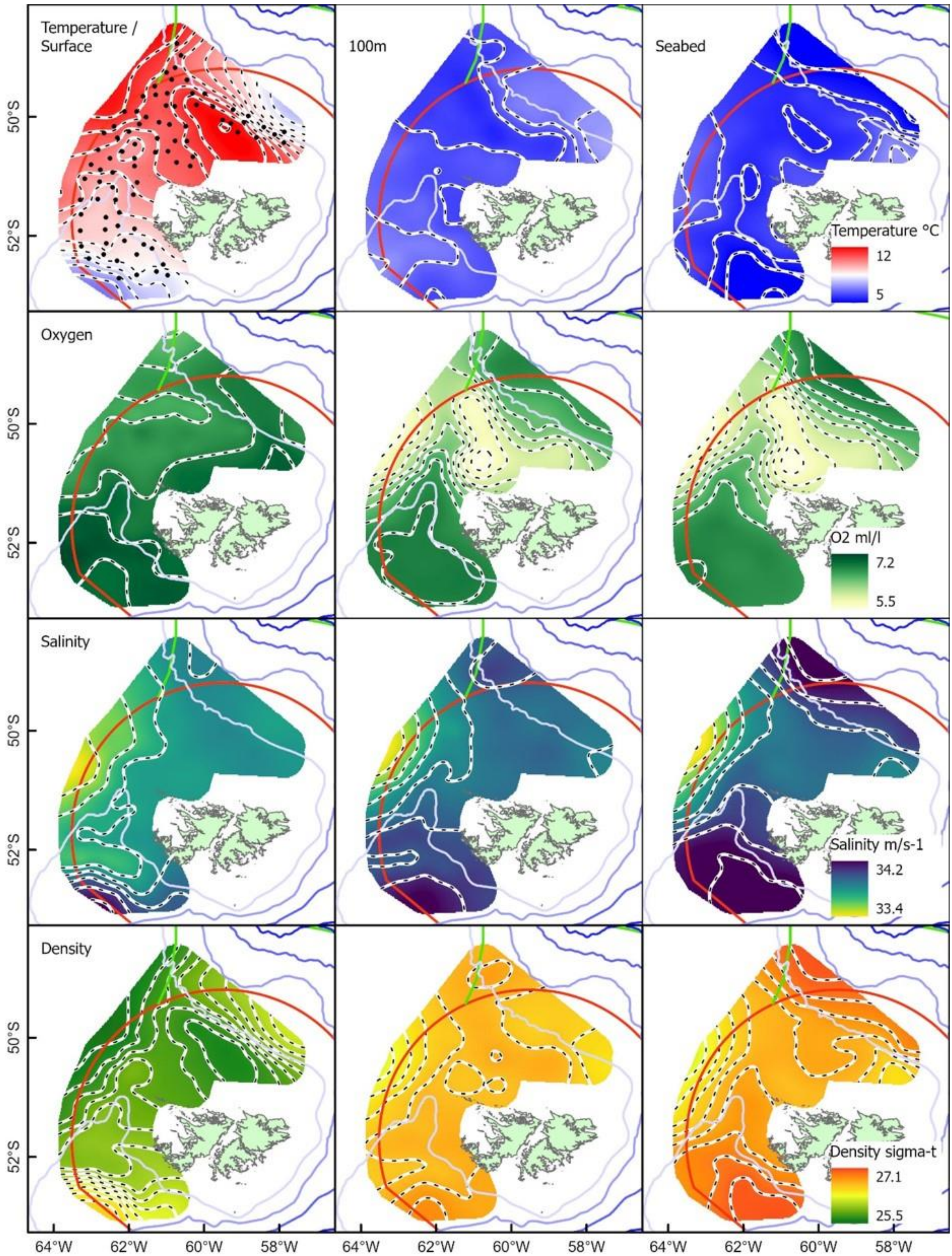

Figure 26. Temperature, oxygen, salinity, and density at surface (15 m), 100 m, and seabed during the February 2024 groundfish survey (2024-02-ZDLT1). Contours at 0.25°C, 0.2 ml/l, 0.1 PSU, and 0.1 sigma t, respectively.

