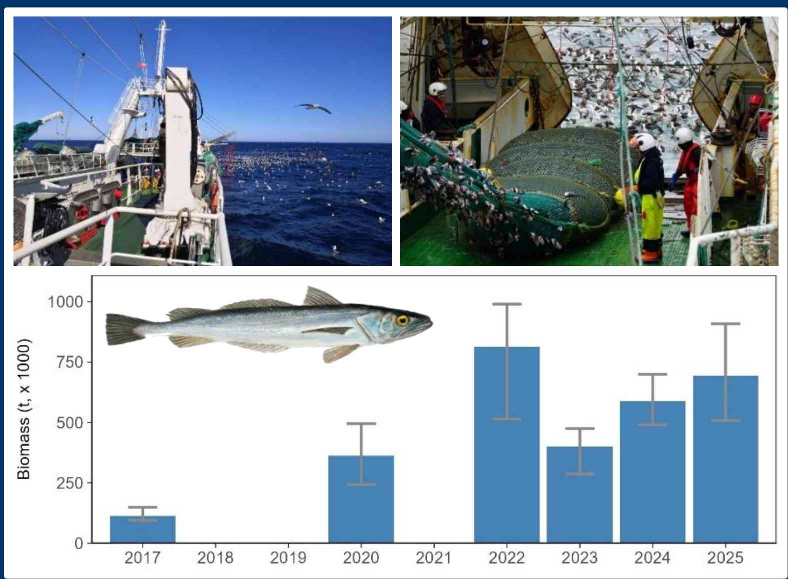
July bottom trawl survey biomasses of fishery species in Falkland Islands waters, 2017–2025



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July bottom trawl survey biomasses of fishery species in Falkland Islands waters, 2017–2025

1. Summary

Biomass assessments were conducted for 11 commercially important fish stocks—Argentine shortfin squid, banded whiptail grenadier, common hake, hoki, kingclip, Patagonian squid, Patagonian toothfish, red cod, rock cod, southern blue whiting, and southern hake—across the northern and western areas of the Falkland Islands Interim Conservation and Management Zone (FICZ), the Falkland Islands Outer Conservation Zone (FOCZ), and the 'Loligo Box'. These assessments were based on catch data from 734 bottom trawls conducted during the July parallel groundfish and calamari pre-season surveys in 2017, 2020, and 2022–2025. The July 2020 groundfish survey was included in the analyses, although it is important to note that this survey was modified for a common hake demographic study, which may affect comparability.

The July surveys reveal divergent biomass trajectories for Falkland Islands marine resources from 2017 to 2025, with the short time-series limiting biomass trend interpretation. Argentine shortfin squid, common hake, and Patagonian toothfish exhibited signs of increasing biomass, while hoki and Patagonian squid exhibited signs of decreasing biomass. Other species showed biomass patterns that should be interpreted cautiously due to wide confidence intervals in some years. Some of these species are not abundant in Falkland Islands waters during July (e.g., Argentine shortfin squid, hoki, southern blue whiting) or they may be under-represented due to the fishing gear used for the surveys (i.e., bottom trawl, whereas the Argentine shortfin squid is mainly caught by jiggers, and the adult portion of the Patagonian toothfish stock is caught by longlines).

Many of the stocks assessed are targeted across multiple nations' Exclusive Economic Zones (EEZs), with the Falkland Islands contributing a relatively small proportion to the total shared catch for some species in the Southwest Atlantic and Southeast Pacific. Declines in biomass for some of these stocks may be partially attributed to fishing pressure outside Falklands waters. However, the Falkland Islands fisheries contribute a significant proportion to the total catch for certain stocks, such as rock cod and red cod, and several species'

spawning grounds lie within the Falkland Islands shelf, including hoki, red cod, rock cod, and southern blue whiting. As such, management decisions made by the Falkland Islands Fisheries Department (FIFD) are critical for the sustainability of these stocks.

2. Introduction

The Falkland Islands shelf is located within the Patagonian Large Marine Ecosystem, one of the world's most productive fishing areas (Arkhipkin et al. 2012). The Patagonian Large Marine Ecosystem comprises two distinct sub-regions: a southern temperate ecosystem in the north and a sub-Antarctic ecosystem in the south (Boltovskoy 1999). The temperate ecosystem lies within waters of subtropical origin, transported onto the shelf by the Brazil Current and mixed with temperate shelf waters. The region's productivity is largely driven by tidal mixing oceanographic fronts and seasonal fronts formed by cold freshwater inflows from the Strait of Magellan. The sub-Antarctic ecosystem is influenced by waters of sub-Antarctic origin carried by the Falkland Current (Peterson & Whitworth 1989). The Falkland Current, which diverges from the Antarctic Circumpolar Current in the Drake Passage, splits into two branches at the continental slope south of the Falkland Islands—one weaker and one stronger—flowing around the west and east of the islands, respectively (Bianchi et al. 1982). These oceanographic features play a crucial role in the distribution and abundance of marine species, such as Argentine shortfin squid (*Illex argentinus*) and hoki (*Macruronus magellanicus*), which migrate to frontal zones for feeding and return to non-frontal zones for spawning (Agnew 2002). In contrast, deep-water species like Patagonian toothfish (*Dissostichus eleginoides*) are influenced by sub-Antarctic water intrusions into the shelf (Laptikhovsky et al. 2008; Arkhipkin & Laptikhovsky 2010).

Commercial squid and fish stocks around the Falkland Islands have been targeted by international fishing fleets for decades, with systematic catch data starting in 1987 (Falkland Islands Government 1989). Total catches reached a peak of 462,487 tonnes in 2015, largely due to an unusually large influx of *I. argentinus* into Falkland waters from April to May 2015, resulting in record catches of 332,862 t for the species (Winter 2015; Falkland Islands Government 1989, 2025). Finfish license allocations in the Falkland Islands were determined using Total Allowable Effort (TAE), based on the catchability of an index species representing the main target of the fishery. This approach worked under the assumption of consistent relationships among catch, effort, and biomass. The first index species for finfish TAE was southern blue whiting (*Micromesistius australis*). However, catches of southern blue whiting declined in the 1990s and the stock collapsed by 2009. Rock cod (*Patagonotothen ramsayi*) was first targeted in 2007 due to the lack of marketability in previous years (Winter et al. 2010), and its catches peaked in 2010 (Laptikhovsky et al. 2013; Ramos & Winter 2023). The index species was re-examined (Payá et al. 2010) and switched in 2011 from southern blue whiting to rock cod to set effort allocation. However, catches of rock cod decreased considerably after 2010 (Falkland Islands Government 2025; Ramos & Winter 2023). In parallel, catches of common hake (*Merluccius hubbsi*) increased, with a peak of 62,624 t in 2022 (Falkland Islands Government 2025). The use of an index species to manage all Falkland Islands commercial finfish species was thus considered unreliable, and the Falkland Islands Government mandated assessing each individual commercial stock to better inform fisheries management.

Scientific surveys are a key source of fisheries-independent data, offering standardized sampling plan and constant catchability that are not influenced by commercial fishing activities (Hilborn & Walters 1992; Alglave et al. 2022; Gallo et al. 2022). The Falkland Islands Fisheries Department (FIFD) has conducted parallel groundfish and calamari (*Doryteuthis gahi*) pre-season surveys every February since 2010, except for 2012, 2013, and 2014. The groundfish surveys are conducted along the north, west and south-west in Falkland Islands waters. The calamari pre-season surveys are conducted along the 'Loligo Box' to the east of the Falkland Islands.

Initially, these surveys aimed to provide biomass estimates for rock cod on the entire Falklands fishing grounds during the austral summer (Winter et al. 2010), which has since been expanded to provide information on other commercial stocks. It is noted, however, that Falkland Islands waters represent only part of the range for most stocks examined. For certain migratory species, such as common hake (Arkhipkin et al. 2015) and kingclip (*Genypterus blacodes*) (Arkhipkin et al. 2012), the February surveys may not coincide with peak abundance periods. Therefore, July surveys that follow the same methodology as the February surveys have also been conducted since 2017 to estimate biomass during the austral winter. Increasing abundance of common hake in the Falkland Shelf in recent years (Ramos & Winter

2022a) triggered a demography survey conducted exclusively for this species during July 2020 (Randhawa et al. 2020).

This report summarizes biomass estimates for key commercial species in Falkland Islands waters based on catch data from both the groundfish and calamari pre-season surveys conducted in July since 2017.

3. Methods

3.1. Bottom trawl stations

Concurrent groundfish and calamari pre-season research surveys were carried out during July 2017, July 2020, and July 2022–2025 onboard chartered fishing trawlers to cover the Falkland Islands fishing zone (Fig. 1). All trawls were bottom trawls; GPS latitude and longitude, vertical net opening, horizontal net opening, trawl door spread, and trawl speed were recorded on the ship's bridge when the net achieved the required configuration at the seafloor (based on net sensor readings, confirmed by the bridge officer), every 15 minutes during the progress of each trawl (in calamari pre-season surveys), and at the end of the trawl at the seafloor.

The duration of each trawl was approximately 60 min on the bottom during groundfish surveys, and 120 min on the bottom during calamari pre-season surveys. Characteristics of the trawl nets, trawl performance, and biological sampling during groundfish (Gras et al. 2017; Lee et al. 2022; Ramos et al. 2023, 2024a; Soeth et al. 2025) and calamari pre-season (Winter et al. 2017, 2020, 2022, 2025; Chemshirova et al. 2023, 2024) surveys can be consulted in detail in their respective survey reports. These surveys were designed to be consistent in the number and position of stations across years. However, there were variations in the number of stations due to mechanical issues, unfavourable weather conditions, logistic setbacks (e.g., pandemic COVID-19), or objectives of each survey. Increasing abundance of common hake in the Falkland Shelf in recent years (Ramos & Winter 2022a) triggered a groundfish survey in July 2020, with emphasis on the abundance and biology of common hake (Randhawa et al. 2020). Data from the July 2020 groundfish survey are also included in this report.

3.2. Catch recording and biological sampling

All species from the catch of each trawl station were sorted by FIFD scientific staff and the vessel's factory crew. FIFD scientific staff recorded the total catch of each species assessed by a combination of weighing on an electronic balance to the nearest 0.01 kg and factory production records.

Random samples of up to 100 individuals of each species were measured to the lowest 1 cm for finfish and to the lowest 0.5 cm for squid species. Dorsal mantle length was measured for Argentine shortfin squid and Patagonian squid (Calamari *D. gahi*). Total length was measured for common hake, kingclip, red cod (*Salilota australis*), rock cod, southern blue whiting, southern hake (*Merluccius australis*), and Patagonian toothfish. Pre-anal length was measured for grenadiers and hoki.

The sampling of fish and squid was prioritized (sharks and skates included, although data on these taxa are not presented in the current report). Benthos sorting was conducted either concurrently with or following the sampling of the primary commercial species. Occasionally, small juvenile fish are encountered within the benthos samples, and these are not included in the random samples. Consequently, abundance estimates and biological data for juvenile fish from random samples should be interpreted with caution.

For comparative purposes, catches and length frequencies were assessed for eleven species that also have been assessed in February parallel demersal surveys (Ramos 2025). These species represent important commercial targets in the Falkland Islands and other neighbour nations' fishing zones (Table I; Appendix I).

Table I. Main commercial species assessed in groundfish and calamari pre-season surveys in Falkland Islands waters during July 2017, 2020, and 2022–2025. Geographic distributions taken from http://www.fao.org/fishery/species/search/en

Common name	Scientific name	Distribution
Argentine shortfin squid	*Illex argentinus*	Southwest Atlantic: Brazil, Uruguay, Argentina, Falkland Islands.
Banded whiptail grenadier	*Coelorinchus fasciatus*	Southwest Atlantic: Brazil, Uruguay, Argentina, Falkland Islands. Southern Pacific: Chile, Australia, New Zealand. Southern Indian: Africa, Australia.
Common hake	*Merluccius hubbsi*	Southwest Atlantic: Brazil, Uruguay, Argentina, Falkland Islands.

Common name	Scientific name	Distribution
Hoki	*Macruronus magellanicus*	Southwest Atlantic: Argentina, Falkland Islands. Southeast Pacific: Chile.
Kingclip	*Genypterus blacodes*	Southwest Atlantic: Brazil, Uruguay, Argentina, Falkland Islands. Southern Pacific: Chile, Australia, New Zealand.
Patagonian squid	*Doryteuthis gahi*	Southwest Atlantic: Argentina, Falkland Islands. Southern Pacific: Peru, Chile.
Patagonian toothfish	*Dissostichus eleginoides*	Southwest Atlantic: Argentina, Falkland Islands. Southeast Pacific: Chile. Southwest Pacific: Macquarie Island. Southern Ocean: South Georgia.
Red cod	*Salilota australis*	Southwest Atlantic: Argentina, Falkland Islands. Southeast Pacific: Chile.
Rock cod	*Patagonotothen ramsayi*	Southwest Atlantic: Argentina, Falkland Islands.
Southern blue whiting	*Micromesistius australis*	Southwest Atlantic: Argentina, Falkland Islands. Southeast Pacific: Chile. Southern Ocean: South Georgia, South Shetland, South Orkney Islands.
Southern hake	*Merluccius australis*	Southwest Atlantic: Argentina, Falkland Islands. Southern Pacific: Chile, New Zealand.

3.3. Abundance calculations

Station and catch data were recorded during the surveys, checked, corrected and uploaded to the FIFD database, from which the data were available for analyses. Trawls were excluded if not quantifiable for the following reasons: 1) the trawl doors did not open properly, 2) the net broke during the trawl, or 3) if the net was quickly filled with medusae, which resulted in the trawl being interrupted (Appendix I).

This approach was conducted following Winter (2019). Densities (kg/km^2) per species at each trawl station were calculated as the species catch weight divided by the trawl area. Trawl area was calculated as the trawl distance covered × horizontal net opening. Trawl distance covered was calculated in R (version 4.5.1; R Core Team 2025) using the *geodist* package (Padgham & Sumner 2025). For calamari pre-season surveys, horizontal net opening was derived from the distance between trawl doors (Seafish 2010). For groundfish surveys, the triangulation method that derives horizontal net opening from the distance between trawl doors is unsuitable because the geometry of the net is different (Ramos et al. 2024b). Since 2016, groundfish survey horizontal net opening has instead been measured directly from Marport sensors fitted to the extremities of the survey vessel's trawl net wings. Generalized Additive Models (GAMs; Wood 2017) were fitted using the *mgcv* package in R (version 4.5.1; R Core Team 2025) to calculate horizontal net opening when this was not recorded due to failure of the Marport sensors. Smooth terms were used for door spread, vertical net opening, trawl speed, and depth, which were treated as random effects (method = REML; Restricted Maximum Likelihood). The model assumed Gaussian distribution of the residuals and used an identity link.

Yearly trawl biomass densities were extrapolated to the survey area combining the finfish zone (122,493.7 km^2) and 'Loligo Box' (31,296.9 km^2), partitioned into grids of 5×5 km^2. Position coordinates of trawls were converted to WGS 84 projection in UTM sector 21, and extrapolation was calculated using inverse distance weighting. The basic inverse distance weighting algorithm assigns a value *u* to any grid location *x* that is the weighted mean of a known scattered set of points x_i according to the inverse of the *i* points' distances from the grid location *x*:

$$u(\mathrm{x}) = \begin{cases} \dfrac{\sum_{i=1}^{N} w_i(\mathrm{x}) u_i}{\sum_{i=1}^{N} w_i(\mathrm{x})}, & \text{if } d(\mathrm{x}, \mathrm{x_i}) \neq 0 \\ u_i, & \text{if } d(\mathrm{x}, \mathrm{x_i}) = 0 \end{cases}$$

where

$$w_i(\mathrm{x}) = \frac{1}{d(\mathrm{x}, \mathrm{x_i})^p}$$

The power parameter *p* (a positive real number) adjusts the weight of points x_i as a function of distance (x, x_i); higher values of *p* put higher influence on the points x_i closest to a given interpolated point *x*. For this survey analysis, an empirical approach to selecting *p* was used running the inverse distance weighting algorithm with *p* values from 1 to 25 by 0.25, and for each *p* calculating the aggregate of log proportional differences between the empirical values of density at every trawl and the interpolation at every trawl from all other trawls. The lowest aggregate of log proportional differences corresponded to the best *p* value. Because some points may be more clustered than others, an isolation parameter was assigned attributing more weight to points x_i in proportion to being further away from any other point

x_i. Isolation parameters (*s*) per yearly survey were calculated as the standardized mean of distances between each point x_i and all other points x_j:

$$s(\mathrm{x_i}) = \overline{d(\mathrm{x_i}, \mathrm{x_j})}$$

An additional weighting factor was included to adjust for trawl differences in area coverage. Survey trawls are generally standardized (60 min duration in groundfish surveys and 120 min in calamari pre-season surveys) but may be shortened on immediate notice for reasons that include unmanageably large concentrations of fish accumulating in the net. Such instances will result in the trawl being stopped just when its biomass density is maximized, rather than being stopped independently of the biomass density, and thereby create a potential bias of the density estimate at that location. For shoaling fish in sparse, highly aggregated distributions, the effect can be substantial (i.e., hoki; Appendix II in Ramos & Winter 2022b). However, the trawl itself is not an error record that should be invalidated and removed from the data set. To mitigate the potential bias effect, the swept area of each trawl was taken as a proportional weighting parameter so that a shortened trawl covering, for example, only half as much ground would have only half as much weight. Like the isolation parameters $s(\mathrm{x_i})$, the area parameters $a(\mathrm{x_i})$ were standardized (divided by their mean among all trawls), then $s(\mathrm{x_i})$ and $a(\mathrm{x_i})$ were added together and divided again by their sum to give a factor centred on 1. The revised inverse distance weighting factor is:

$$w_i(\mathrm{x}) = \left(\frac{\left(\frac{s(\mathrm{x_i}) + a(\mathrm{x_i})}{\overline{\overline{\left(s(\mathrm{x_i}) + a(\mathrm{x_i})\right)}}} \right)}{d(\mathrm{x}, \mathrm{x_i})} \right)^p$$

Distance $d(x, x_i)$ is inherently calculated as Euclidean (straight-line) distance. However, the survey area surrounds the Falkland Islands and between two remote points a fish or ship would have to travel a real distance longer than straight-line; circumnavigating the landmass. Therefore, an axial loop was drawn through the survey area (Fig. 1), and $d(x, x_i)$ was defined as the longer of either the Euclidean distance between x and x_i, or the distance on the axial loop between its two points respectively closest to x and x_i (Winter 2019).

As an extrapolation algorithm, calculated biomass over a given area will depend on the spatial distribution of surveyed densities, not just their total or mean value. Accordingly, the total biomass (hereafter referred to as biomass) is considered an estimate.

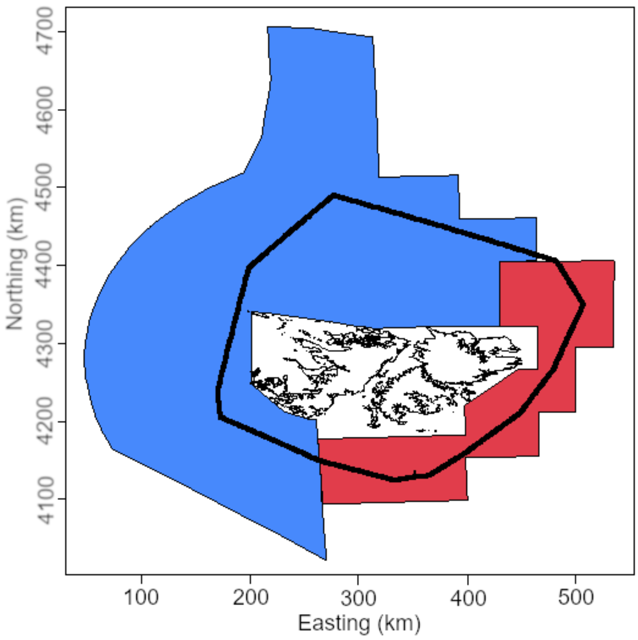

Fig. 1. Groundfish (blue) and calamari pre-season (red) survey areas, with axial loop (black line) used to define relative distances for the inverse distance weighting algorithm.

Uncertainty of the biomass estimate was calculated by a hierarchical bootstrap algorithm. Survey trawls and their catches were first randomly re-sampled with replacement for 10,000 iterations, whereby each year's groundfish survey and parallel calamari pre-season survey were re-sampled separately so that both 'halves' of the survey area retained about the same relative coverage. Second, each re-sampled trawl was given a random uniform re-assignment of its coordinate position between start latitude and longitude and end latitude and longitude. Third, the isolation parameters were re-calculated for the randomized set of trawl data, and the inverse distance weighted algorithm re-applied. One iteration might thus re-sample any trawl twice or more, but each would have a slightly different position. The 95% confidence intervals of the 10,000 bootstrap iterations were used to infer uncertainty.

3.4. Temporal biomass changes

The difference in mean biomass across the 10,000 bootstrap samples was computed to assess specific year-to-year changes in the biomass of each species for:

1) the first year (2017) and the most recent year (2025) in the time series. For July, the groundfish and calamari pre-season surveys were conducted in parallel for the first time in 2017. Therefore, 2017 was taken as the year one for comparative purposes. However, it must be noted that commercial fisheries have been conducted in the Southwest Atlantic for several decades already (Falkland Islands Government 1989), and that the state of the stocks in 2017 does not represent virgin stocks.

2) the previous year (2024) and the most recent year (2025) in the time series, and

3) the 2022–2024 mean and the most recent year (2025). A total of 10,000 mean values were calculated from the respective 10,000 biomass samples from 2022, 2023, and 2024. These 10,000 mean values were then compared with the 10,000 biomass samples derived from 2025.

This method circumvented assumptions of normality and homogeneity of variance, which were violated by the distribution of biomass for certain species in some years. To assess statistical significance, a 95% bootstrap confidence interval (CI) was constructed for each year-to-year difference. A change was considered statistically significant if the CI did not contain zero, indicating a deviation from equality. The Holm's method was used to control for the family-wise error rate when conducting multiple tests, to prevent the risk of Type I error (false positives) by adjusting the p-value threshold (Holm 1979):

$$p_{adjusted} = \frac{\alpha}{m} = \frac{0.05}{3} = 0.017$$

Where α is the significance level, and *m* is the number of tests (three comparisons: 2017 vs 2025, 2024 vs 2025, and 2022–2024 mean vs 2025).