4. Discussion and Conclusions

This report summarises the findings of the groundfish survey conducted during February 2024 in the FICZ and FOCZ. This fisheries-independent survey followed an array of stations similar to the array of stations originally used in the February 2010 groundfish survey (Brickle & Laptikhovsky 2010), which was replicated in subsequent February groundfish surveys conducted in 2011 (Arkhipkin et al. 2011), and from 2015 to 2023 (Gras et al. 2015, 2016, 2017b, 2018; Arkhipkin et al. 2019; Randhawa et al. 2020b; Trevizan et al. 2021, 2022, 2023). The February groundfish surveys provide valuable information on some demersal fisheries resources with higher presence in the FICZ during summer due to their seasonal migratory patterns (Arkhipkin et al. 2012). July groundfish surveys are also conducted since 2017 to provide further information on demersal fisheries resources with higher presence in the FICZ during winter (Gras et al. 2017a; Randhawa et al. 2020a; Lee et al. 2022; Ramos et al. 2023). These 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 Argentine shortfin squid was the highest catch (16 t; 23%) during the survey. This is the third highest CPUE (222 kg/h) of Argentine shortfin squid during February groundfish surveys since 2010, and it was above the average CPUE (116 kg/h) of the time series. High abundance may reflect early migration to the north-west in the FICZ as it was observed in the February 2015, and February 2018–2021 groundfish surveys (Gras et al. 2015, 2018; Arkhipkin et al. 2019; Randhawa et al. 2020b; Trevizan et al. 2021). At least two length-groups were detected with most individuals >20 cm length.

Rock cod was the second highest catch (15 t; 22%) during the survey. Catch proportion and CPUE (178 kg/h) were higher than in the February 2023 groundfish survey; however, CPUE was below average (351 kg/h) amongst February groundfish surveys since 2010. Rock cod were caught through the survey area, with denser aggregations to the north-west in the FICZ; dense aggregations of rock cod are located mainly along the west in the FICZ this time of the year. Consistent with previous February groundfish surveys, rock cod were mainly in resting or immature maturity stages, as spawning occurs in autumn on the Argentine Shelf at 42°S, at the end of autumn and in part of winter at the shelf break in Falkland Islands waters, and in spring at the Burdwood Bank (Ekau 1982; Brickle et al. 2006). Length frequency distributions allowed detecting two length-groups, with the length-group with mode at 19 cm length remaining the dominant group as in February 2023. However, the length-group with mode at 25 cm length observed in February 2023 (Trevizan et al. 2023) was not observed in February 2024.

The Patagonian squid *D. gahi* comprised the third highest catch (8 t; 12%) during the survey. Catch proportion and CPUE (97 kg/h) were the highest amongst February groundfish surveys since 2010. The Patagonian squid was distributed across the survey area, and the largest densities were found to the south-west. Consistent with previous surveys, most females were immature, whereas males were immature, preparatory or maturing; length frequency distributions showed similar patterns across surveys, with modal lengths from 8.5 to 10 cm (Gras et al. 2017b; Randhawa et al. 2020b; Lee et al. 2022; Trevizan et al. 2023).

Common hake was the fourth highest catch (6 t; 9%) during the survey. Catch proportion and CPUE (112 kg/h) were the fourth highest amongst February groundfish surveys, and above the average (5%; 69 kg/h) of the time series. Common hake were distributed across the survey area but with higher densities to the north-west, consistent with previous February groundfish surveys. Common hake starts its migration to the Falkland shelf with the Argentine inflow, and use this area as feeding ground (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 was absent from Falklands waters, was from December to February". This may explain why ripe or running females were not common during February surveys, despite some ripe males were reported. Contrasting maturity patterns observed across February surveys 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 artifact caused by the misidentification of maturity stages, which requires further examination and detailed description of the eight-stage maturity scale used at FIFD. Hake was in the range of sizes between 30 cm and 90 cm total length during the February groundfish surveys in 2010 and 2011. However, individuals were smaller in most February surveys from 2015 to 2023, with the largest individuals reaching up to 60 cm. A few individuals between 70 cm and 80 cm length were also reported in February 2024.

Red cod was the fifth highest catch (5.7 t; 8%) during the survey. However, catch proportion and CPUE (101 kg/h) were below average (13%; 168 kg/h) amongst the February groundfish surveys since 2010; indeed, this is the third lowest CPUE in the time series. 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). Red cod was distributed across the survey area and with high densities to the north-west and to the south-west, consistent with patterns observed in most February groundfish surveys since 2010. Females in resting maturity stage were more frequent, consistent with previous February groundfish surveys, suggesting that red cod uses Falkland Islands waters mainly as feeding grounds during February, whereas spawning occurs between August and October to the south and south-west of West Falkland (Arkhipkin et al. 2010; Brickle et al. 2011). For two consecutive years, the length-group of <20 cm animals was represented in lower numbers in February 2024 compared with most February groundfish surveys since 2010, likely a sign of poor recruitment.

Hoki was the sixth highest catch (5.5 t; 8%) during the survey. However, catch proportion and CPUE (198 kg/h) were the third lowest amongst February groundfish surveys since 2010, and were below the average (18%; 432 kg/h) of the time series. As this species is demersal-pelagic (Froese & Pauly 2024), it must be noted that the groundfish survey may represent a portion of the stock that was collected near the seabed. Denser aggregations occurred to the south-west in the FICZ, at stations deeper than 200 m; this pattern has been observed in February groundfish surveys since 2016 (Gras et al. 2016, 2017b, 2018; Arkhipkin et al. 2019; Randhawa et al. 2020b; Trevizan et al. 2021, 2022, 2023). Post-spawning (recovering spent and resting maturity stages) hoki are common during February in Falkland Islands waters. However, a high proportion of early developing individuals were also reported during the February 2024 groundfish survey. Spawning occurs during winter outside of Falkland Islands waters, and part of the hoki population migrates in spring to feeding grounds in the slope areas of the Falkland Current Front (west in the FICZ) (Brickle et al. 2009; Arkhipkin et al. 2012). Length frequency distributions showed relatively similar patterns compared with the February 2023 groundfish surveys (Trevizan et al. 2023), except for the smaller length-group with mode at 14 cm length that was not observed in February 2024.

Kingclip catch (4 t), catch proportion (6%), and CPUE (63 kg/h) during the survey were below average (6 t; 6%; 79 kg/h) amongst February groundfish surveys since 2010. Kingclip catch distribution was scattered across the survey area, as in previous February groundfish surveys, although distinct aggregations were observed to the north-east, north-west, and south-west in the FICZ. Resting individuals are mainly present this time of the year in Falkland Islands, and in small numbers given that most of the kingclip stock moves out of Falkland Islands from January through March to spawn (Arkhipkin et al. 2012). Modal length was detected at about 84 cm total length for females and at 72 cm total length for males, which were relatively higher than those reported during the February 2018–2023 groundfish surveys.

Banded whiptail grenadier catch (3.7 t) and CPUE (147 kg/h) during this survey were below average (4.6 t; 268 kg/h) amongst February groundfish surveys since 2010; this was the second lowest CPUE in the time series. Denser aggregations occurred at stations deeper than 200 m to the south-west in the FICZ, consistent with patterns of distribution observed since the February 2016 groundfish survey. Individuals were mainly post-spawning at resting, spent, or recovering spent maturity stages, although high proportions of early developing individuals were also reported as per previous February groundfish surveys. Length frequency distributions seem consistent across February groundfish surveys, with range of sizes between 4 and 15 cm length, with slightly variations in modal lengths between 9 cm and 10 cm.