Locally Estimated Scatterplot Smoothing (LOESS; span = 1.0, CI = 0.95) was implemented to characterize the temporal trend in annual biomass estimates from the July parallel demersal surveys conducted in 2017, 2020, and 2022 to 2025. LOESS is a non-parametric method that allows to fit a weighted regression model to localized subsets of data points to estimate the relationship between the variables at each point in the data set (Cleveland 1979; Cleveland & Devlin 1988). A change in biomass was inferred when the 95% confidence interval around the fitted values did not allow a horizontal line to pass entirely through it, indicating that the data were not consistent with a stationary trend. This criterion provides a visually interpretable way to detect significant departures from constancy in generalized additive model smooths (Swartzman et al. 1992).

4. Results and Discussion

4.1. Bottom trawl stations

A total of 734 bottom trawls were carried out during the July groundfish and calamari pre-season surveys from 2017, 2020, and 2022–2025; a range of 33 to 82 trawls were carried out during groundfish surveys each year, and 47 to 60 trawls were carried out during calamari pre-season surveys each year. In 2025, a total of 82 trawls were carried out during the groundfish survey, and 60 trawls were carried out during the calamari pre-season survey (Appendix I).

4.2. Abundance, distribution and size structure

Biomass estimates and catches of each commercial stock assessed during the July parallel demersal surveys in 2017, 2020, and 2022–2025 are summarized in Table II and in Appendix II, respectively. Biomass histograms and the distribution of each species in the survey area during the July parallel demersal surveys are presented in Appendix III and IV, respectively. Indicators of biomass change are summarized in Table III and in Appendix V.

Table II. Biomass calculations (t) of main commercial species during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. The 95% confidence intervals are indicated in parentheses.

Year	Argentine shortfin squid	Banded whiptail grenadier	Common hake	Hoki
2017	140.38	88.39	112973.24	81888.86
	(92.98-191.07)	(2.99-235.54)	(94883.33-149313.91)	(26258.16-159761.23)
2020	60.23	16291.17	362810.82	41385.59
	(32.70-86.69)	(848.25-22931.73)	(241976.86-494774.17)	(7619.52-64130.09)
2022	58.33	12074.7	812859.2	2776.39
	(34.75-81.80)	(3388.30-16623.02)	(514497.46-990071.28)	(155.50-4916.82)
2023	102.29	101.26	399808.51	878.02
	(56.71-139.63)	(13.95-137.16)	(287297.91-474558.82)	(432.78-2014.46)
2024	344.13	2126.63	588422.31	2728.52
	(216.33-482.69)	(363.50-3353.74)	(490165.40-699467.03)	(881.37-4834.04)
2025	696.10	10669.36	694327.73	3744.51
	(415.47-1007.14)	(3817.99-15225.75)	(508225.35-907855.14)	(808.34-7827.01)

Table II. *continued*

Year	Kingclip	Patagonian squid	Patagonian toothfish	Red cod
2017	18841.14	345846.47	1365.32	12384.49
	(5170.30-33657.94)	(247893.93-435232.46)	(1060.57-1597.51)	(6420.61-17896.36)
2020	35280.07	257507.72	7814.66	38808.34
	(20331.17-50260.38)	(211454.59-364202.28)	(2613.27-9762.09)	(6320.91-68377.24)
2022	19105.14	206640.18	1318.72	28065.9
	(8635.13-40125.23)	(176919.40-256330.86)	(803.53-1685.00)	(4607.76-46783.62)
2023	26289.34	129242.71	522.2	35913.12
	(7630.35-65456.91)	(107499.58-161883.97)	(335.03-669.12)	(4422.53-77296.16)
2024	29557.81	75518.97	2117.4	26062.19
	(6923.31-82590.52)	(63743.43-85857.67)	(1422.84-2645.95)	(9768.25-38396.31)
2025	54688.29	121936.85	9929.53	21251.83
	(5669.78 140754.91)	(101861.17-149299.02)	(7891.53-11348.41)	(12034.34-30481.08)

Table II. *continued*

Year	Rock cod	Southern blue whiting	Southern hake
2017	51728.07	1585.17	501.1
	(32112.03-66518.09)	(338.45-2675.77)	(213.85-716.95)
2020	5927.97	8895.08	176.94
	(4279.70-7473.88)	(505.15-13409.20)	(1.74-391.60)
2022	54443.94	412.67	682.02
	(19950.60-91307.58)	(184.60-753.75)	(0.00-866.85)
2023	29163.79	1437.04	99.35
	(12630.26-46731.41)	(572.04-2201.07)	(0.00-269.56)
2024	48722.67	330.88	276.43
	(24664.36-71873.45)	(203.98-440.72)	(128.37-432.01)
2025	86123.02	307.87	1201.17
	(49956.90-138520.77)	(73.39-496.23)	(549.18-1639.73)

Table III. Indicators of biomass change of main commercial species in July groundfish and calamari pre-season surveys in Falkland Islands waters. The values indicate the ratio of biomass increase (+) or decrease (-) in 2025 compared with the 2017, 2024, and the 2022–2024 mean biomasses. Bold font indicates significant changes for year-to-year comparisons (p adjusted threshold = 0.017) and for LOESS smooth.

Species	2017 vs 2025	2024 vs 2025	Mean vs 2025	LOESS 2017–2025
Argentine shortfin squid	**+4.96**	**+2.02**	**+4.14**	**Increase**
Banded whiptail grenadier	**+120.71**	**+5.02**	+2.24	No change
Common hake	**+6.15**	+1.18	+1.16	Increase
Hoki	**-21.87**	+1.37	+1.76	**Decrease**
Kingclip	+2.90	+1.85	+2.19	No change
Patagonian squid	**-2.84**	**+1.61**	-1.12	Decrease
Patagonian toothfish	**+7.27**	**+4.69**	**+7.53**	No change
Red cod	+1.72	-1.23	-1.41	No change
Rock cod	+1.66	+1.77	+1.95	No change
Southern blue whiting	-5.15	-1.07	**-2.36**	No change
Southern hake	+2.40	**+4.35**	**+3.41**	No change

4.2.1. Argentine shortfin squid (*Illex argentinus*)

On average, 59% of the total Argentine shortfin squid catches in the time series were from groundfish surveys and 41% were from calamari pre-season surveys. The highest catch was reported in 2025 (0.199 t), representing a sevenfold greater than the 2022–2024 mean (0.03 t; Fig. 2; Appendix II).

The highest densities occurred in 2025 (mean ± SE: 4.29 ± 1.51 kg/km²), representing a sixfold increase compared with the 2017 densities (0.68 ± 0.14 kg/km²), a threefold increase relative to the 2024 densities (1.44 ± 0.41 kg/km²), and a sixfold increase compared with the 2022–2024 mean (0.70 ± 0.14 kg/km²; Fig. 2).

The highest biomass in the time series was calculated for 2025 (696.10 t; Table II; Appendix III). Biomass in 2025 represented a significant fivefold increase compared to the biomass in 2017 (140.38 t; $p < 0.001$), a significant twofold increase compared to the 2024 biomass (344.13 t; $p = 0.01$), and a significant fourfold increase relative to the 2022–2024 mean (168.25 t; $p < 0.001$; Fig. 2; Appendix V–VI). LOESS revealed a statistically significant increasing trend in biomass from 2017 to 2025 (Appendix VII).

In 2025, *I. argentinus* was distributed through the survey area in small densities, and the highest density (201 kg/km^2; the highest density in the time series) was observed to the west at approximately 51.5°S and 62°W (4,315 km northing and 120 km easting, respectively; Fig. 3). Across years, it was mainly distributed through the north and west in the FICZ, with no consistent areas of higher densities (Appendix VIII).

Length-frequency histograms indicated a size range of *I. argentinus* from 4.5 to 34.5 cm ML across years, with small modal lengths of 8.5–12 cm ML. In 2025, the modal length of females (9.0 cm ML) was slightly greater than that of males (8.5 cm ML). A few juveniles were also reported during the surveys (≤21 individuals per survey; 6–9.5 cm ML; Fig. 4). The apparent abundance of juveniles should be interpreted with caution. The increase of biomass in July 2025 was partly attributable to higher densities of small individuals (≤10 cm dorsal mantle length), which are typical of the survey area at this time of year. The July pattern contrasts with February surveys results: February 2025 biomass decreased relative to February 2024, was similar to the 2010–2024 February mean, and showed no long-term trend from February 2010 to February 2025 (Ramos 2025). Argentine shortfin squid biomass is considerably lower in July compared to February. This species is primarily captured by commercial jiggers during the first half of the year when it is more abundant in Falkland Islands waters (Falkland Islands Government 2025). July biomass calculated from bottom trawl surveys should be interpreted with caution.

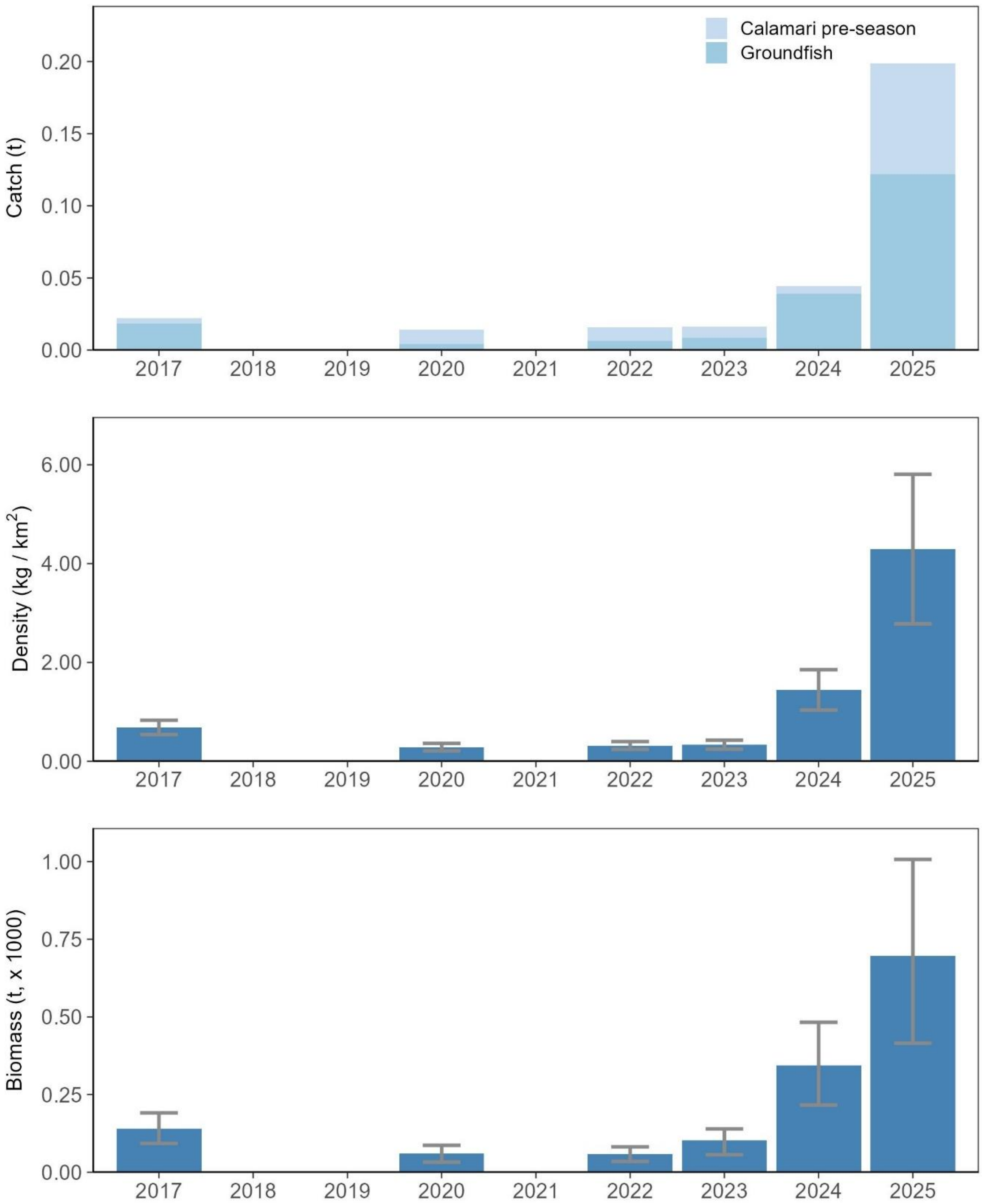

Fig. 2. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of the Argentine shortfin squid (*Illex argentinus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

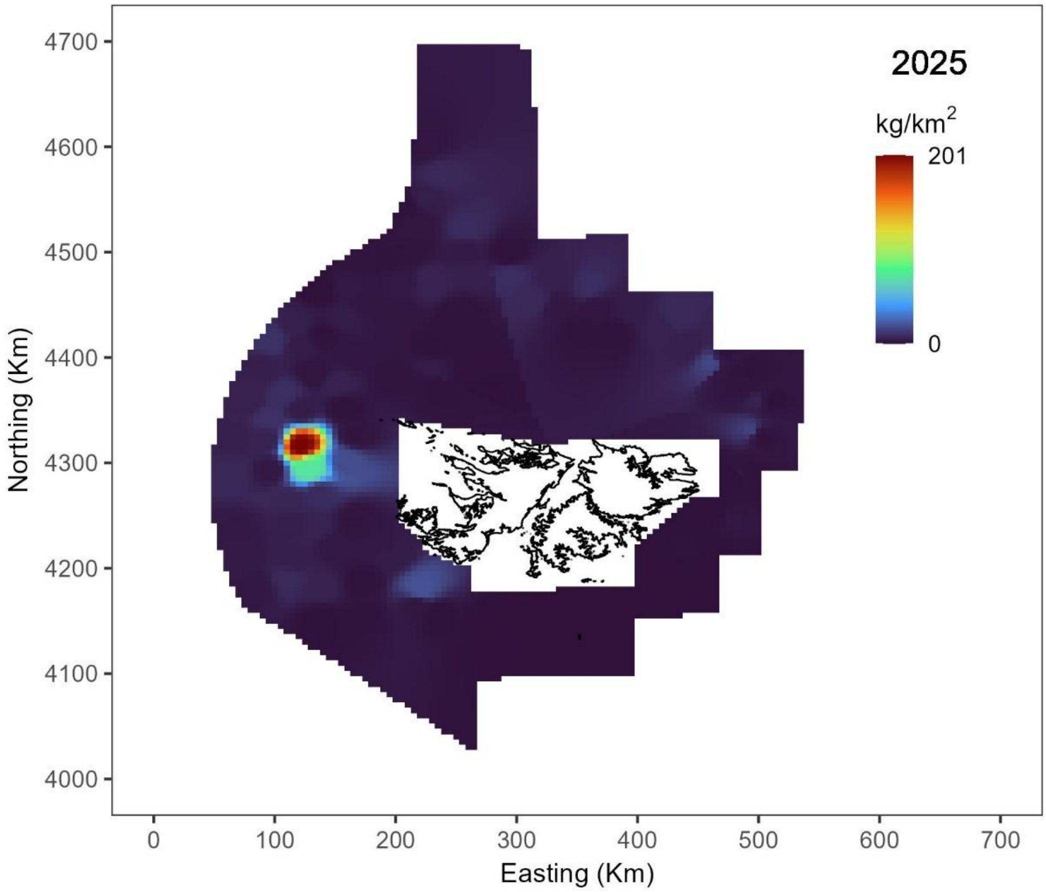

Fig. 3. Distribution and abundance of the Argentine shortfin squid (*Illex argentinus*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

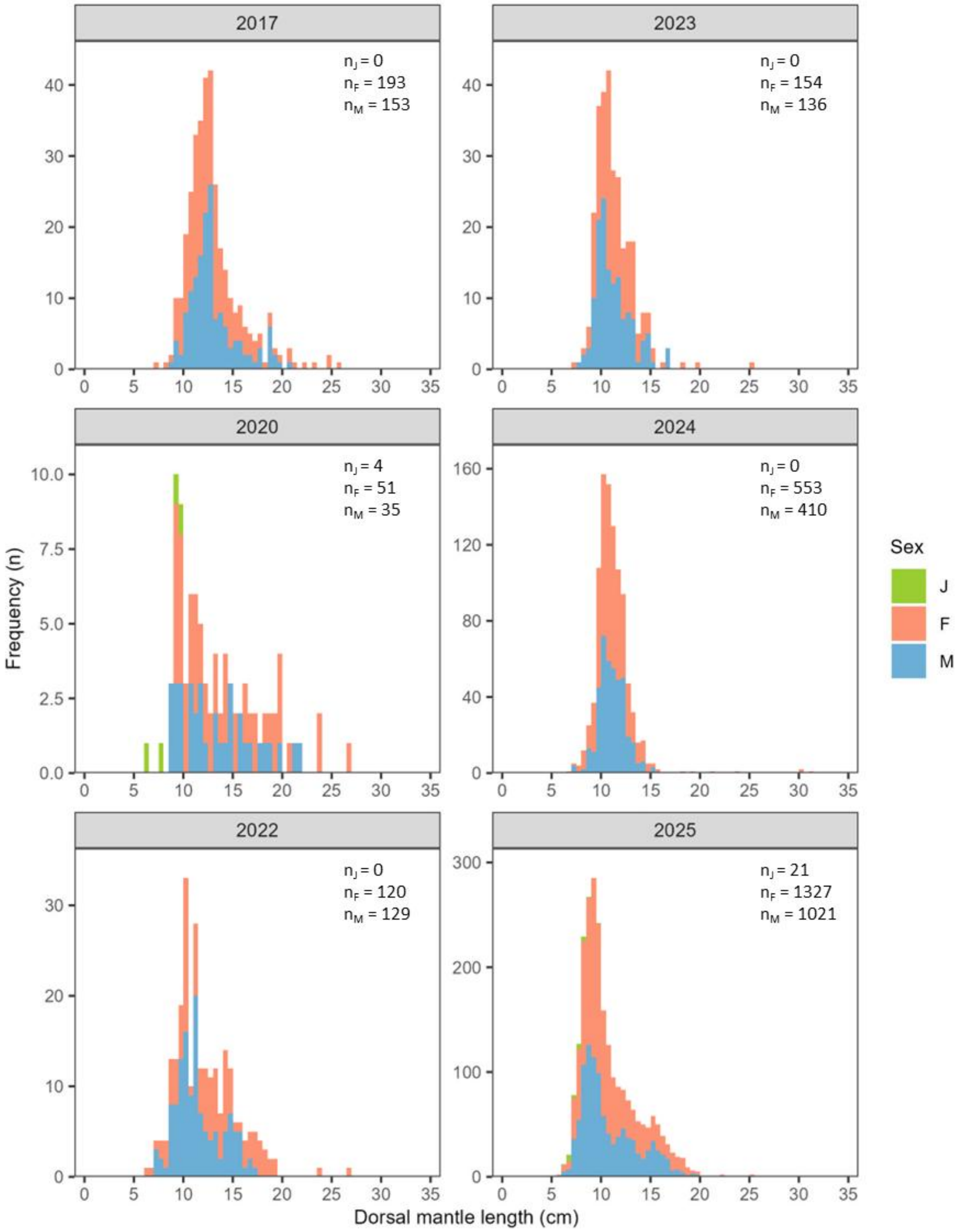

Fig. 4. Length-frequency distribution of Argentine shortfin squid (*Illex argentinus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.2. Banded whiptail grenadier (*Coelorinchus fasciatus*)

Patterns of catch and biomass across years were variable, likely due to the small catches and patchy distribution of this species, which is reflected by wide biomass confidence intervals (Table II). On average, 76% of the total banded whiptail grenadier catches were from groundfish surveys, and 24% were from calamari pre-season surveys. The highest catch was reported in 2025 (1.10 t), representing nearly a threefold increase relative to the 2022–2024 mean (0.43 t; Fig. 5; Appendix II).

The highest densities occurred in 2020 (mean ± SE: 38.04 ± 6.23 kg/km²). Densities in 2025 (35.65 ± 16.58 kg/km²) were fivefold greater than the 2024 densities (7.38 ± 3.53 kg/km²) and twofold greater than the 2022–2024 mean (14.56 ± 6.23 kg/km²; Fig. 5).

The highest biomass was calculated for 2020 (16,291.17 t), followed by a steep decline to 2023 (101.26 t); biomass then increased for two consecutive years and reached 10,669.36 t in 2025 (Table II; Appendix III). Biomass in 2017 (88.39 t) accounted for <1% of the 2025 biomass and was significantly lower ($p < 0.001$) in comparison. Biomass in 2025 represented a significant fivefold increase compared to the 2024 biomass (2,126.63 t; $p = 0.01$) and a twofold but not significant increase compared with the 2022–2024 mean (4,767.53 t; $p > 0.017$; Fig. 5; Appendix V–VI). Marked biomass fluctuations from 2017 to 2025 and wide confidence intervals resulted in a no statistically significant trend (Appendix VII). It should be noted that the widest confidence intervals were calculated for 2020, when the groundfish survey was modified for a demographic study of common hake and included only 33 stations in the survey area, rather than the 84 stations typically planned for standard groundfish surveys.

Comparison of biomass with other data is limited, given that information on this species in the region is scarce. Biomass had no trend in February surveys from 2010 to 2025, although the biomass in February 2025 was lower compared to February 2017, 2024, and the 2010–2024 mean (Ramos 2025). The only stock assessment conducted for this species in the Falkland Islands employed OCOM with alternative priors of intrinsic growth rate, yielding lower biomass estimates for 2017 compared to 1988, whereas the CMSY approach produced a higher biomass estimate for 2017 compared to 1988 (Winter & Lee 2018). Approximately 68.3% of grenadier catches in Falkland Islands trawl fisheries are identified as banded whiptail grenadier (Falkland Islands Government 2025), with over 85% of these identified catches being discarded (Winter & Lee 2018).

Banded whiptail grenadier was distributed to the south-west of West Falkland during 2025, with the maximum density (1,507 kg/km^2) at approximately 52.5°S and 61°W (4,155 km northing and 235 km easting, respectively; Fig. 6). Across years, there was a consistent pattern of distribution to the south-west in the FICZ, with the highest density calculated for 2022 (1,853 kg/km^2; Appendix IX).

Length-frequency histograms revealed a size range of banded whiptail grenadier from 3 cm to 16 cm pre-anal length across years, and with modal lengths of 7–10 cm pre-anal length. Modal lengths were generally consistent, with females at 8 cm and males at 7 cm pre-anal length, except in 2020 when the size of both sexes was larger (10 cm and 8 cm pre-anal length, respectively). A few juveniles (n = 3; 3–4 cm pre-anal length) were reported during the July 2022 survey, whereas no juveniles were reported in other years (Fig. 7).