Southern blue whiting catch (1.5 t) and CPUE (35 kg/h) during the survey are below average (1.7 t; 50 kg/h) amongst February groundfish surveys since 2010. However, catch, catch proportion and CPUE have increased for second consecutive year since the February 2022 groundfish survey. This species is demersal-pelagic (Froese & Pauly 2024), and it must be noted that the groundfish survey may represent a portion of the stock that was collected near the seabed. Southern blue whiting aggregations occurred to the south-west in the FICZ, at stations deeper than 200 m; this pattern has been observed since 2016. Immature individuals are frequent during February in Falkland Islands waters, and individuals at resting maturity stage in minor proportion. This finding is consistent with the reproductive timing of this species in Falkland Islands waters, i.e., spawning occurs during September and October to the south of West Falkland (Macchi et al. 2005; Arkhipkin et al. 2022). The majority of individuals were of small size (<25 cm length), consistent with February surveys since 2021. High abundance of animals >25 cm length has been infrequent during the February groundfish surveys, except for the February 2011, and 2015–2016 groundfish surveys (Arkhipkin et al. 2011; Gras et al. 2015, 2016).

Ridge scaled rattail is occasionally caught in February groundfish surveys. Catch (732 kg) and CPUE (81 kg/h) were below average amongst February groundfish surveys, whereas catch proportion (1%) was just above average (0.8%). Butterfish catch (449 kg), catch proportion (0.7%), and CPUE (12 kg/h) during the survey decreased compared with the February 2023 groundfish survey (1.1 t; 1.5%; 22 kg/h), and were below average (661 kg; 0.9%; 14 kg/h) amongst February groundfish surveys since 2010. Driftfish catch (447 kg), catch proportion (0.6%), and CPUE (89 kg/h) during the survey were above average (259 kg; 0.4%; 28 kg/h) amongst February groundfish surveys since 2010. CPUE increased for second consecutive year since the February 2022 groundfish survey. Toothfish was a minor catch (364 kg) during the survey, with catch proportion (0.5%) and CPUE (7 kg/h) below average (0.6%; 11 kg/h) amongst February groundfish surveys since 2010. Relatively small individuals at immature or resting maturity stages were caught mainly at stations >200 m deep to the south-west in the FICZ. 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 hake was a minor catch (270 kg; 0.4%) during the survey, with CPUE (15 kg/h) below average (19 kg/h) amongst February groundfish surveys since 2010.

Skates had minor catches (≤157 kg each species) and the CPUEs of all skate species were below average amongst February groundfish surveys. The blonde skate, the warrah skate, and the Falkland skate had the lowest CPUEs amongst February groundfish surveys since 2010. Accordingly, skate biomass calculated from surveys designed to assess skates abundance in Falkland Islands waters was found to decrease approximately 61% from 2013 to 2021; this finding is correlated with continuing skate bycatch in the bottom trawl finfish fishery (Winter & Arkhipkin 2023). Nevertheless, skates discards in the Falkland Islands fisheries increased considerably again in 2017 after high discard levels in the late 1990s; average discard levels were reported 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 and Falkland skate; Pollom et al. 2020c, d) by The International Union for Conservation of Nature (IUCN).

Catshark and dogfish were caught in relatively small amounts, i.e., 51 kg and 133 kg, respectively. CPUE of catfish (1.7 kg/h) and dogfish (4 kg/h) are below average (3.3 kg/h and 8 kg/h, respectively) amongst February groundfish surveys. These are the lowest and third lowest CPUEs for catshark and for dogfish, respectively. Dogfish is classified as vulnerable by the IUCN (Finucci et al. 2020).

Conversion factor for driftfish was calculated at 1.66. Driftfish collected in this survey had a relatively uniform range of sizes (45–58 cm total length) and similar maturity stages (VII: spent, or VIII: recovering spent). Driftfish of this range of sizes are processed for sale, and should therefore provide a reasonable CF of commercial catch. However, the smaller-than-intended CF samples available per station (33 kg and 96 kg against the intended 100–150 kg) may affect the accuracy of calculating CF. Additionally, the smaller catches taken during surveys, compared to commercial fishing, allow for slower, more careful processing, and may therefore result in a different CF specificity than if the CF was sampled and calculated during the course of regular commercial fishing. Other factors such as stomach fullness and reproductive maturity should also be taken in consideration, as animals with full stomachs or ripe gonads will result in lower CF compared with lean condition animals. These and other considerations discussed by Hearne (2008) and Pompert (2016) should be taken into account when implementing a conversion factor for any given season or fishery.

5. Recommendations

1. Some finfish species showed declining trends in CPUE across February groundfish surveys for a number of years since 2010. Some of these species showed signs of slow recovery with positive trends but still low CPUE in recent years: red cod, rock cod, southern blue whiting, and southern hake. Common hake showed relatively high abundance but with declines in the two most recent years. Squids, including the Argentine shortfin squid and the Patagonian squid showed positive numbers at the start of the first fishing season in 2024. Further studies are required to better understand the drivers of common hake and other species' distribution and abundance in the FICZ/FOCZ.
2. Dogfish, catshark, and several skates showed lower catches than in previous surveys, with the blonde skate showing negative trends in CPUE across February groundfish surveys since 2010. The generally low productivity of Chondrichthyes, 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.
3. The eight-stage maturity scale for fishes used at FIFD (Brickle et al. 2005, modified from Nikolsky 1963) 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. Accordingly, a gonad histology project for several finfish species started at FIFD with the first samples taken during the February 2024 groundfish survey. This should facilitate the identification of maturity stages for each species and minimize subjectivity in the interpretation of the scale by different scientists.
4. The identification of maturity stages of some species may require the use of a stereomicroscope or magnifying glasses, e.g., butterfish. Pertinent arrangements should be made to facilitate the use of this equipment at sea if possible.
5. The catch must be sorted only by species and not by species and size before it's sent to the conveyor to record the weight and take the random samples. This should be reminded to the factory bosun before the first station, and supervised as necessary to prevent errors.
6. An identification guide is required at FIFD to differentiate common hake *M. hubbsi* from southern hake *M. australis* based on their morphology, which is particularly problematic in individuals of similar size. Accordingly, notes on morphological characteristics were made based on a limited number of common hake and southern hake individuals sampled during the survey, and it should be discussed if a systematic scientific study should be conducted to produce a proper identification guide.
7. In previous surveys it was noticed that often the number of individuals is not the same before (green weight) and after processing (HGT weight) for CF. Therefore, scientific staff must closely supervise the counting of animals before and after HGT weighing to provide correct CF.
8. A functional fume cupboard aboard the survey vessel would be ideal to handle and store gonads sampled for histology. Given that the fume cupboard was not functional during the survey, gonad handling was conducted in the hall next to the laboratory, which had sufficient ventilation and allowed other scientific staff to quickly assist the person conducting the procedure if needed. In the absence of a functional fume cupboard, it would be preferable if this procedure was conducted in a separate area where transit of the vessel's crew is minimum and at a further distance from food freezers to minimize potential hazards.
9. Oceanographic data provides valuable insights towards understanding the distribution, abundance, and other demographic patterns of the stocks, and should be recorded and described in every survey report. Issues with the FIFD CTDs cables and in-built battery have been encountered on repeated occasions. In this survey, oceanographic data from three CTD stations were lost due to battery failure. The CTDs should be serviced regularly to ensure correct functioning, and spare accessories in working condition should be in stock at FIFD. The CTD should be returned to as close to the surface as possible (~ 2 m depth) after the soak period

before the main down cast. Therefore, the winch and the length of the cable used to deploy the CTD should be checked before the survey, and approximately once a week during the survey.

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Appendix I. Comparative total catch per station during February groundfish surveys.