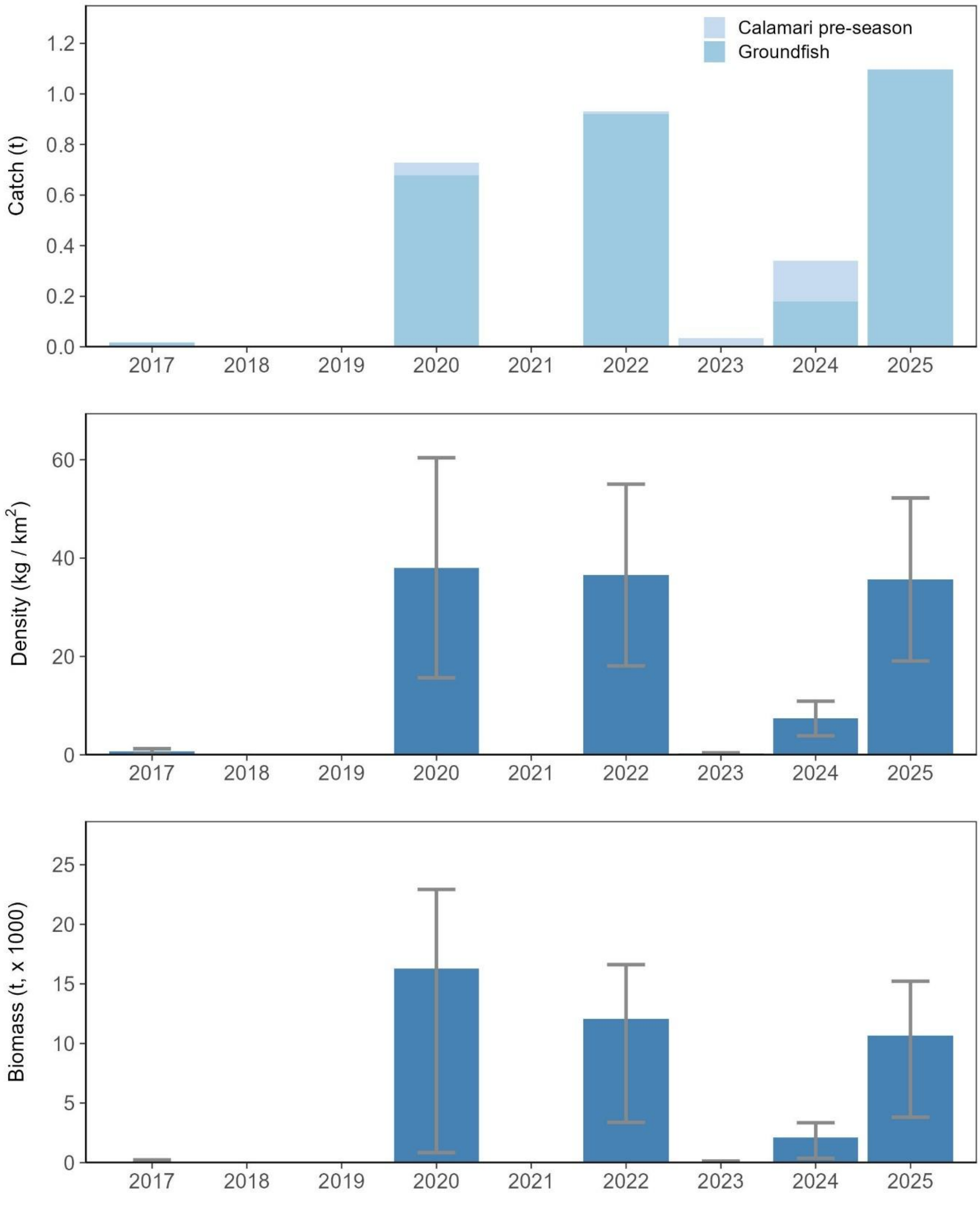

Fig. 5. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of banded whiptail grenadier (*Coelorinchus fasciatus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

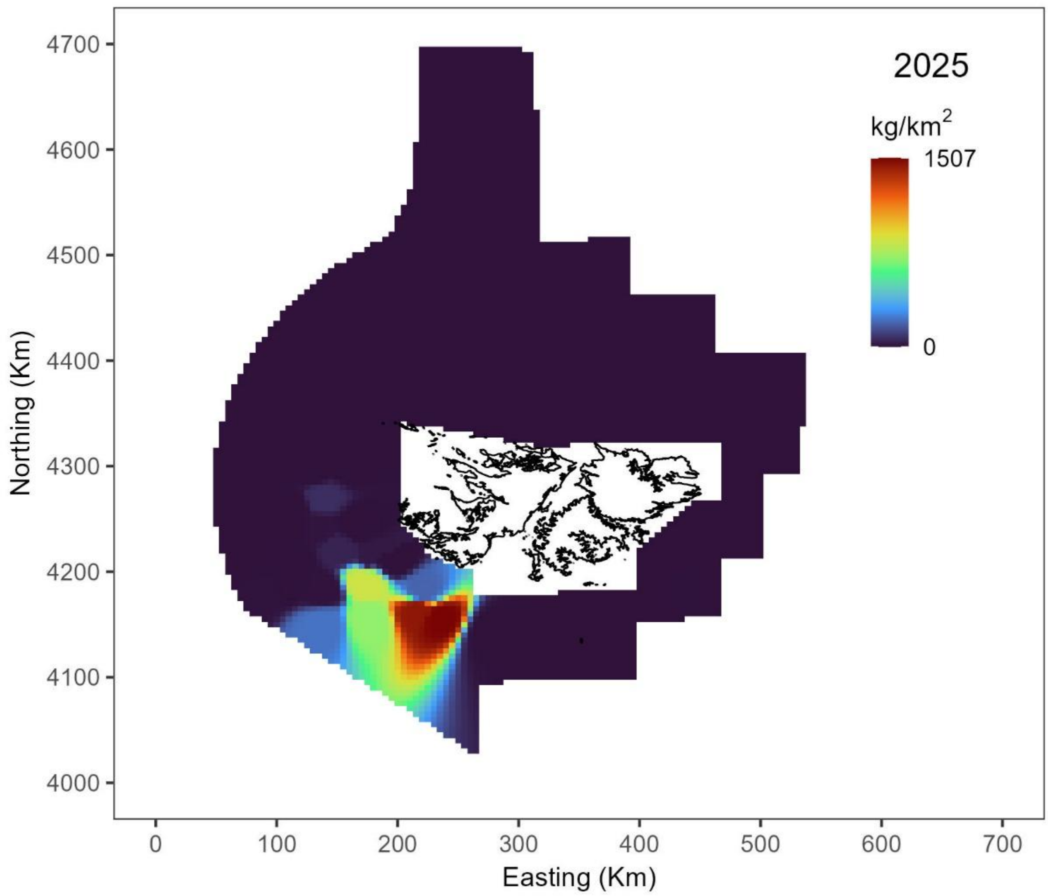

Fig. 6. Distribution and abundance of banded whiptail grenadier (*Coelorinchus fasciatus*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

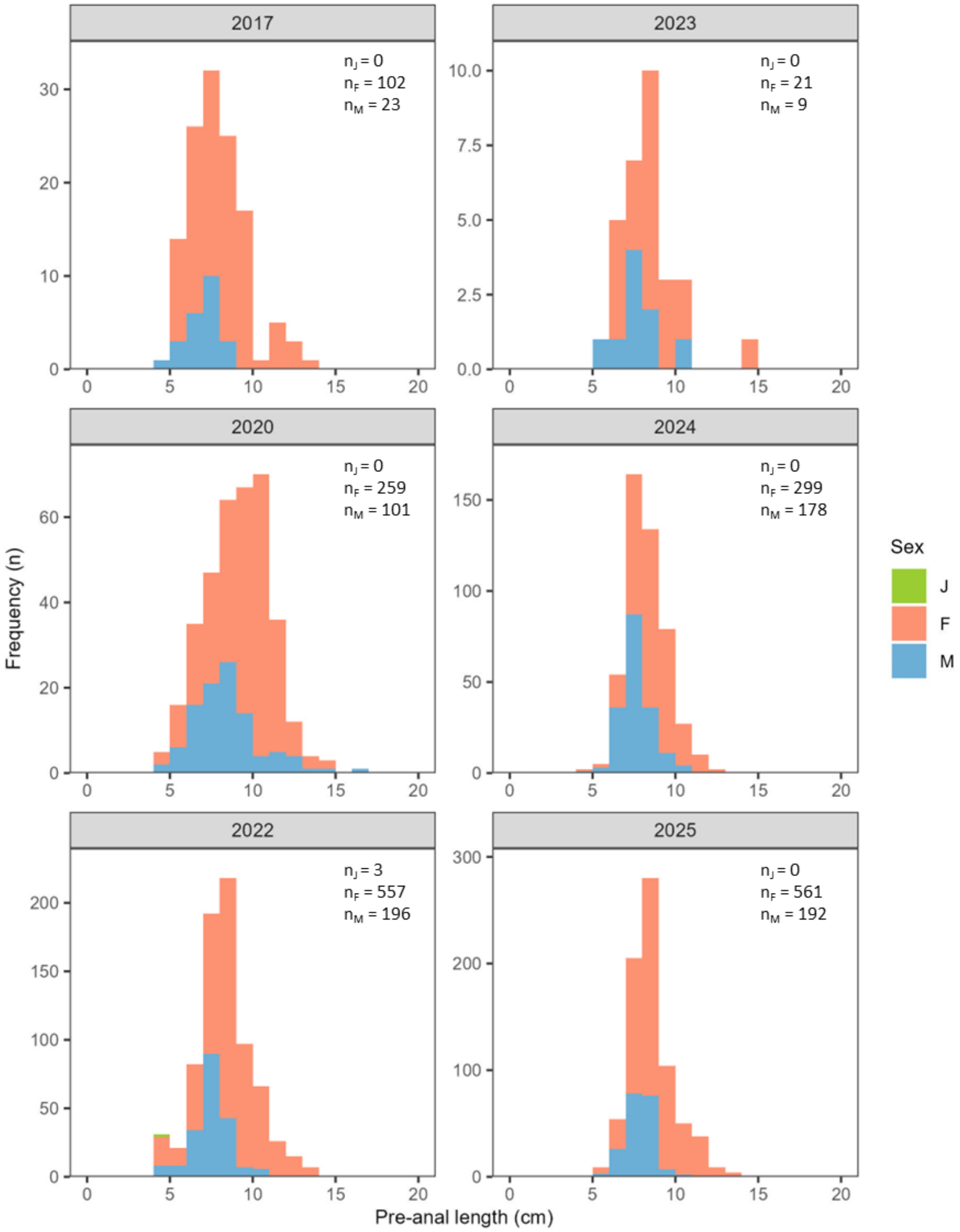

Fig. 7. Length-frequency of banded whiptail grenadier (*Coelorinchus fasciatus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.3. Common hake (*Merluccius hubbsi*)

On average, 49% of the total common hake catches in the time series were from groundfish surveys and 51% were from calamari pre-season surveys. The highest catch was reported in 2025 (250.91 t), representing a twofold greater than the 2022–2024 mean (118.62 t; Fig. 8; Appendix II).

The highest densities in the time series occurred in 2025 (mean ± SE: 3,824.22 ± 585.85 kg/km^2), representing a fivefold increase relative to the 2017 densities (705.88 ± 106.94 kg/km^2), and a slight increase relative to both the 2024 densities (3,584.45 ± 418.56 kg/km^2) and the 2022–2024 mean (2,708.56 ± 222.77 kg/km^2; Fig. 8).

The biomass of common hake increased steeply from 2017 (112,973.24 t) to 2022 (812,859.20 t; the highest biomass in the time series), declined in 2023 (399,808.51 t), and rose again for two consecutive years (Table II). The 2025 biomass (694,324 t) represented a significant sixfold increase compared to the 2017 biomass (112,973.24 t; $p < 0.001$). Biomass in 2025 was marginally and not significantly higher than that recorded in 2024 (588,422.31 t; $p > 0.017$) and the 2022–2024 mean (600,363.34 t; $p > 0.017$; Fig. 8; Appendix V–VI). LOESS revealed an overall increasing trend in biomass but this was not statistically significant from 2017 to 2025 (Appendix VII).

In 2025, common hake was present across the survey area. However, its highest density (56,900 kg/km^2; the highest density in the time series) occurred to the north in the FICZ at approximately 49.5°S and 60°W (4,500 km northing and 295 km easting, respectively). Moderate densities were also observed to the west in the FICZ (Fig. 9). Across years, scattered patches of high densities were detected mainly to the north in the FICZ/FOCZ. July 2024 showed a different pattern, with distinctive aggregations to the south-west in deeper stations (Appendix X).

Length-frequency histograms indicated a broad size range of common hake from 20 cm to 88 cm total length across years, and with modal lengths of 38–45 cm. Females were generally larger than males, with modal lengths of 40–45 cm compared to 38–41 cm for males. Modal lengths of females shifted from 45 cm in 2017 to 42 cm in 2025, while those of males shifted from 41 cm in 2017 to 38 cm in 2025. Notably, the smaller length group (<33 cm total length) was absent after 2017 (Fig. 10).

Common hake abundance is typically higher from May to September in Falkland Islands waters (Ramos & Winter 2022a), making July surveys particularly informative for stock assessment, and ahead of the finfish and calamari fisheries during the second half of the year. The common hake biomass estimated from the July 2025 surveys was the second highest in the 2017–2025 period, while the February 2025 biomass was the highest recorded in February from 2010 to 2025 (Ramos 2025). CPUE data from commercial trawlers in the FICZ/FOCZ indicated a peak in 2021 (Ramos & Winter 2022a), although no post-2021 abundance indices are available for comparison. These findings are consistent with biomass trends of the southern stock (south of 41°S) in Argentine waters, where biomass declined from 1986 to 2000, fluctuated from 2001 to 2007–2008, increased thereafter, and reached a maximum in 2023 (Santos et al. 2024). Modal lengths of common hake in July groundfish and calamari pre-season surveys declined between 2017 and 2025 (females: 45 cm to 42 cm; males: 41 cm to 38 cm). A decreased in modal length was also described by Soeth et al. (2025) from predicted length–biomass distributions using July groundfish survey data alone. However, analyses of the median, upper quartile (75%), and 90th percentile (90%) lengths contributions to the total biomass suggest the increase of lengths in 2025 compared with the 2022–2024 mean, and with 2024 (Soeth et al. 2025).

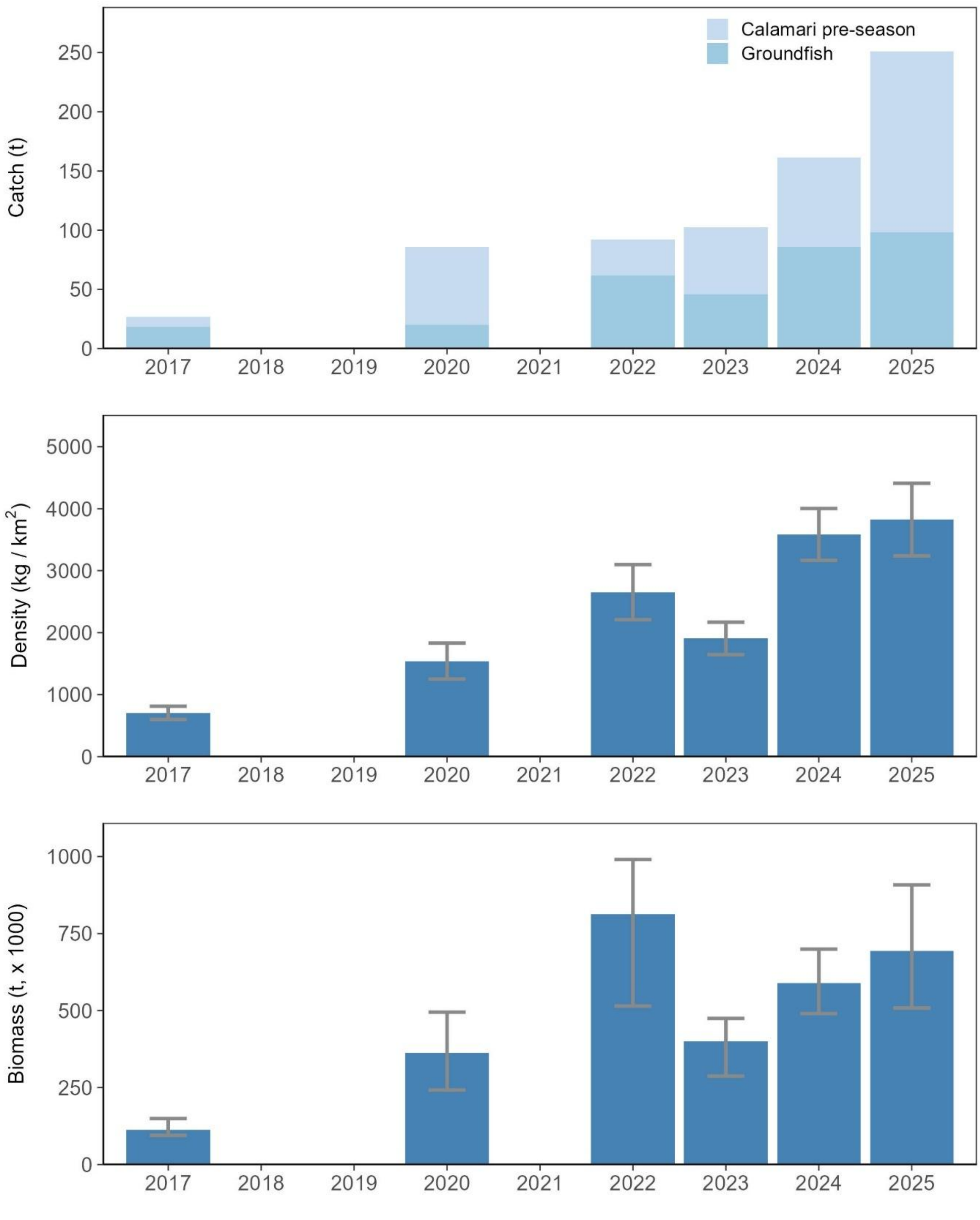

Fig. 8. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of common hake (*Merluccius hubbsi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

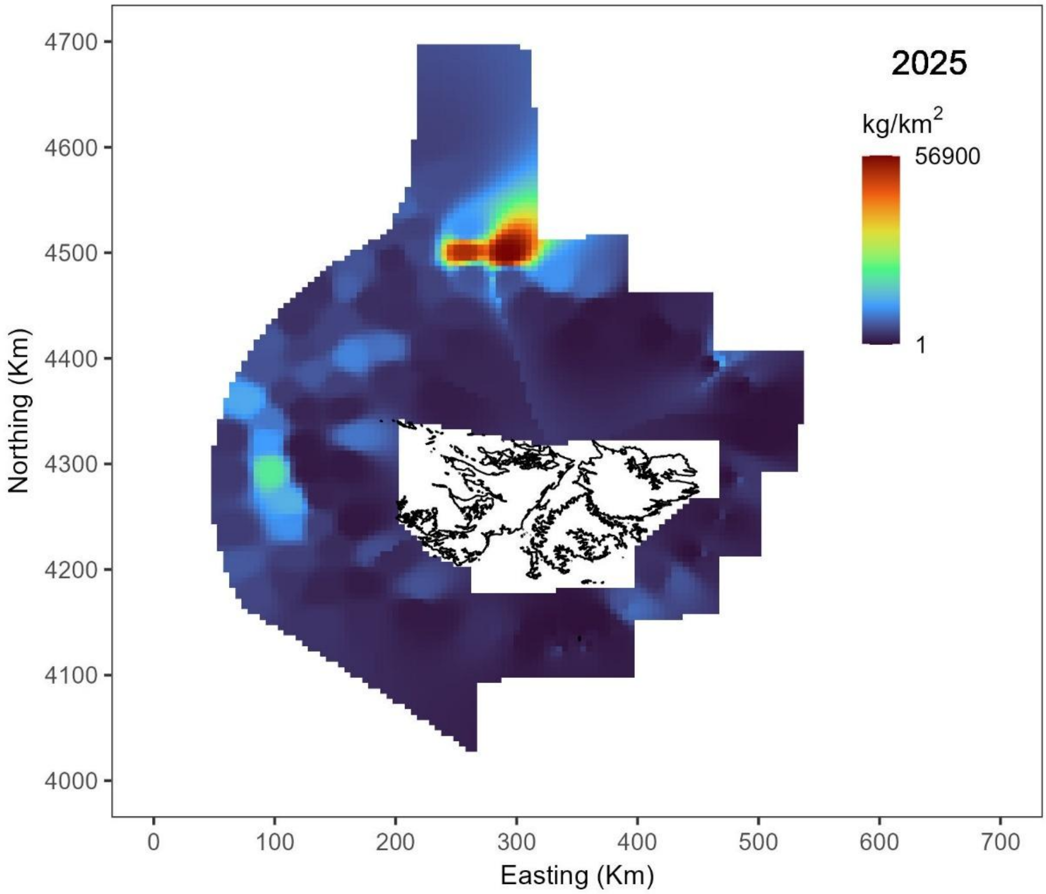

Fig. 9. Distribution and abundance of common hake (*Merluccius hubbsi*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

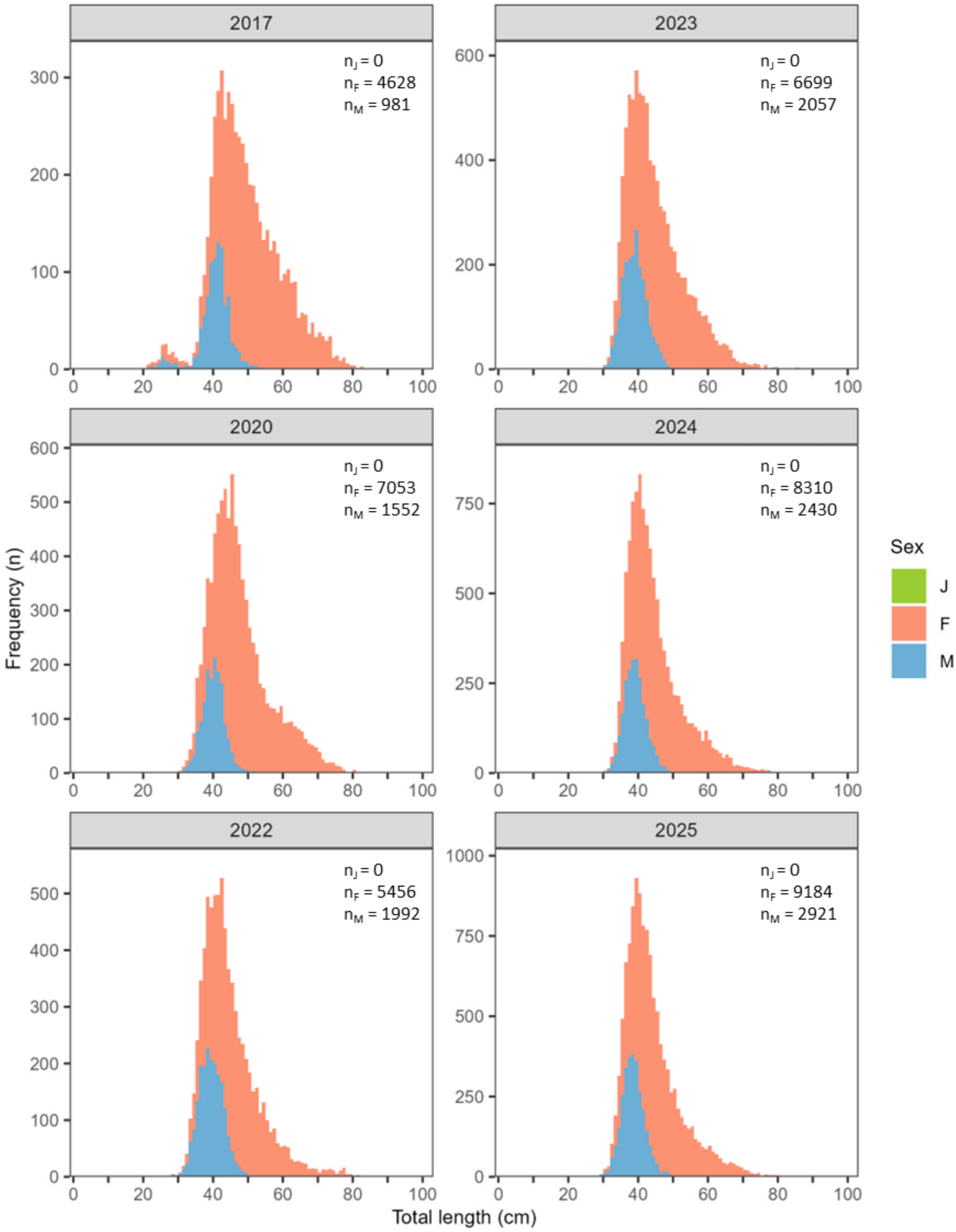

Fig. 10. Length-frequency of common hake (*Merluccius hubbsi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.4. Hoki (*Macruronus magellanicus*)

On average, 64% of the total hoki catches in the time series were obtained from groundfish surveys and 36% from calamari pre-season surveys. The highest catch was reported in 2017 (114.72 t), mainly due to high catches in two nearby stations (52.84 t and 55.29 t, respectively), whereas catches remained low in subsequent years (<2 t). Hoki catch in 2025 (0.49 t) was slightly higher than the 2020–2024 mean (0.45 t; Fig. 11; Appendix II).

The highest densities occurred in 2017 (mean ± SE: 1,267.16 ± 752.76 kg/km²). Densities in 2025 (16.12 ± 10.38 kg/km²) represented only 1% of the 2017 densities, were similar to those in 2024 (15.66 ± 5.87 kg/km²) and represented a twofold increase relative to the 2022–2024 mean (9.64 ± 2.7 kg/km²; Fig. 11).

The highest biomass in the time series was calculated for 2017 (81,888.86 t). Biomass declined sharply, reached the lowest level in 2023 (878.02 t) and remained at low levels thereafter (Table II). Hoki biomass in 2025 (3,744.51 t) represented only 5% of the 2017 biomass and was significantly lower ($p < 0.001$) in comparison. Biomass in 2025 was slightly higher than the 2024 biomass (2,728.52 t) and nearly twofold greater than the 2022–2024 mean (2,127.64 t) but these differences were not significant ($p > 0.017$; Fig. 11; Appendix V–VI). LOESS revealed a statistically significant decreasing trend in biomass from 2017 to 2025 (Appendix VII); however, this trend must be interpreted cautiously given the wide confidence intervals observed in 2017 and in 2020.

In 2025, hoki were found to the south-west in the FICZ, with the highest density (1,378 kg/km^2) at approximately 52.5°S and 61.5°W (4,190 km northing and 175 km easting, respectively; Fig. 12). From 2017 to 2025, hoki occurred mainly to the south-west in FICZ. However, its spatial distribution extended to the east in the 'Loligo Box' in 2017 and in 2024, with the highest density (84,023 kg/m^2) of the time series occurring in July 2017 (Appendix XI).

Length-frequency histograms indicated a size range of hoki from 8 cm to 36 cm pre-anal length across years, with modal lengths of 14–21 cm. Modal length increased from 2017 (15 cm for females and 14 cm for males) to 2020 (20 cm for both sexes), and this pattern persisted in 2022. In 2023, modal length decreased to 16 cm for both sexes, before increasing again in 2024 and 2025 to approximately 20 cm. No juveniles were reported in any year (Fig. 13).

The declining biomass trend of hoki observed in July surveys is consistent with February surveys data and commercial fisheries indicators. February surveys show that February 2025 biomass represented only 2% of the February 2010 level (Ramos 2025). Analyses of commercial data using data-poor methods (LBB, OCOM) estimated that 2018 biomass was 13% of the 1987 level and revealed a long-term decline from 1987 to 2018 (Ramos & Winter 2019). Using data from Argentine surveys and from commercial fleets from Argentina, Uruguay, and international waters (including the Falkland Islands), Zavatteri & Giussi (2022) found that biomass peaked in 2000, declined sharply to a minimum in 2016, and increased slightly in 2017–2019. No biomass estimates have been generated from Falkland Islands commercial data since 2019 (Ramos & Winter 2022c), limiting recent fishery-survey comparisons.

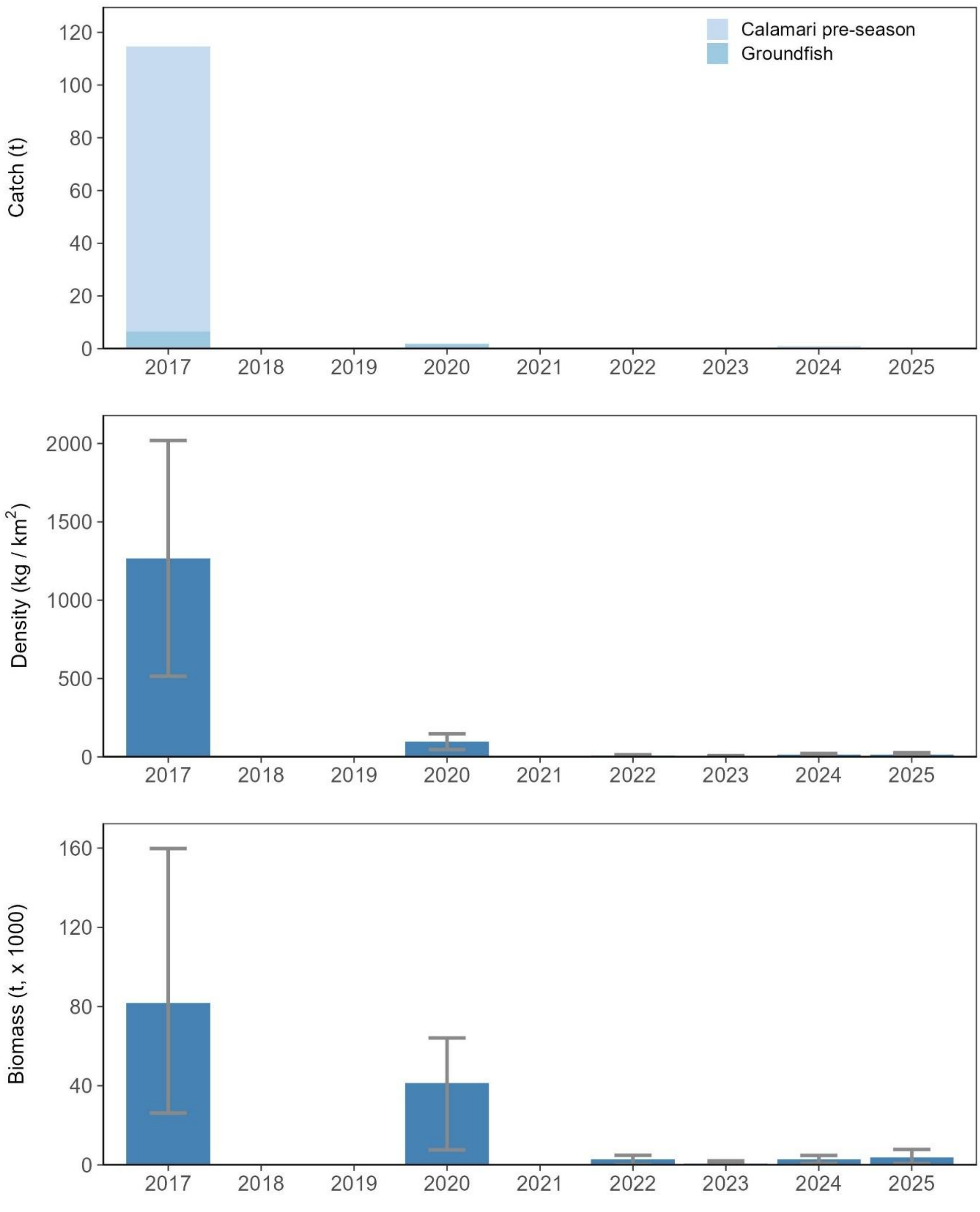

Fig. 11. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of hoki (*Macruronus magellanicus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

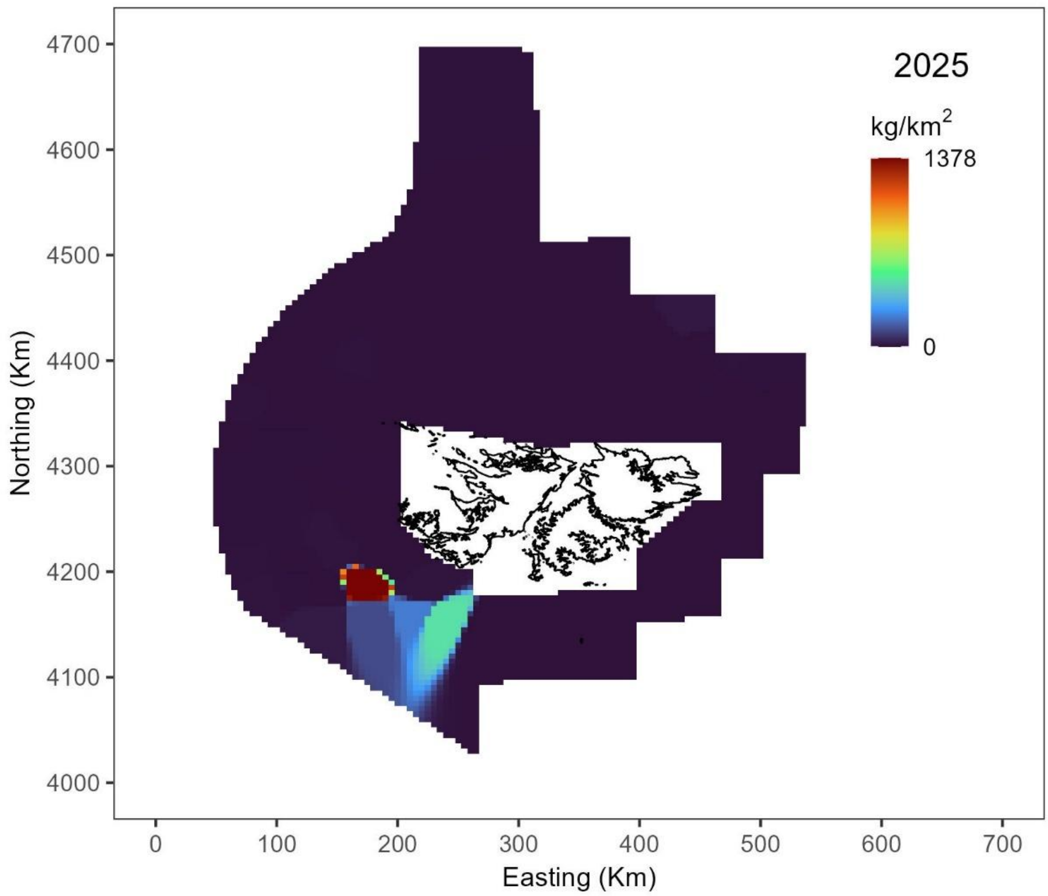

Fig. 12. Distribution and abundance of hoki (*Macruronus magellanicus*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

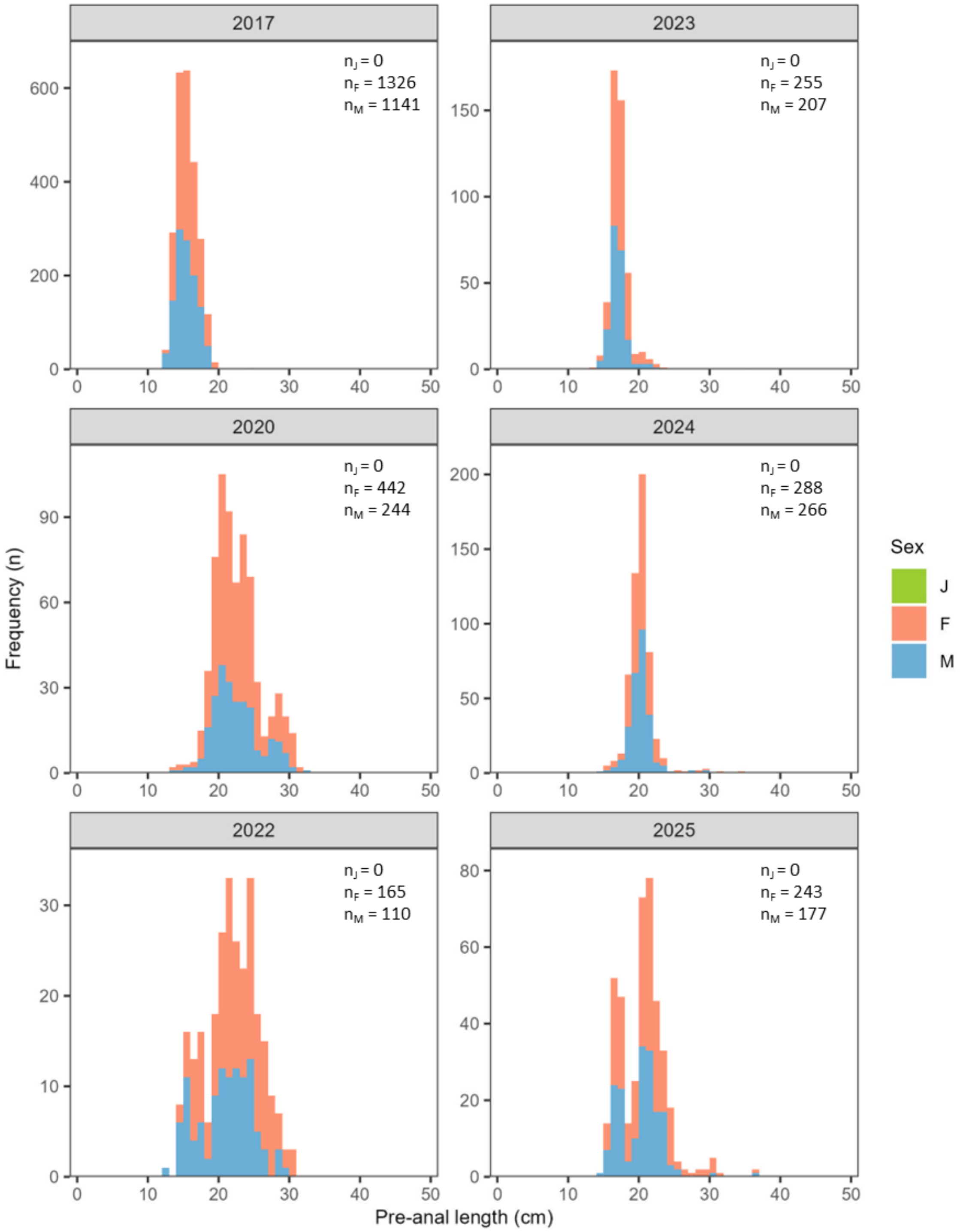

Fig. 13. Length-frequency of hoki (*Macruronus magellanicus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.5. Kingclip (*Genypterus blacodes*)

On average, 92% of the total kingclip catches in the time series were obtained from groundfish surveys and 8% from calamari pre-season surveys. The highest catch of kingclip occurred in 2025 (12.42 t), representing a threefold increase relative to the 2022–2024 mean (4.25 t; Fig. 14; Appendix II).

The highest densities were also recorded in 2025 (mean ± SE: 402.32 ± 278.85 kg/km²), representing a threefold increase relative to the 2017 densities (140.30 ± 64.04 kg/km²), a twofold increase relative to the 2024 densities (215.82 ± 142.46 kg/km²) and a threefold increase compared with the 2022–2024 mean (149.07 ± 54.32 kg/km²; Fig. 14).

Kingclip biomass in 2025 was the highest in the time series (54,688.29 t; Table II; Appendix III; although note the wide confidence intervals), whereas the lowest biomass was calculated for 2017 (18,841.14 t; Table II). Biomass in 2025 represented a threefold increase relative to the 2017 biomass, and a twofold increase compared to both the 2024 biomass (29,557.81 t) and the 2022–2024 mean (24,984.09 t; Table II; Fig. 14). These differences were not statistically significant ($p > 0.017$; Appendix V–VI). LOESS revealed an apparent upward trend in biomass in recent years; however, this trend was not statistically significant from 2017 to 2025 (Appendix VII), in part due to the wide confidence intervals observed during this period.

In 2025, the highest density (37,550 kg/km^2) of kingclip occurred to the south-west near West Falkland, at 52°S and 61°W (4,215 km northing and 182 km easting, respectively; Fig. 15). A secondary aggregation with moderate density was also detected to the north-west in the FICZ, at 50.5°S and 62°N (4,390 km northing and 130 km easting, respectively; Fig. 15). Kingclip had a minor presence to the south-east in the 'Loligo Box'. These patterns were consistent throughout the time series (Appendix XII).

Length-frequency histograms revealed a broad size range of kingclip from 26 cm to 120 cm total length across years, reflecting the presence of multiple overlapping length groups. In 2017, the main modal length was 43 cm for females and 46–47 cm for males. In subsequent years, higher frequencies of females were observed at larger sizes between 45 cm and 83 cm, and of males between approximately 50 cm and 75 cm (Fig. 16).

The biomass pattern of kingclip observed from July surveys contrasts with that of February surveys, where the biomass in February 2025 was the lowest since February 2010 (Ramos 2025), consistent with declining CPUE in the Falkland Islands finfish fishery since 2013 (García 2024). Analyses of Argentine survey and fishery data also show an overall biomass decline from 1987 to 2021, a period of stability from 2014 to 2017, and a gradual increase thereafter (Di Marco 2022). Because kingclip are caught at small sizes in the Falkland Islands and stock status remains below the limit reference point, harvesting closer to 80 cm has been recommended to improve fishing mortality and yield per recruit, facilitating stock recovery (García 2025). The frequent presence of large individuals (70–95 cm) in recent February and July surveys suggests that such animals are available in the FICZ/FOCZ. Additional work is needed to evaluate whether restricting fishing in specific grid squares or adjusting fishing gear could reduce catches of small individuals.

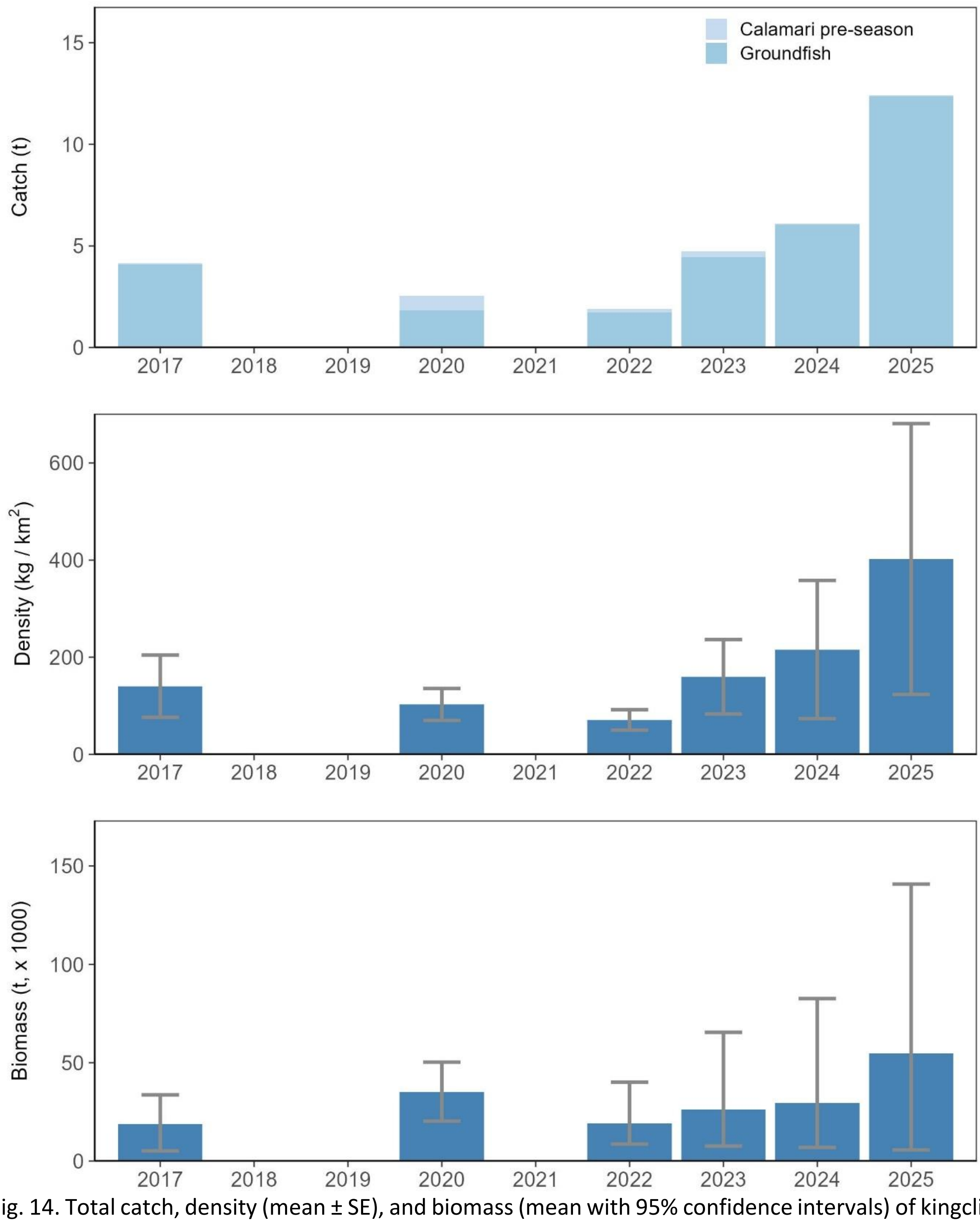

Fig. 14. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of kingclip (*Genypterus blacodes*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

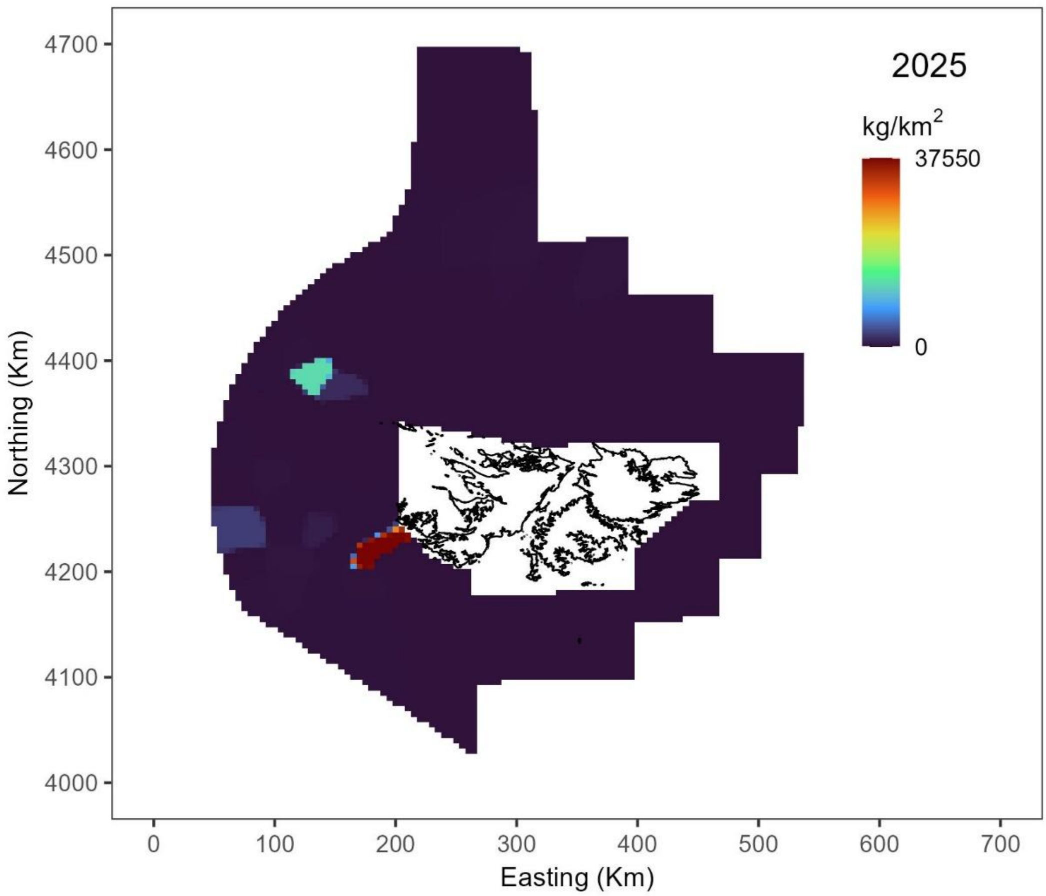

Fig. 15. Distribution and abundance of kingclip (*Genypterus blacodes*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

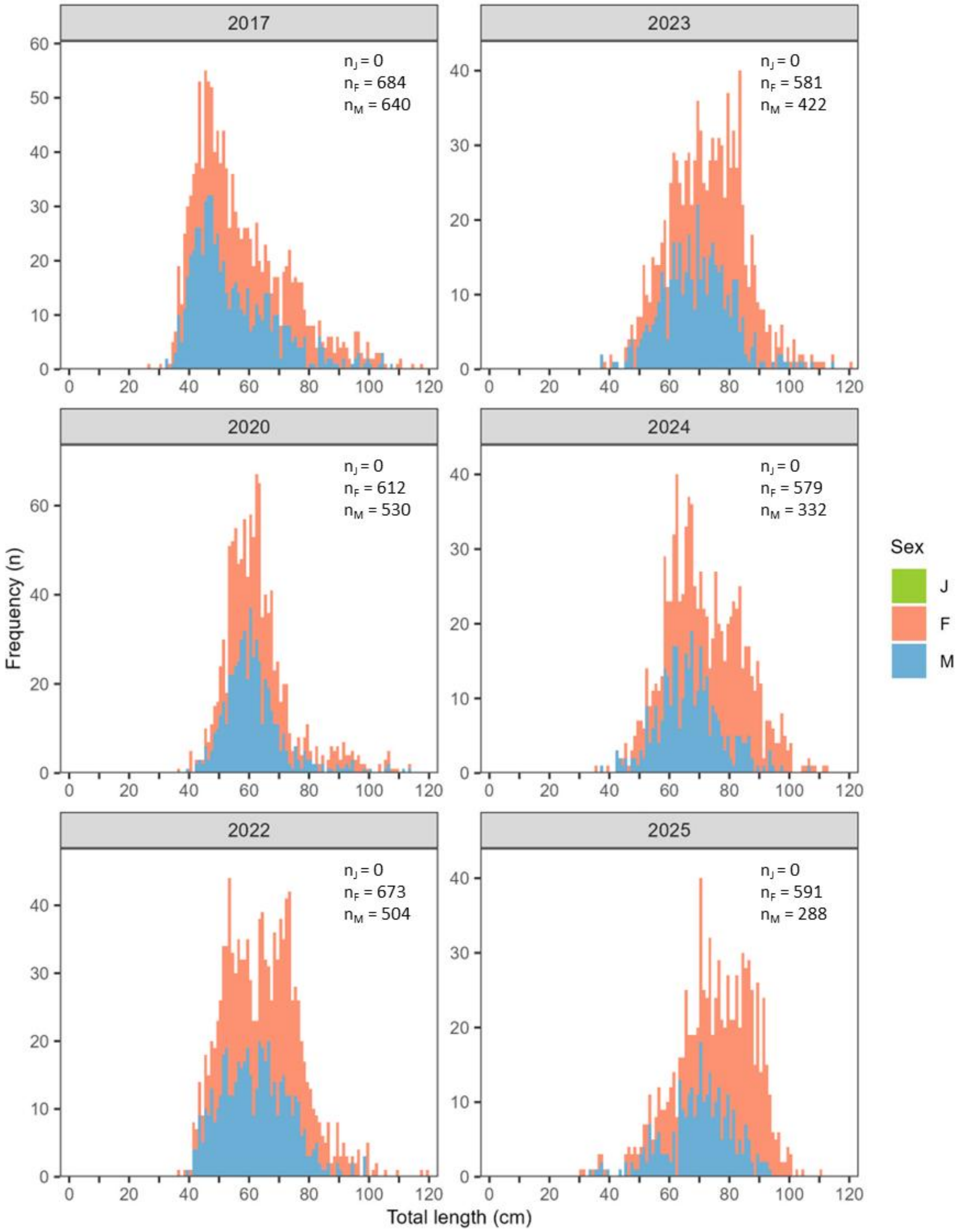

Fig. 16. Length-frequency of kingclip (*Genypterus blacodes*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.6. Patagonian squid (*Doryteuthis gahi*)

On average, 3% of the Patagonian squid catches were obtained from groundfish surveys and 97% from calamari pre-season surveys. The highest total catch occurred in 2020 (580.08 t). Catches declined after 2020 and remained at low levels in 2024 (54.81 t) and 2025 (205.81 t; Fig. 17; Appendix II); the 2022–2024 mean catch was 267.60 t.

The highest densities were recorded in 2020 (mean ± SE: 6,263.94 ± 2,075.89 kg/km²). Densities in 2025 (1,185.54 ± 145.59 kg/km²) were the second lowest in the time series, representing 40% of the 2017 densities (2,707.64 ± 557.28 kg/km²) but a twofold increase relative to the 2024 densities (493.65 ± 65.28 kg/km²). Densities in 2025 were only 70% of the 2022–2024 mean (1,819.52 ± 232.44 kg/km²; Fig. 17).

The highest biomass in the time series was estimated for 2017 (345,846.47 t), whereas the lowest biomass was calculated for 2024 (75,518.97 t; Table II). Biomass in 2025 (121,936.85 t) represented 35% of the 2017 biomass and was significantly lower ($p < 0.001$) in comparison. Biomass in 2025 represented a significant twofold increase compared to the 2024 biomass ($p = 0.001$) but was slightly below the 2022–2024 mean (137,133.95 t; $p > 0.017$; Fig. 17; Appendix V–VI). LOESS revealed a marginally not statistically significant declining trend from 2017 to 2025 (Appendix VII).

In 2025, the highest densities (7,181 kg/km²) were recorded to the south of East Falkland within the ‘Loligo Box’, at approximately 53°S and 59°W (4,135 km northing and 370 km easting, respectively; Fig. 18), although a dense aggregation was also observed to the west at 51°S and 62°W (4,315 km northing and 120 km easting, respectively). Overall densities in 2025 were relatively low compared with other years. Throughout the time series, Patagonian squid were predominantly distributed in the southern portion of the ‘Loligo Box’, where the highest density in the series was calculated for 2020 (130,731 kg/km²). In 2024, aggregations of low density were observed along the ‘Loligo Box’, with a broader distribution extending northward beyond the ‘Loligo Box’ towards the boundary of the FICZ. Notably, the second Patagonian squid fishing season was cancelled in 2024 due to the low abundance of this species within the ‘Loligo Box’ (Appendix XIII); instead, the fishing fleet operated in international waters to the north of the FOCZ.

Length-frequency histograms indicated a size range of Patagonian squid from 3 cm to 41.5 cm dorsal mantle length across years, with modal lengths of 10–14 cm. In 2017, modal length was approximately 14 cm for both females and males. Over subsequent years, a shift toward smaller sizes (<12 cm) was observed; for example, in 2025 modal length was 10 cm for both sexes. A few juveniles were reported across years (n = 11; 3.0–8.5 cm; Fig. 19).

Patagonian squid biomass pattern was mainly driven by July calamari pre-season surveys. In July 2024, densities in the 'Loligo Box' were particularly low, producing the lowest second-season biomass estimate since 2006 (Falkland Islands Government 2025). Squid distributions extended north of the 'Loligo Box' toward the FICZ boundary, prompting cancellation of the 2024 second season and displacement of the fleet into international waters north of the FOCZ (Falkland Islands Government 2025). Total catch during the 2025 second fishing season was the second lowest since 2016 (Skeljo & Winter 2025). It's likely that declines in individual size, with a decrease of modal length from ~14 cm in 2017 to 10 cm in 2025 for both sexes, contributed further to biomass reduction.

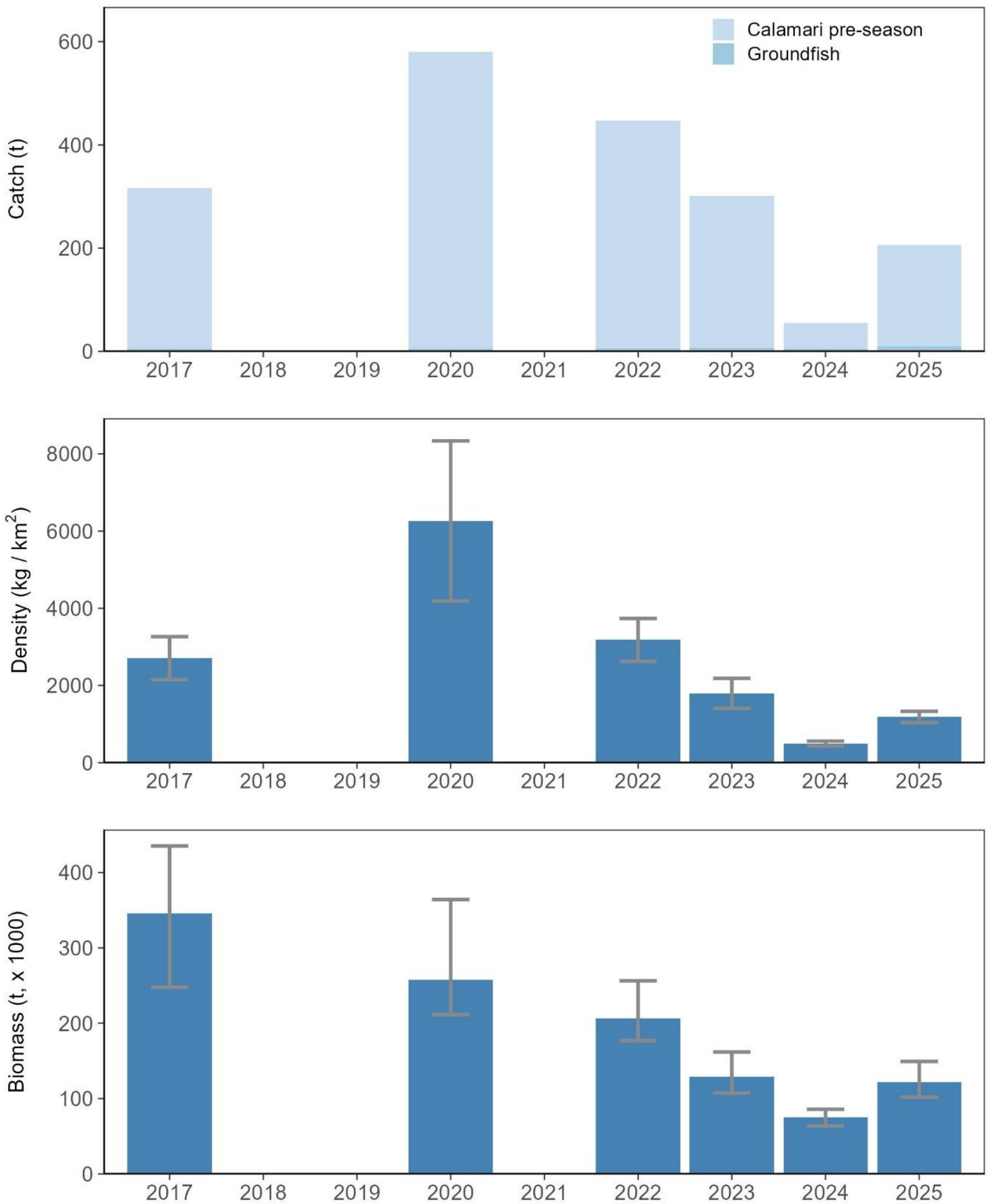

Fig. 17. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of the Patagonian squid (*Doryteuthis gahi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

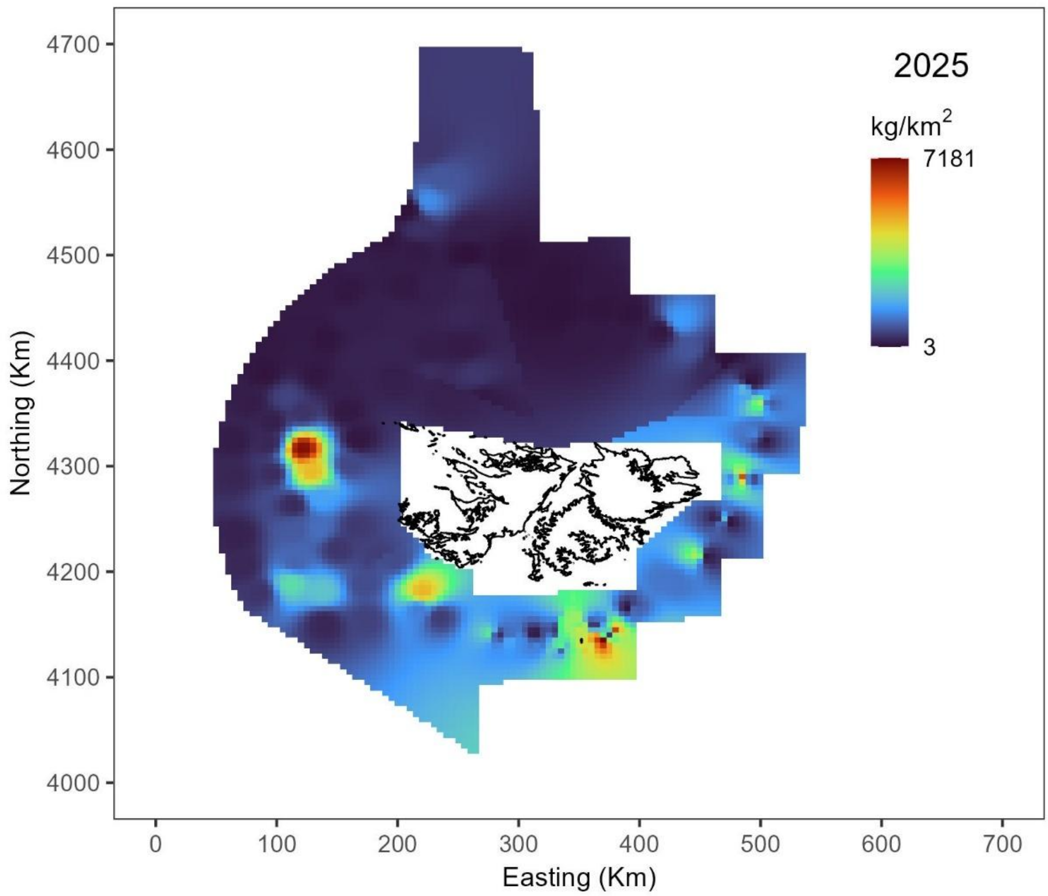

Fig. 18. Distribution and abundance of the Patagonian squid (*Doryteuthis gahi*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

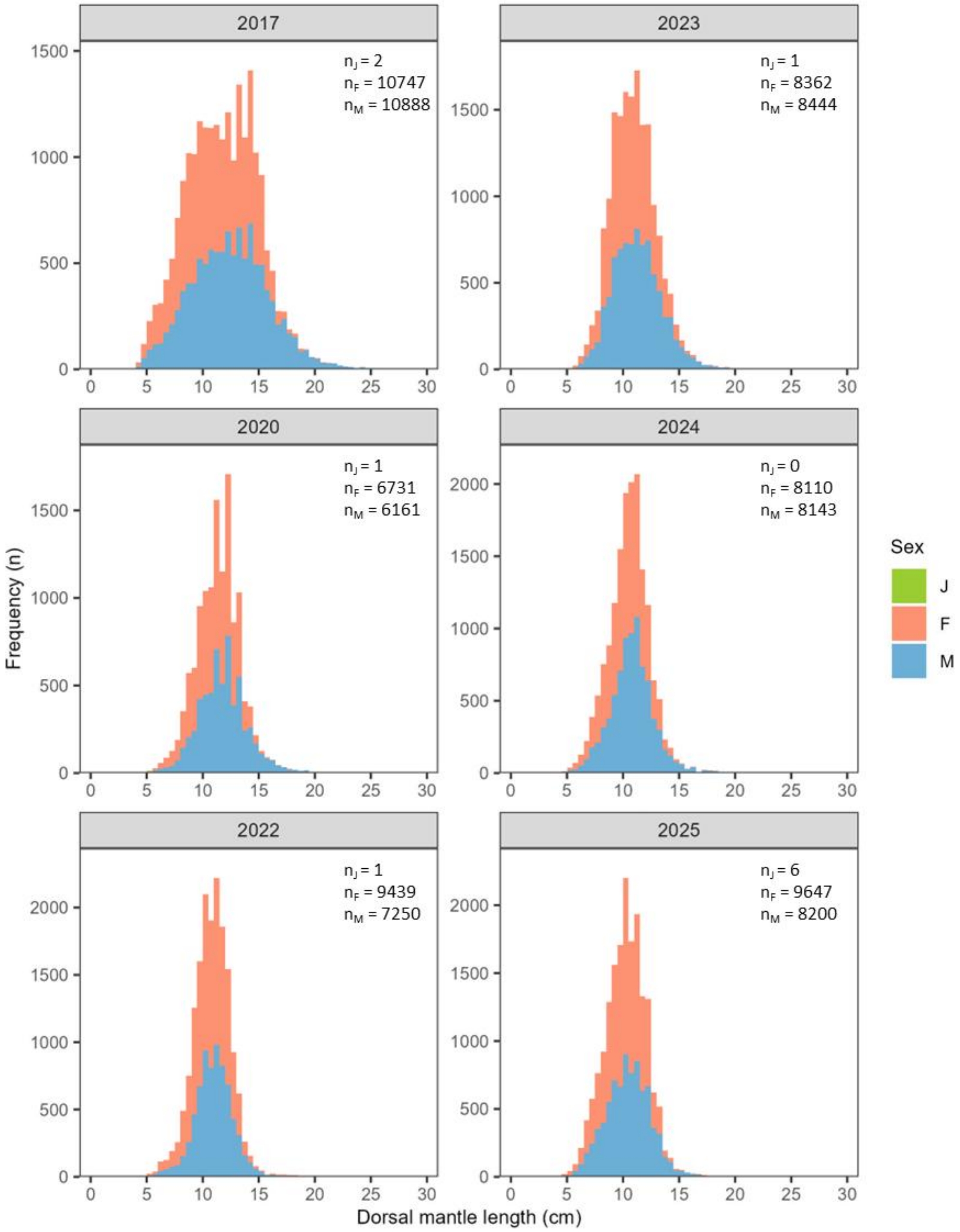

Fig. 19. Length-frequency of the Patagonian squid (*Doryteuthis gahi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.7. Patagonian toothfish (*Dissostichus eleginoides*)

On average, 33% of the total Patagonian toothfish catches in the time series were obtained from groundfish surveys and 67% from calamari pre-season surveys. The highest total catch occurred in 2025 (3.84 t; Fig. 20; Appendix II), representing a sevenfold increase relative to the 2022–2024 mean (0.53 t).

The highest densities were recorded in 2025 (mean ± SE: 52.42 ± 7.14 kg/km²), representing a sixfold increase relative to the 2017 densities (8.70 ± 1.29 kg/km²), a fourfold increase relative to the 2024 densities (11.92 ± 2.21 kg/km²), and an eightfold increase compared with the 2022–2024 mean (6.71 ± 0.88 kg/km²; Fig. 20).

The highest biomass of Patagonian toothfish in the time series was calculated for 2025 (9,929.53 t; Table II; Appendix III), representing a significant sevenfold increase relative to the 2017 biomass (1,365.32 t; $p < 0.001$), a significant fivefold increase relative to the 2024 biomass (2,117.40 t; $p < 0.001$), and a significant eightfold increase compared with the 2022–2024 mean (1,319.44 t; $p < 0.001$; Fig. 20; Appendix V–VI). However, LOESS revealed that there was no statistically significant trend in biomass from 2017 to 2025 (Appendix VII). It should be noted that the widest confidence intervals were calculated for 2020, when the groundfish survey was modified for a demographic study of common hake and included only 33 stations in the survey area, rather than the 84 stations typically planned for standard groundfish surveys.

In 2025, high densities of Patagonian toothfish were recorded in the south-west FICZ, with the highest concentrations (435 kg/km²) to the south of West Falkland at approximately 52.5°S and 61°W (4,155 km northing and 235 km easting, respectively; Fig. 21). Across years, relatively higher densities were predominant to the west and occasionally to the east below 52°S. The highest density in the time series (982 kg/km²) was reported in 2020 south of West Falkland at the southern limit of the FICZ (Appendix XIV).

Length-frequency histograms revealed a broad size range of Patagonian toothfish from 12.5 cm to 100 cm total length across years, reflecting multiple overlapping length groups with modal lengths between 22 cm and 28 cm. In 2017, the main modal length was 22 cm for both sexes, with secondary groups at 40 cm and 47 cm for females, and at 38 cm and 46 cm for males. In 2020, modal length increased, with dominant groups at 47 cm for females and

48 cm for males. Only a few individuals were collected in 2022, with the apparent modal length at 40 cm for both sexes. In 2023, smaller individuals with modal lengths of 23 cm were predominant for both sexes, suggesting recruitment; a secondary group at 37–38 cm was observed for both sexes. This secondary group became dominant in 2024 and increased in size in 2025 to modal lengths of 46 cm for females and 45 cm for males. A relatively high number of juveniles (n = 239) were detected in 2017, whereas no more than one juvenile was reported in each subsequent year (Fig. 22), suggesting low recruitment in recent years.

The relatively higher biomass of Patagonian toothfish in July 2025 may be in part caused by the growth of recruits detected in 2022–2023, coupled with reduced fishing pressure as a result of the all year-round closure of fishing grid squares to the south-west in the FICZ (south of 52.5°S and west of 60.5°W) since December 2023 (FIFD, *unpublished internal document*). Because the groundfish and the calamari pre-season surveys do not effectively sample adult toothfish, which are primarily caught with longlines, these results are not representative of the adult stock.

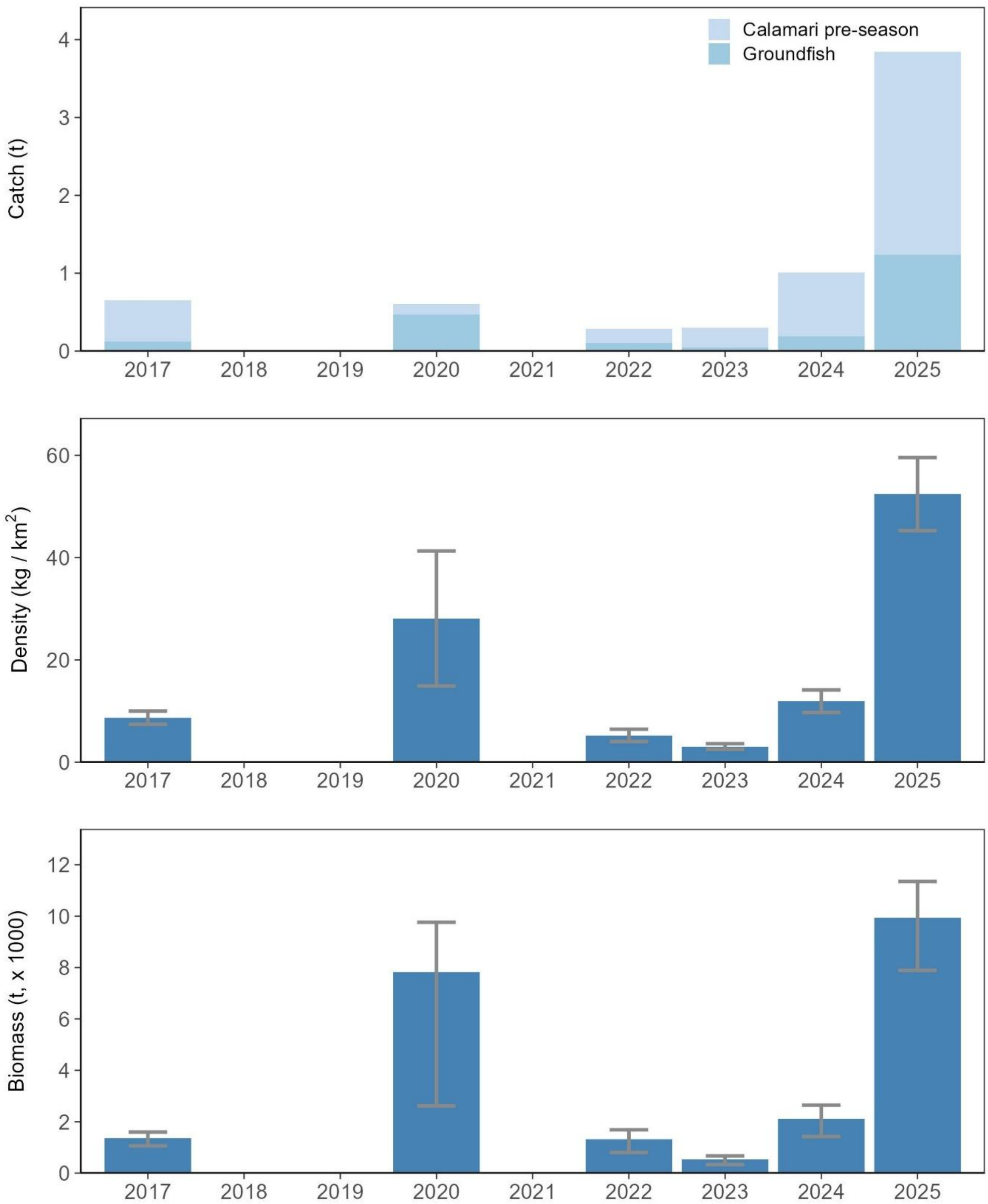

Fig. 20. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of Patagonian toothfish (*Dissostichus eleginoides*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

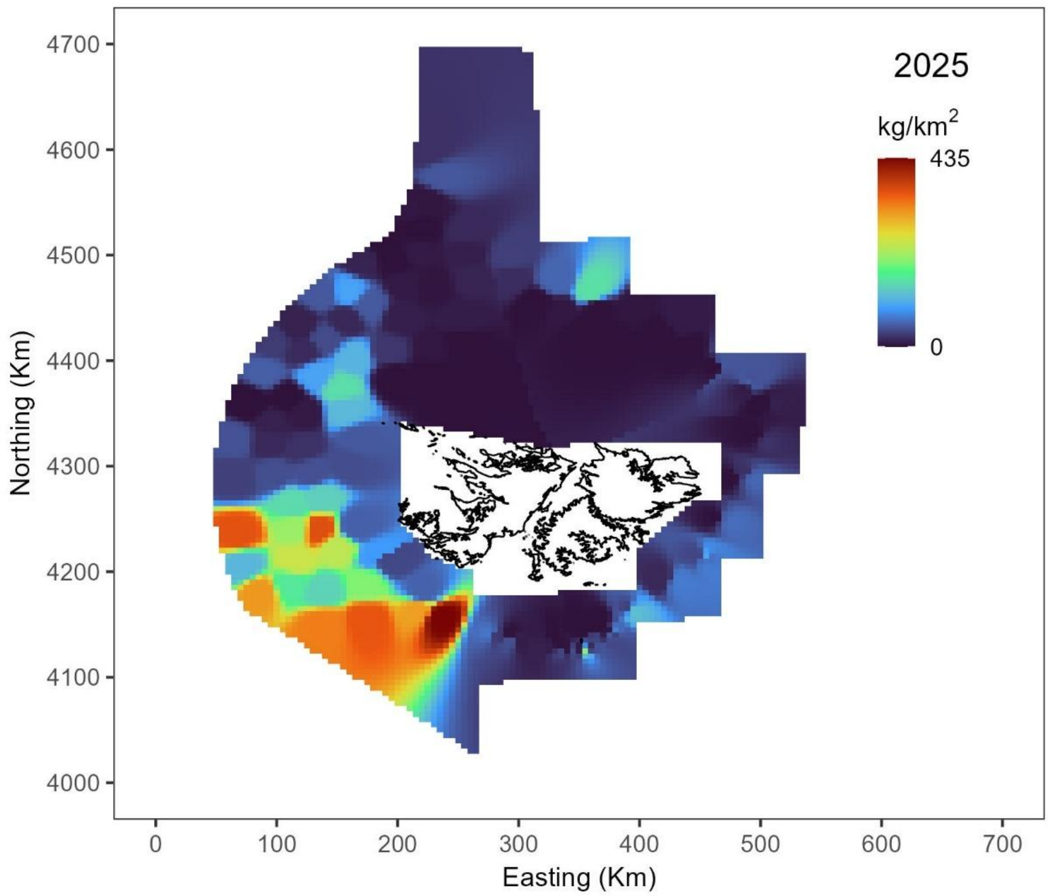

Fig. 21. Distribution and abundance of Patagonian toothfish (*Dissostichus eleginoides*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

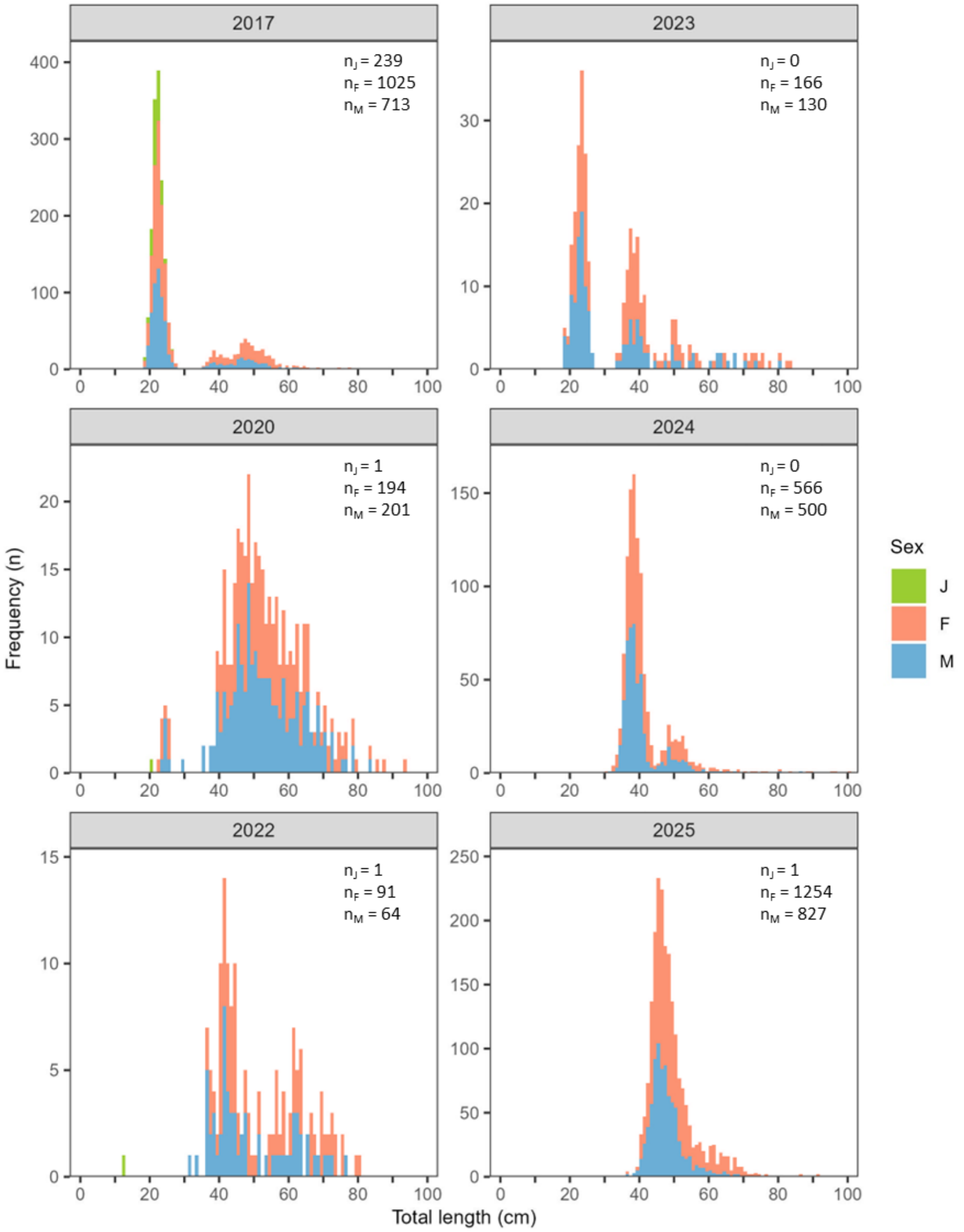

Fig. 22. Length-frequency of Patagonian toothfish (*Dissostichus eleginoides*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.8. Red cod (*Salilota australis*)

On average, 66% of the total red cod catches in the time series were obtained from groundfish surveys and 34% from calamari pre-season surveys. The highest total catch occurred in 2023 (8.91 t), and the second highest catch was reported in 2025 (6.90 t; Fig. 23; Appendix II), slightly above the 2022–2024 mean (6.28 t).

The highest densities were recorded in 2023 (mean ± SE: 326.30 ± 248.44 kg/km²). Densities in 2025 (112.63 ± 32.02 kg/km²) represented a nearly twofold increase compared with the 2017 densities (69.21 ± 20.62 kg/km²) but a slight decrease relative to the 2024 densities (119.76 ± 39.30 kg/km²), and were 60% of the 2022–2024 mean (182.69 ± 87.58 kg/km²; Fig. 23).

Red cod biomass was the highest in 2020 (38,808.34 t; Table II; although note the wide confidence intervals). Biomass of red cod in 2025 (21,251.83 t) represented nearly a twofold increase relative to the 2017 biomass (12,384.49 t), but it was 82% of the 2024 biomass (26,062.19 t) and 71% of the 2020–2024 mean (30,013.74 t). These differences were not statistically significant ($p > 0.017$; Fig. 23; Appendix V–VI). Considerable inter-annual variability and wide confidence intervals resulted in a no statistically significant trend in biomass from 2017 to 2025 as revealed by LOESS (Appendix VII). Wide confidence intervals were calculated for 2020, when the groundfish survey was modified for a demographic study of common hake and included only 33 stations in the survey area, rather than the 84 stations typically planned for standard groundfish surveys.

The 2025 biomass represented a decline for the second consecutive year. This is consistent with the downward trend in biomass observed in February surveys (2010–2025; Ramos 2025) and the declining CPUE from finfish-licensed vessels in the FICZ (Ramos & Winter 2022d). This stock has exhibited significant fluctuations in CPUE within the commercial fishery, with notable peaks in 1996 and 2011, and a decline since 2013 (Ramos & Winter 2022d; Falkland Islands Government *unpublished data*). A survey conducted in late September 2022 reported low biomass of spawning red cod in the spawning grounds to the south and south-west of West Falkland, concluding that this stock has decreased within the Falkland Islands fishing area (Arkhipkin et al. 2022). In Argentina, red cod biomass declined from 1980 to 2015 but increased slowly thereafter. However, the biomass in 2023 was only

58% of the 1980 level (Troccoli et al. 2024). The red cod spawning grounds to the south and south-west of West Falkland have been closed to fishing since 2010 (Ramos & Winter 2022d) and should remain closed as a conservation measure.

In 2025, the highest densities (2,485 kg/km^2) occurred below 51.5°S, mainly near the south-west limit of the FICZ at approximately 52.3°S and 62.7°W (4,190 km northing and 110 km easting, respectively; Fig. 24). Discrete patches of relatively high densities were also observed to the south-east in the 'Loligo Box' and at the north-west limit of the FICZ (Fig. 24). Through the time series, red cod occurred mainly along the west in the FICZ, with sporadic aggregations to the north between 49°S and 50°S. The highest density in the time series (30,883 kg/km^2) was calculated for 2023 in a distinct area to the north-west limit of the FICZ (Appendix XV).

Length–frequency histograms revealed a broad size distribution of red cod, ranging from 8 cm to 86 cm total length across years, indicative of multiple overlapping length groups. Between 2017 and 2022, the dominant modal length was 21–22 cm in both sexes. In 2023, a larger group (40–41 cm) became predominant, accompanied by a secondary mode at 21–22 cm. By 2024, the smaller group shifted to 28–29 cm. In 2025, the dominant mode was 12 cm, with additional modes at 21–22 cm, 37 cm, and larger sizes. Juveniles were scarce from 2017 to 2024 (<5 individuals each survey), but their abundance increased in 2025 (n = 218; Fig. 25).

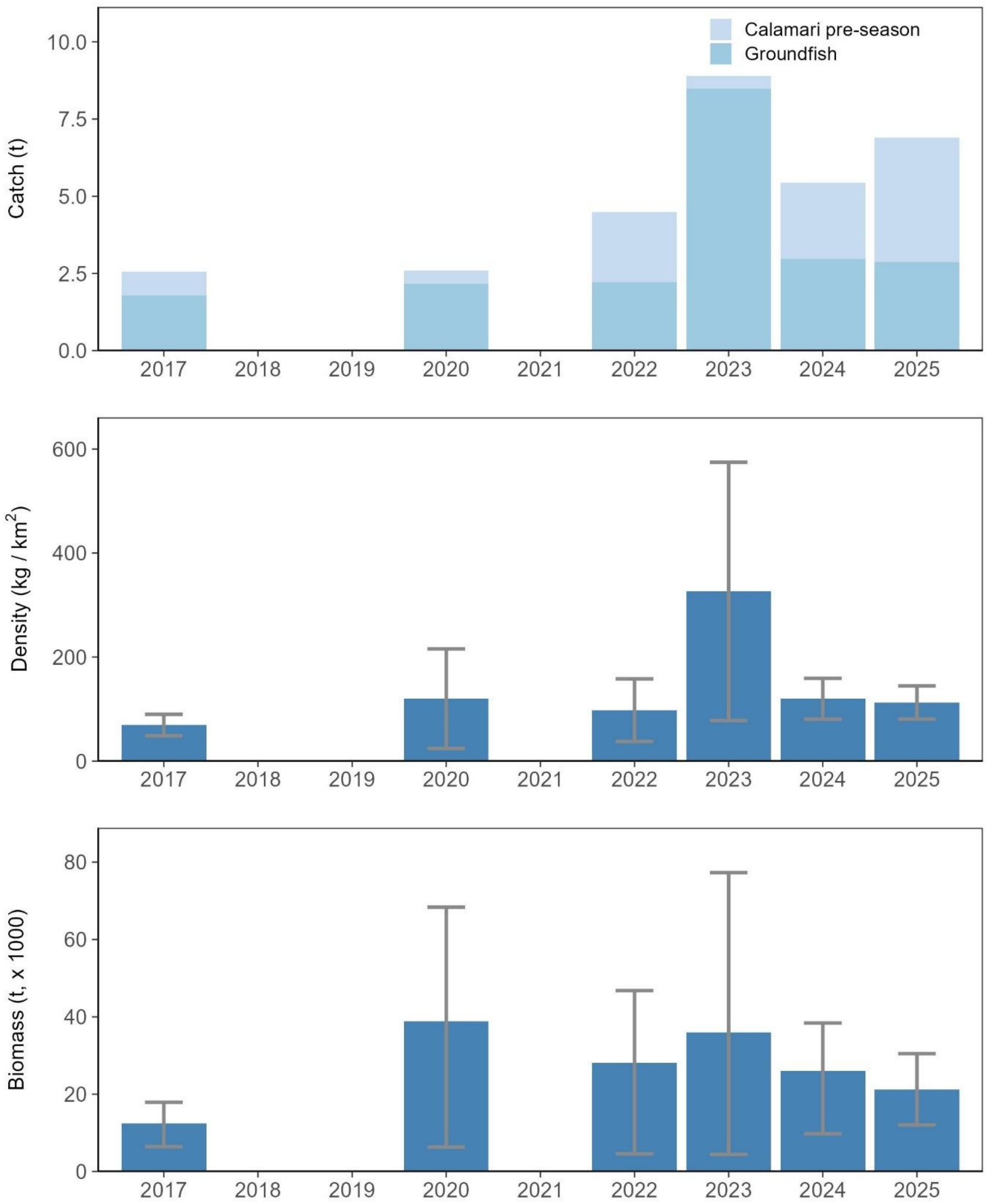

Fig. 23. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of red cod (*Salilota australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

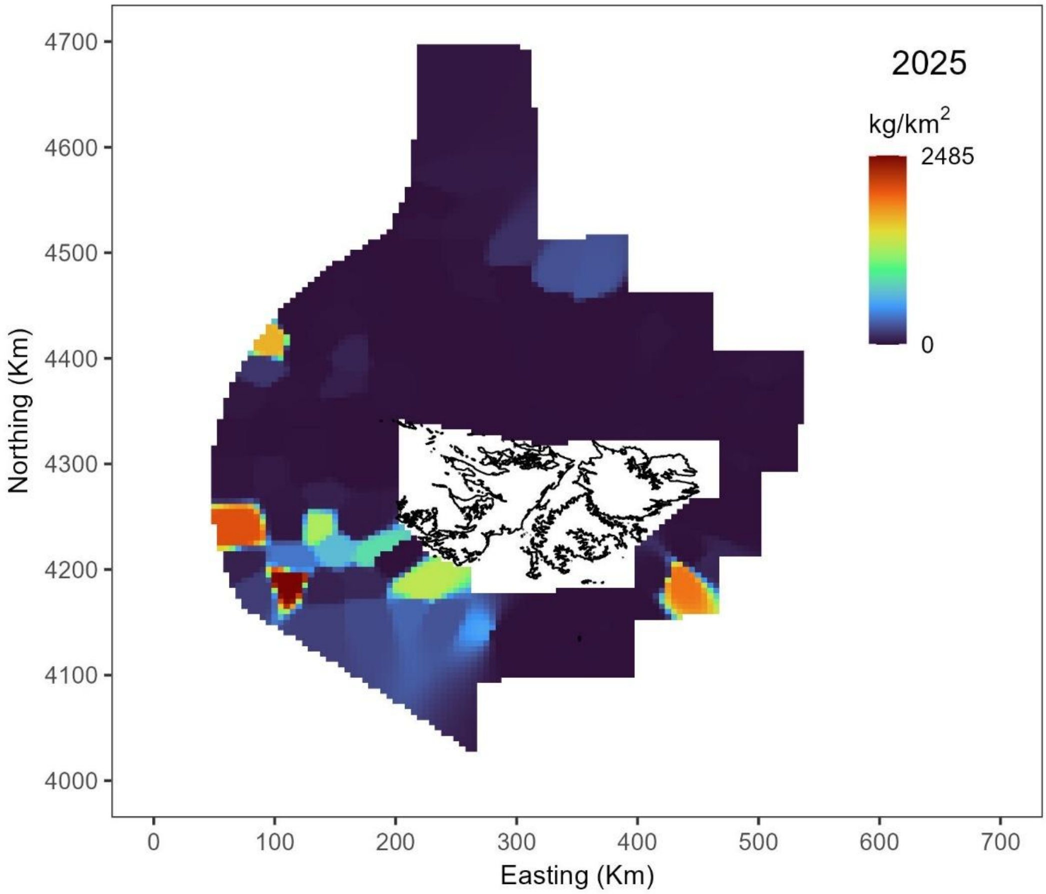

Fig. 24. Distribution and abundance of red cod (*Salilota australis*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

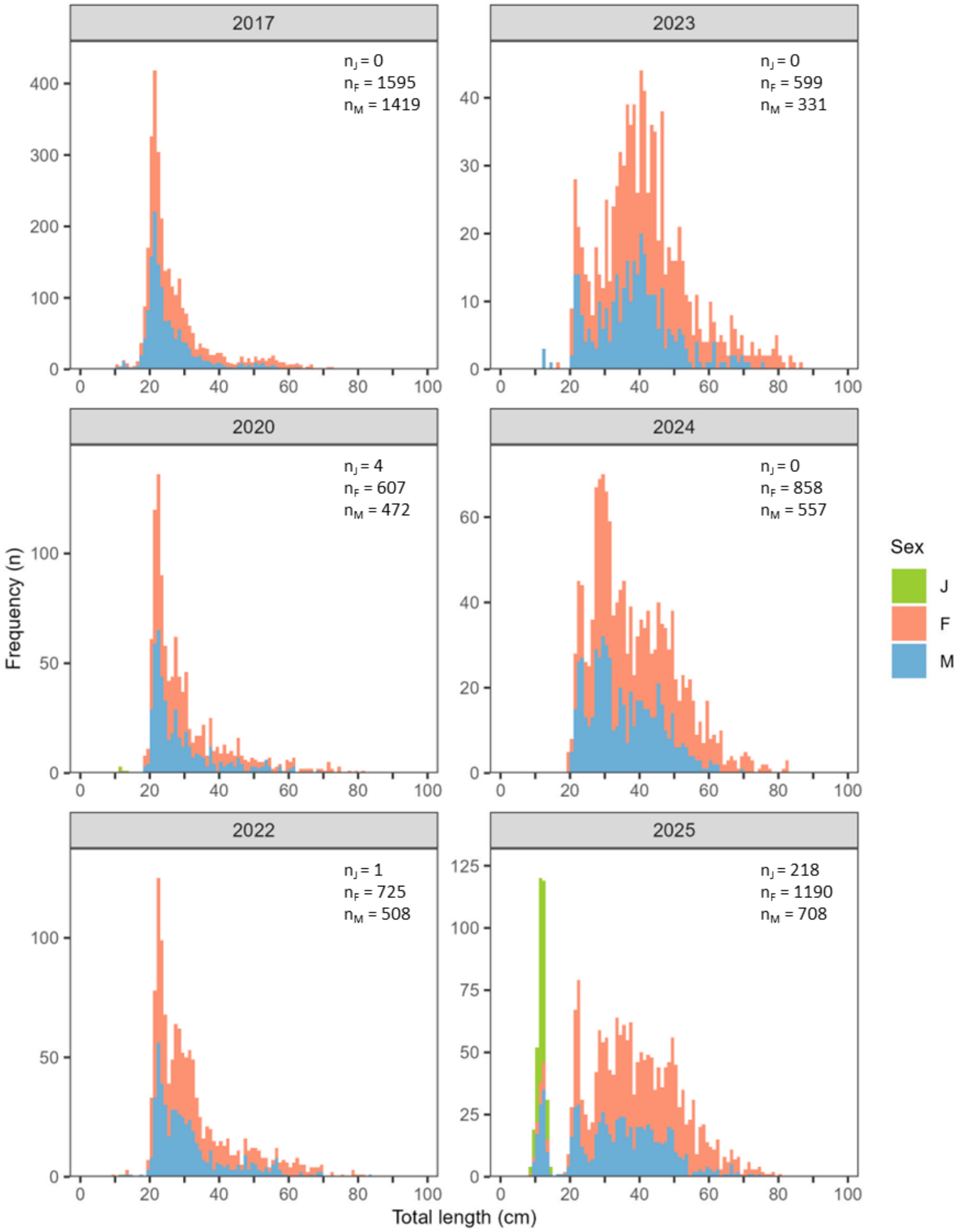

Fig. 25. Length-frequency of red cod (*Salilota australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.9. Rock cod (*Patagonotothen ramsayi*)

On average, 35% of the total rock cod catches in the time series were obtained from groundfish surveys and 65% from calamari pre-season surveys. The highest total catch occurred in 2017 (32.91 t), and the second highest catch was reported in 2025 (31.80 t), representing a nearly twofold increase relative to the 2022–2024 mean (18.87 t; Fig. 26; Appendix II).

The highest densities were recorded in 2025 (mean ± SE: 679.66 ± 297.51 kg/km²), representing approximately a twofold increase relative to the 2017 densities (321.22 ± 58.94 kg/km²), the 2024 densities (447.22 ± 185.51 kg/km²), and the 2022–2024 mean (340.90 ± 84.67 kg/km²; Fig. 26).

Biomass in 2025 (86,123.02 t; Table II; Appendix III) was nearly twofold greater than the 2017 biomass (51,728.07 t), the 2024 biomass (48,722.67 t), and the 2022–2024 mean (44,110.13 t). However, these differences were not significant ($p > 0.017$; Fig. 26; Appendix V–VI). LOESS revealed that there was no statistically significant trend in biomass from 2017 to 2025 (Appendix VII).

In 2025, the highest density of rock cod (41,296 kg/km²; the highest density in the time series) occurred to the north-west limit of the FICZ, at approximately 50°S and 62°W (4,465 km northing and 160 km easting, respectively; Fig. 27). A similar pattern was observed in 2023 and in 2024, although with lower densities. In 2017, rock cod was mainly present to the south-east in the 'Loligo Box'. In 2020, densities were considerably low and scattered mainly to the north-west in the FICZ. In 2022, discrete aggregations were observed along the west in the FICZ (Appendix XVI).

Length–frequency histograms revealed a size range of rock cod from 4 cm to 39 cm total length across years, indicating the presence of at least three distinct length groups. The smallest length group exhibited a modal length of 7–9 cm, the predominant length group 14–16 cm, and the third length group 20–23 cm. Juveniles were recorded in all surveys (≤113 individuals per survey; 4–10 cm; Fig. 28). The apparent abundance of juveniles should be interpreted with caution.

In comparison, rock cod biomass exhibited an overall decline in February parallel demersal surveys from February 2010 to February 2025 (Ramos 2025), aligning with the declining biomass trend from 2005 to 2019 observed in commercial fisheries data (Winter 2020), and with the declining CPUE trend since 2011, which has stabilized at low levels since 2020 (Ramos & Winter 2023a). An apparent shift in geographic distribution, inferred from increasing out-of-zone catches, may have contributed to the reduced abundance of this stock in Falkland Islands waters between 2016 and 2018 (Table A1 in Winter 2021). The proportion of rock cod discarded in Falkland Islands fisheries increased from an average of 13% annually during 2010–2015 to 72% during 2016–2024, with up to 94% discards reported in 2021 (Falkland Islands Government *unpublished data*). Rock cod are typically discarded due to their small size, and most of these individuals have not yet reproduced. As survival rates of discarded fish are low, the future growth and biomass of these individuals are effectively lost. Furthermore, discarding may introduce uncertainty in stock assessments, as discarded catch is often inaccurately recorded (Guillen et al. 2018). Currently, rock cod remains a permitted catch under finfish vessel licenses (A, G, and W licenses). Aside from a total allowable catch (TAC), no other conservation measures are in place within Falkland Islands fisheries (Falkland Islands Government 2025), including the Patagonian squid fishery, which has accounted for the majority of rock cod catches and discards in Falkland Islands waters since 2016 (Ramos & Winter 2023a). The absence of conservation measures to address the incidental catch and discard of juvenile individuals may negatively impact the sustainability of the stock and recruitment to the fishery (Gilman et al. 2020).

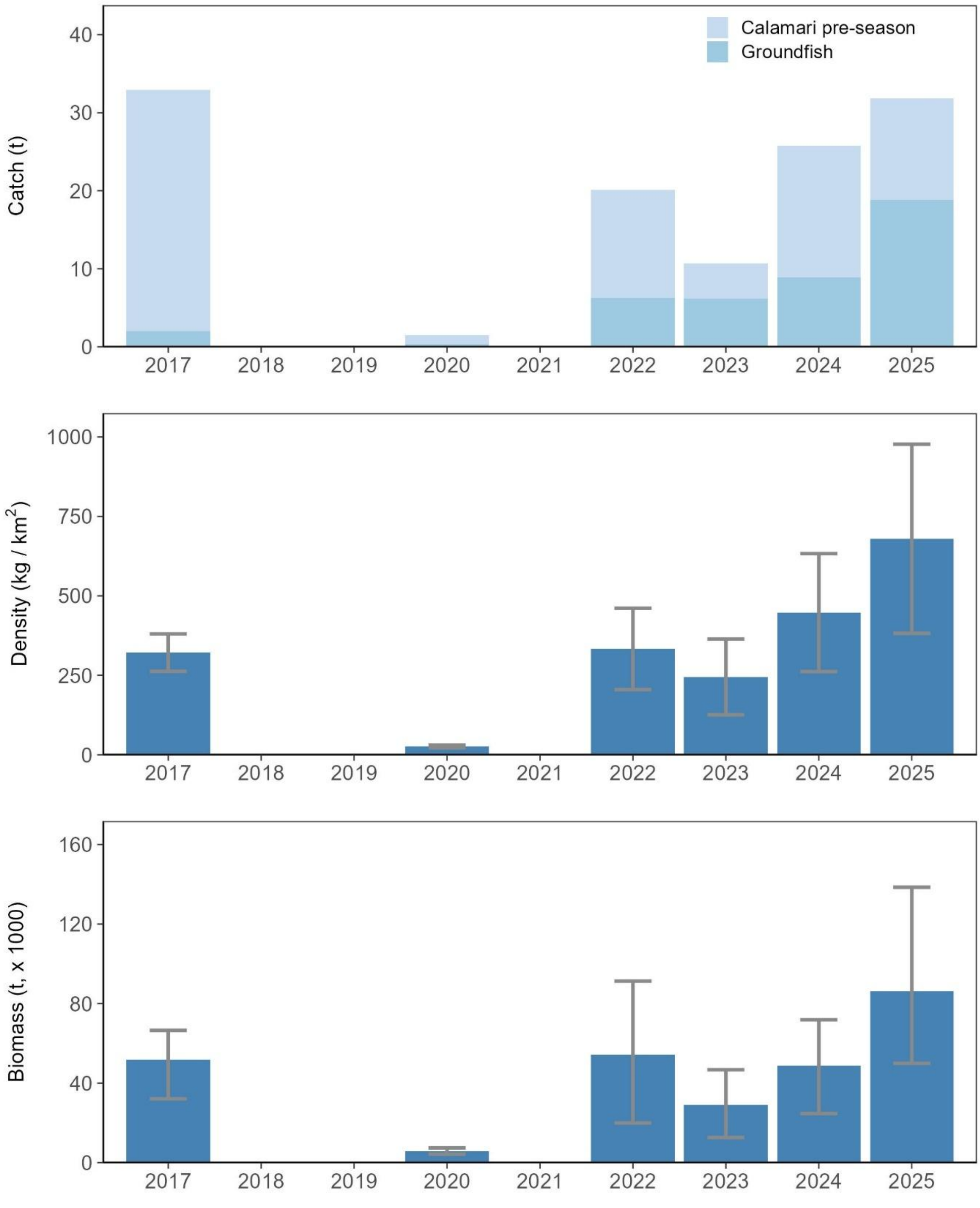

Fig. 26. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of rock cod (*Patagonotothen ramsayi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

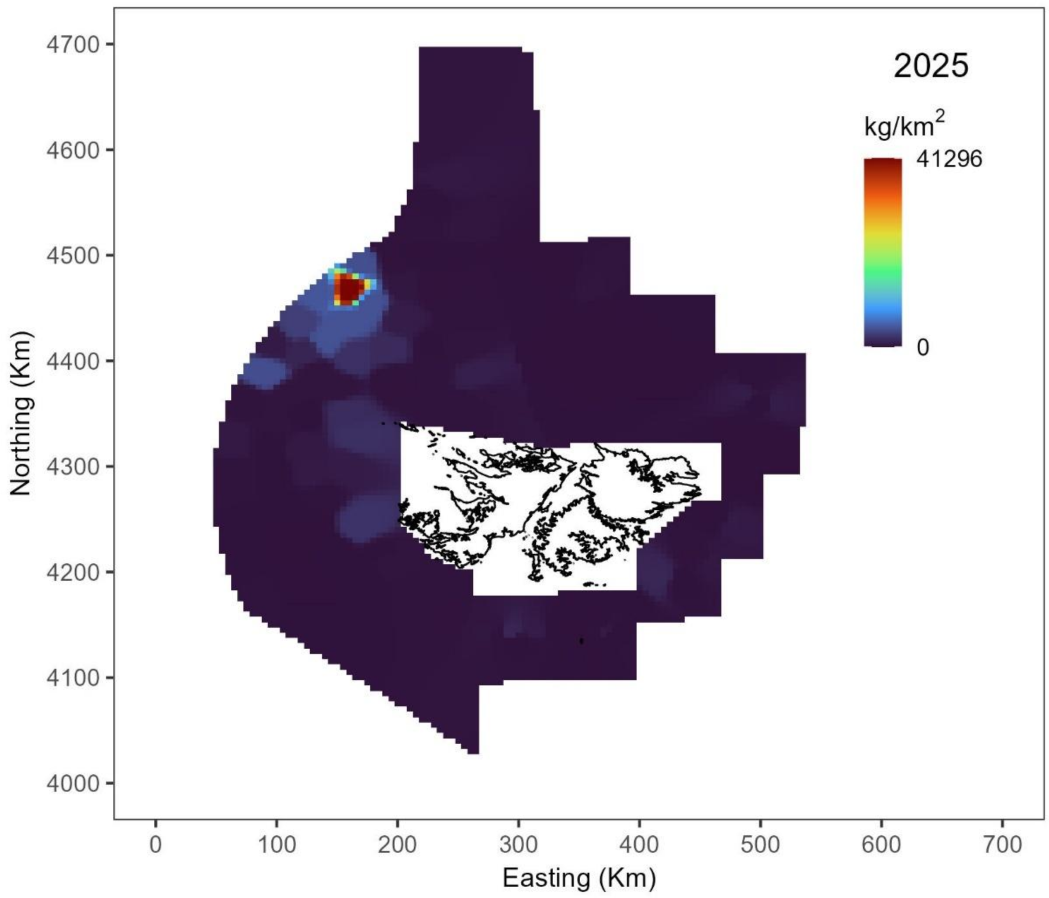

Fig. 27. Distribution and abundance of rock cod (*Patagonotothen ramsayi*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

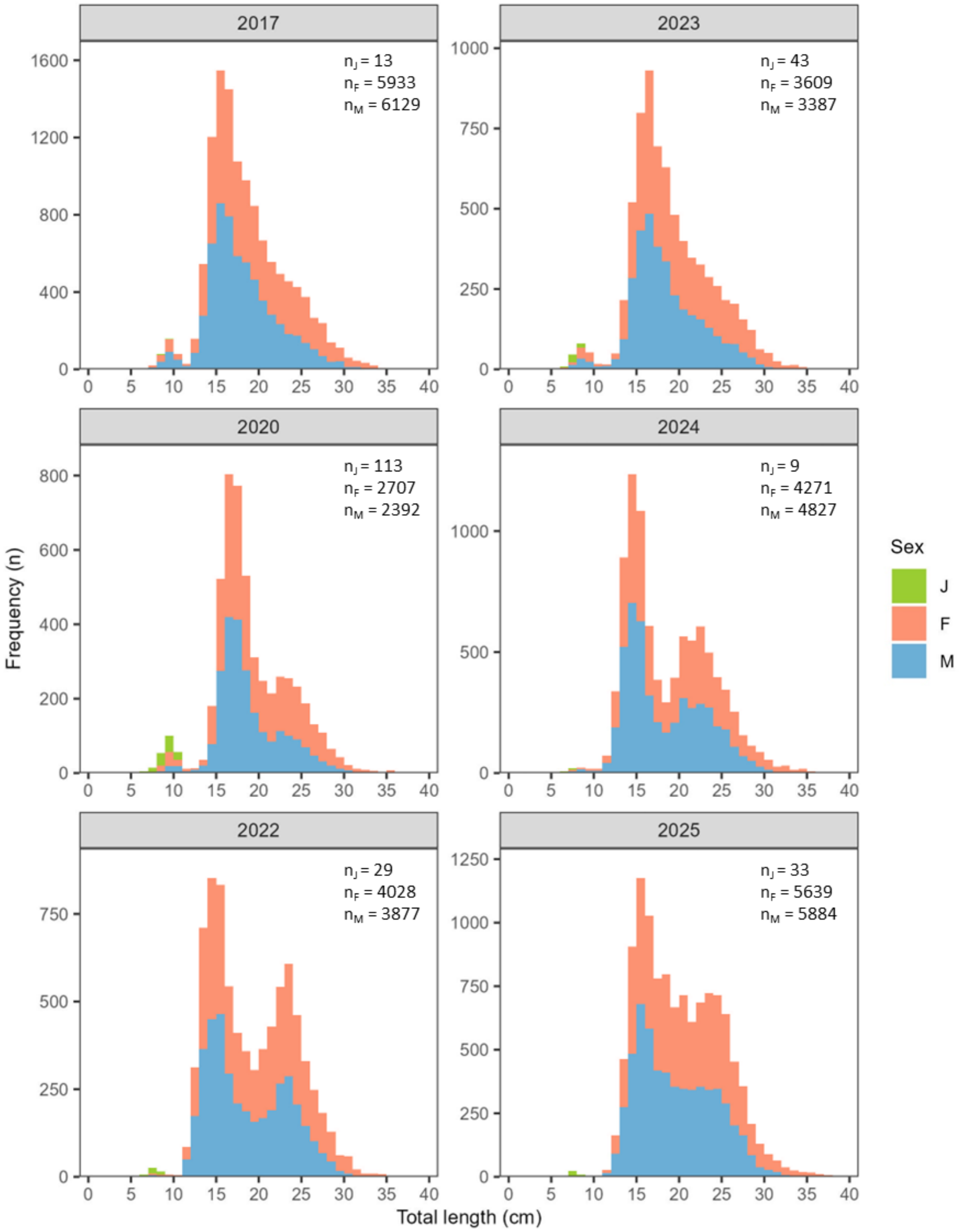

Fig. 28. Length-frequency of rock cod (*Patagonotothen ramsayi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.10. Southern blue whiting (*Micromesistius australis*)

On average, 34% of the total southern blue whiting catches in the time series were obtained from groundfish surveys and 66% from calamari pre-season surveys. The highest total catch occurred in 2023 (1.85 t), driven by a large aggregation caught in a single trawl during the calamari pre-season survey. The 2025 catch (0.04 t) was the lowest in the time series, representing 6% of the 2022–2024 mean (0.80 t; Fig. 29; Appendix II).

The highest densities were recorded in 2020 (mean ± SE: 35.62 ± 20.88 kg/km²). Densities in 2025 (1.11 ± 0.52 kg/km²) were the lowest in the time series, representing 10% of the 2017 densities (9.59 ± 5.14 kg/km²), 60% of the 2024 densities (2.01 ± 0.74 kg/km²), and 20% of the 2022–2024 mean (5.15 ± 2.19 kg/km²; Fig. 29).

Southern blue whiting biomass increased steeply from 2017 (1,585.17 t) to 2020 (8,895.08 t; although note the wide confidence intervals), followed by a marked overall decline that reached the lowest level in 2025 (307.87 t; Table II; Appendix III). Biomass in 2025 represented 19% of the 2017 biomass and was slightly lower than the 2024 biomass (330.88 t); however, these differences were not significant ($p > 0.017$). In contrast, biomass in 2025 was significantly lower ($p = 0.013$) compared to the 2022–2024 mean (726.86 t; Fig. 29; Appendix V–VI). LOESS revealed a no significant trend in biomass between 2017 and 2025 (Appendix VII). It should be noted that the widest confidence intervals were calculated for 2020, when the groundfish survey was modified for a demographic study of common hake and included only 33 stations in the survey area, rather than the 84 stations typically planned for standard groundfish surveys.

In 2025, southern blue whiting occurred to the south-west and to the north-east in the FICZ. The highest density (68 kg/km^2) occurred to the south-west of West Falkland at approximately 53°S and 61°W (4,155 km northing and 235 km easting, respectively; Fig. 30), around the area identified as spawning ground during September and October. The area of higher density was not consistent across years, and alternated between the south-west, the south-east, and the north-east. The highest density in the time series was calculated for 2020 at the southern limit of the FICZ off West Falkland (1,288 kg/km^2; Appendix XVII).

Length–frequency histograms revealed a broad size range of southern blue whiting from 9 cm to 63 cm total length across years, reflecting multiple overlapping length groups. A small length group with a modal length of 16–17 cm was predominant in most years for both sexes, except in 2024. In 2020, a secondary length group was observed at 39–41 cm. In 2024, the predominant length group shifted to 27 cm, with secondary modes at 16 cm and 50–53 cm. In 2025, the predominant length group again comprised small individuals (17 cm), accompanied by smaller numbers of larger individuals (27 cm and 49–51 cm; Fig. 31).

The abundance of the southern blue whiting stock has remained low for many years following heavy exploitation in the Southwest Atlantic beginning in the early 1990s and a collapse in 2009 (Navarro et al. 2014; Falkland Islands Government 2025). A no-fishing area was established south-west of the Falkland Islands from 1 July to 15 October in 2007 for S-licensed vessels targeting southern blue whiting and hoki (Falkland Islands Government 2025). The absence of S-licence fishing since 2017 may have provided some protection; however, the species is exploited across multiple EEZs, and the Falkland Islands contributed only 4% of the catch shared with Argentina and 2.5% of the total catch shared among Argentina, Chile, and the Falklands from 2017 to 2024 (Ramos & Winter 2023b; Falkland Islands Government 2025; Government of Argentina[1]). Thus, low biomass likely reflects high fishing pressure outside Falklands waters. Continued protection of the spawning ground south of the Falkland Islands (Shubnikov et al. 1969; Pájaro & Macchi 2001; Macchi et al. 2005) remains essential, particularly given its variability in size and location with the intensity of the Falkland Current (Arkhipkin et al. 2009, 2012).

[1] https://www.magyp.gob.ar/sitio/areas/pesca_maritima/desembarques/

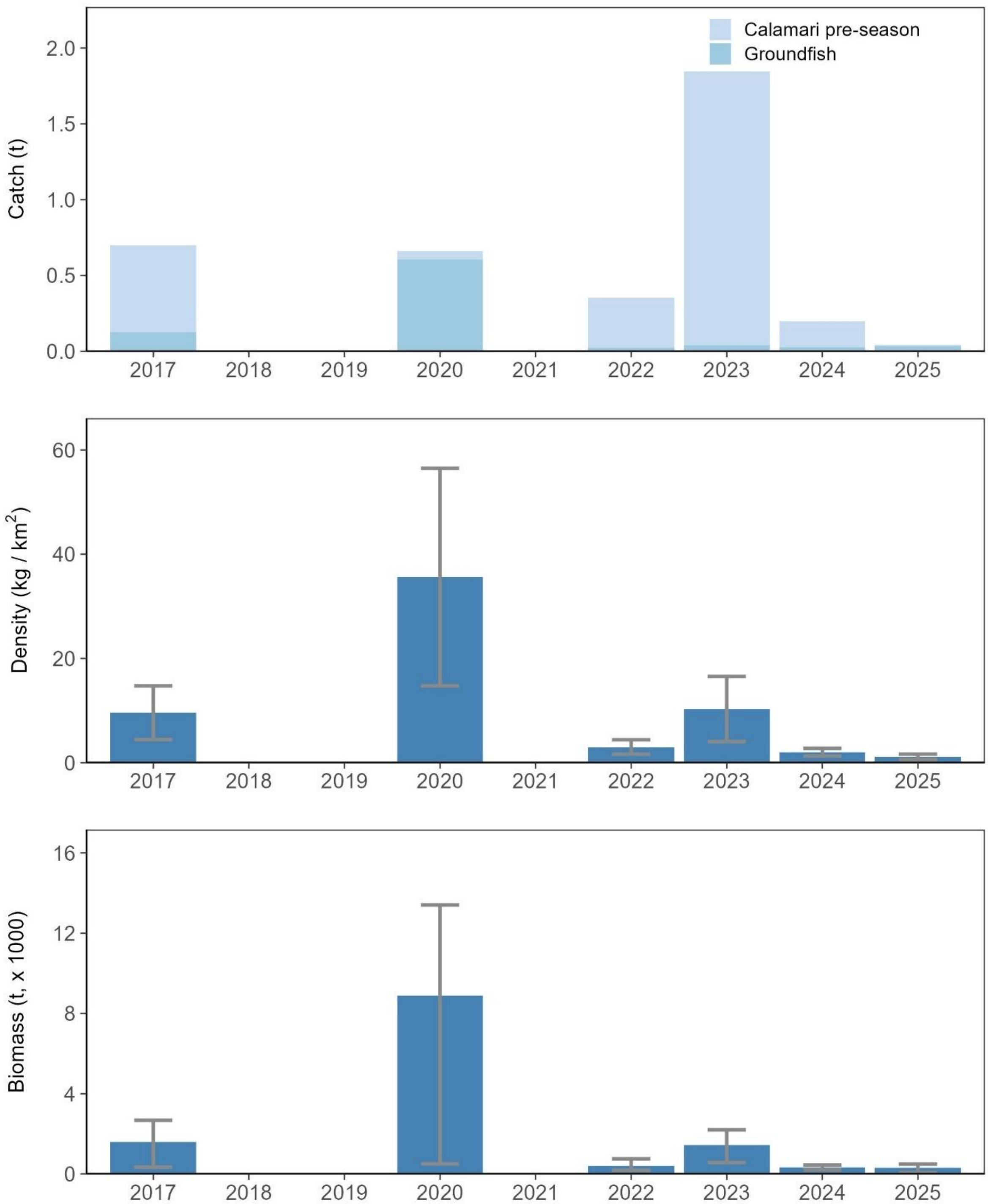

Fig. 29. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of southern blue whiting (*Micromesistius australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

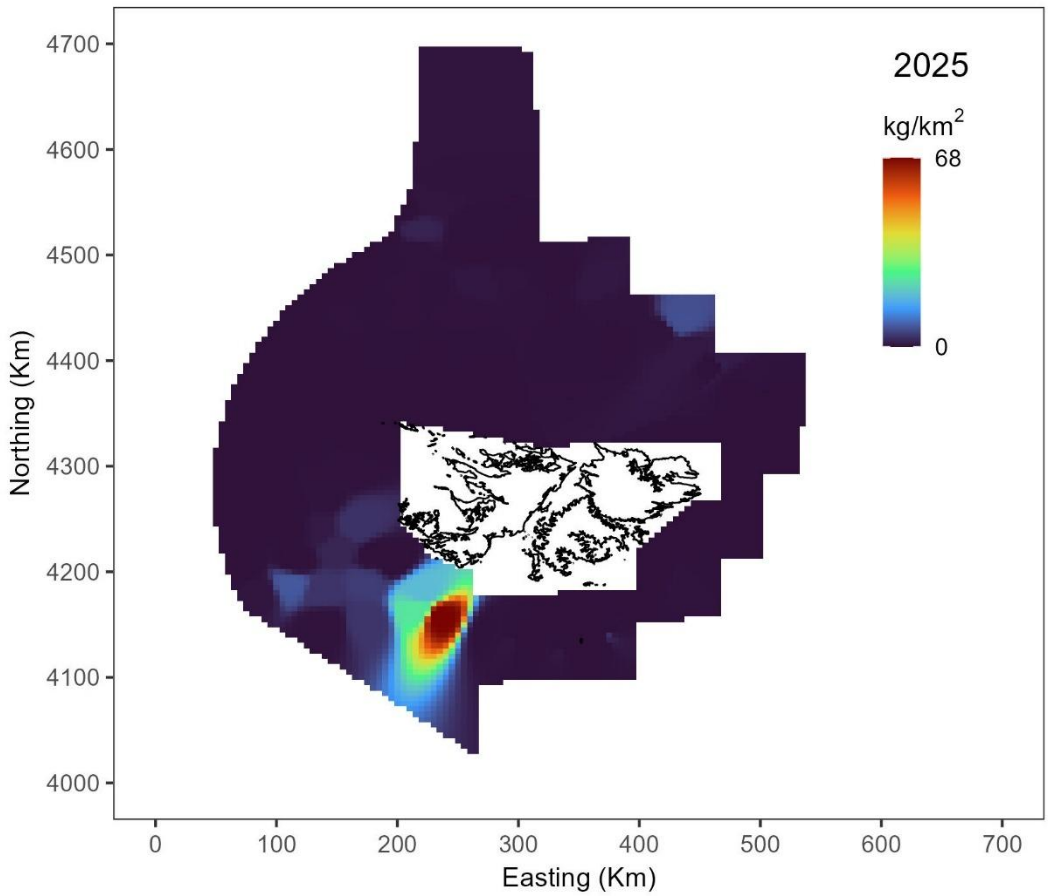

Fig. 30. Distribution and abundance of southern blue whiting (*Micromesistius australis*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

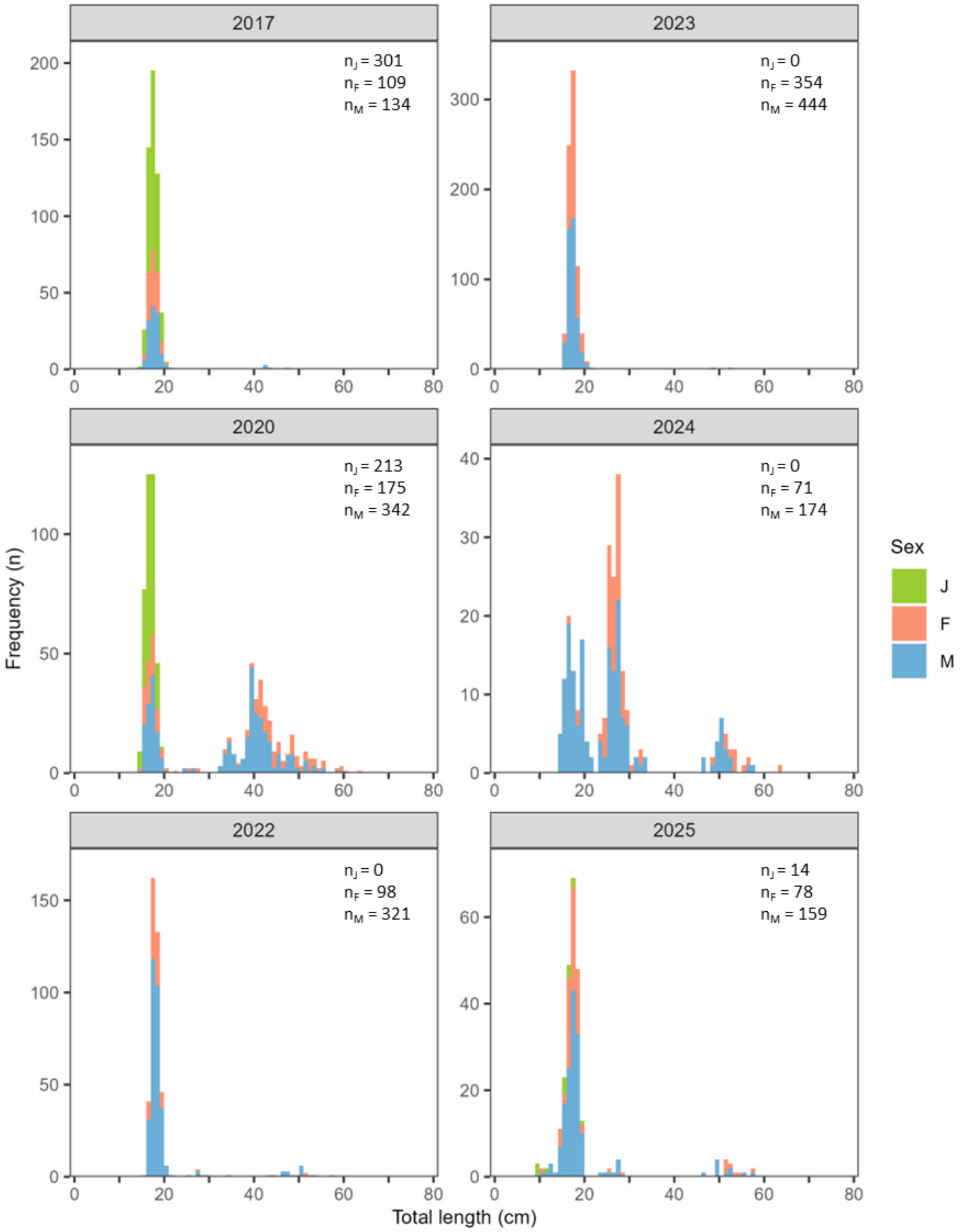

Fig. 31. Length-frequency of southern blue whiting (*Micromesistius australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

4.2.11. Southern hake (*Merluccius australis*)

Southern hake are caught in low numbers in Falkland Islands waters. On average, 72% of the total southern hake catches in the time series were obtained from groundfish surveys and 28% from calamari pre-season surveys. The highest total catch occurred in 2025 (0.19 t), representing a sixfold increase relative to the 2022–2024 mean (0.03 t; Fig. 32; Appendix II). This species is often misidentified as large common hake (*M. hubbsi*). The extent of the effect of misidentification on catch recording, and on density and biomass calculations is unknown. Ongoing research is focused on enhancing the ability to distinguish southern hake from common hake with greater confidence, based on morphological characteristics (Soeth 2024).

The highest densities were recorded in 2025 (mean ± SE: 4.53 ± 1.72 kg/km²), representing a threefold increase relative to both the 2017 densities (1.70 ± 0.68 kg/km²) and the 2024 densities (1.44 ± 0.51 kg/km²), and a fivefold increase compared with the 2022–2024 mean (0.85 ± 0.27 kg/km²; Fig. 32).

The highest biomass of southern hake was calculated for 2025 (1,201.17 t; Table II; Appendix III; the highest biomass in the time series), after a steep increase over two consecutive years from 2023 (99.35 t; the lowest biomass in the time series). Biomass in 2025 represented a twofold but not significant increase compared to the 2017 biomass (501.10 t; $p > 0.017$), a significant fourfold increase compared to the 2024 biomass (276.43 t; $p = 0.01$), and a significant threefold increase compared to the 2022–2024 mean (352.60 t; $p = 0.01$; Fig. 32; Appendix V–VI). LOESS revealed no statistically significant biomass trend between 2017 and 2025 (Appendix VII).

In 2025, the highest densities of southern hake in the time series (146 kg/km²) were recorded south-west of West Falkland at approximately 52.5°S and 61.5°W (4,190 km northing and 175 km easting, respectively; Fig. 33). The spatial distribution of southern hake remained consistent throughout the time series, with occasional low-abundance incursions to the south-east within the ‘Loligo Box’ (Appendix XVIII).

The broad size range observed across years (36–108 cm total length) suggests the presence of multiple overlapping length groups. Females ranged from 36 cm to 108 cm, whereas males ranged from 46 cm to 88 cm. It was not possible to reliably distinguish length groups or modal lengths due to the limited number of individuals (≤73 individuals per survey) and the wide size distribution (Fig. 34).

Falkland Islands fisheries contribute a minor proportion (≤12%) of the southern hake catch in the Southwest Atlantic, which is shared with Argentina (Ramos & Winter 2022e), likely having a relatively small impact on this stock. Limited data on this species from Falkland Islands fisheries constrains our ability to assess the status of the stock effectively.

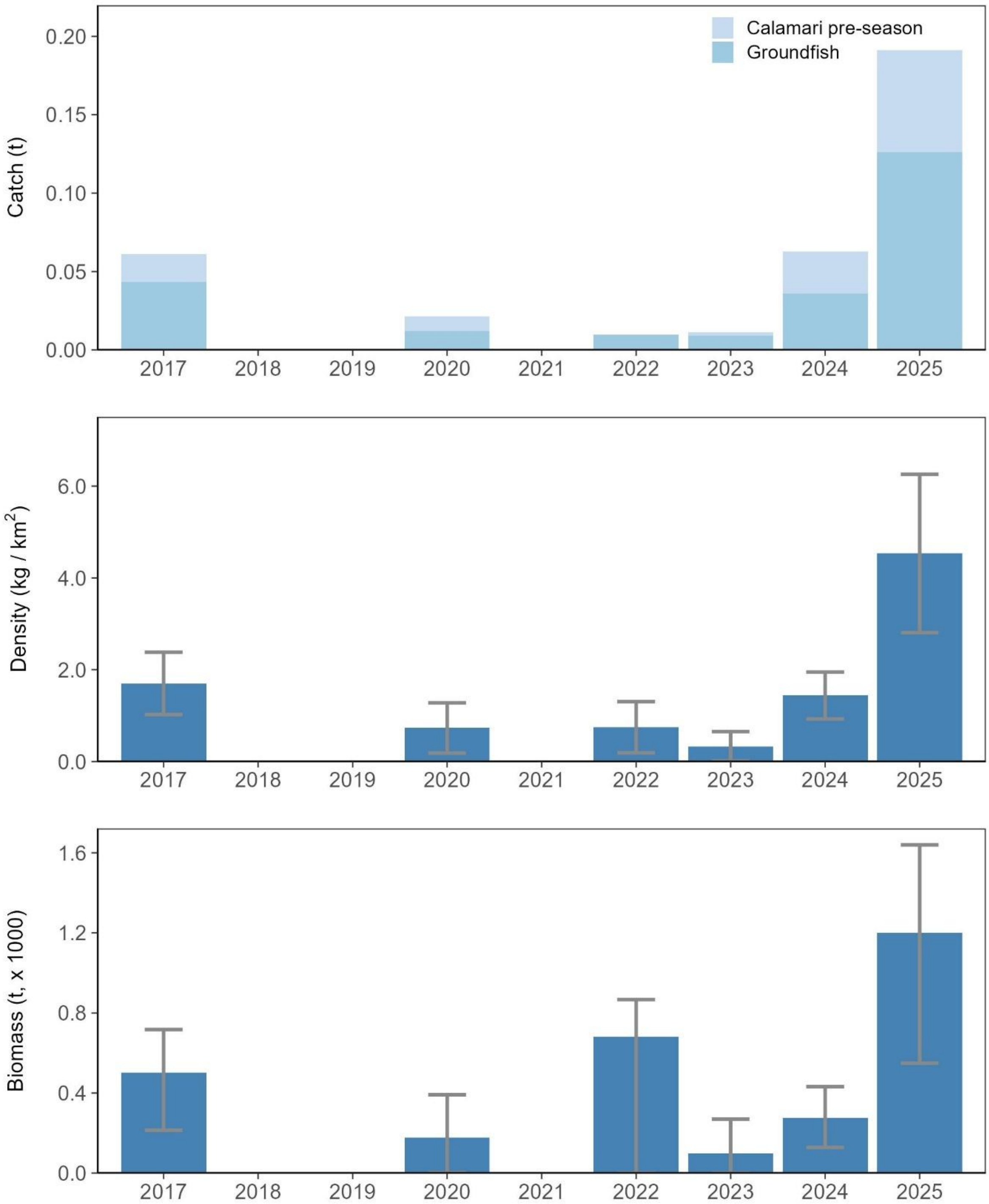

Fig. 32. Total catch, density (mean ± SE), and biomass (mean with 95% confidence intervals) of southern hake (*Merluccius australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

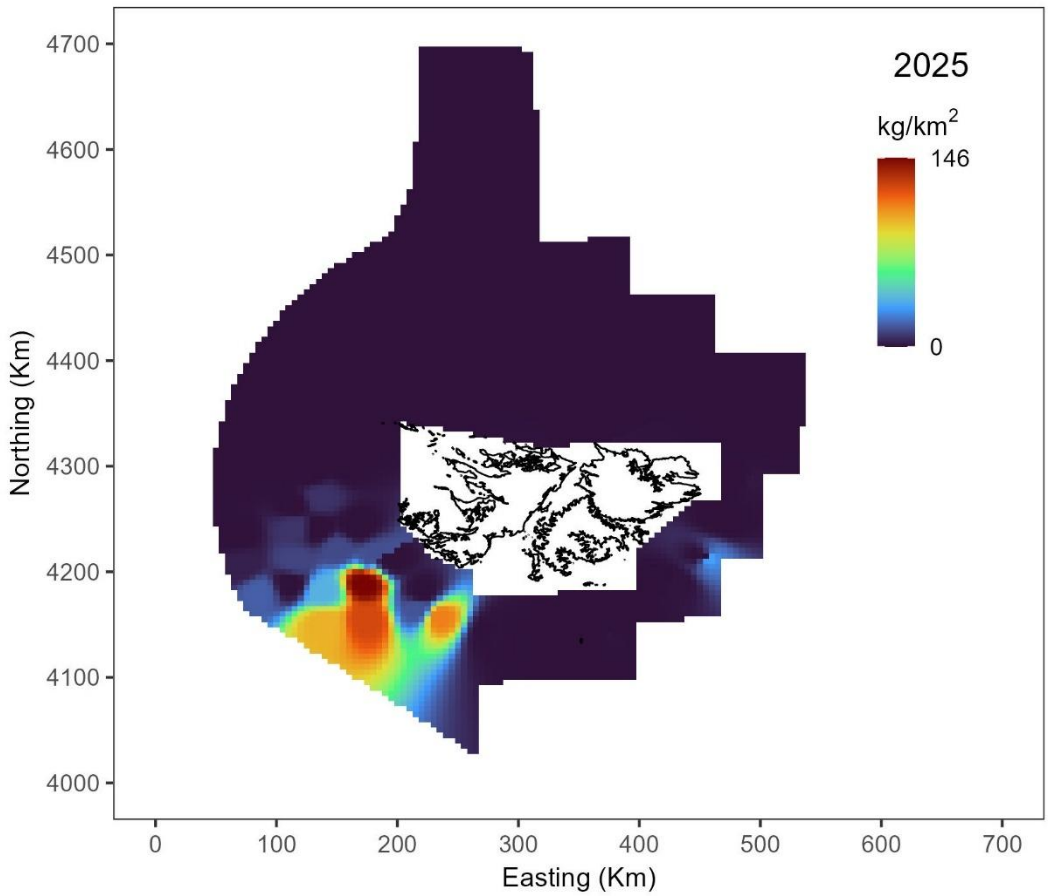

Fig. 33. Distribution and abundance of southern hake (*Merluccius australis*) calculated from the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

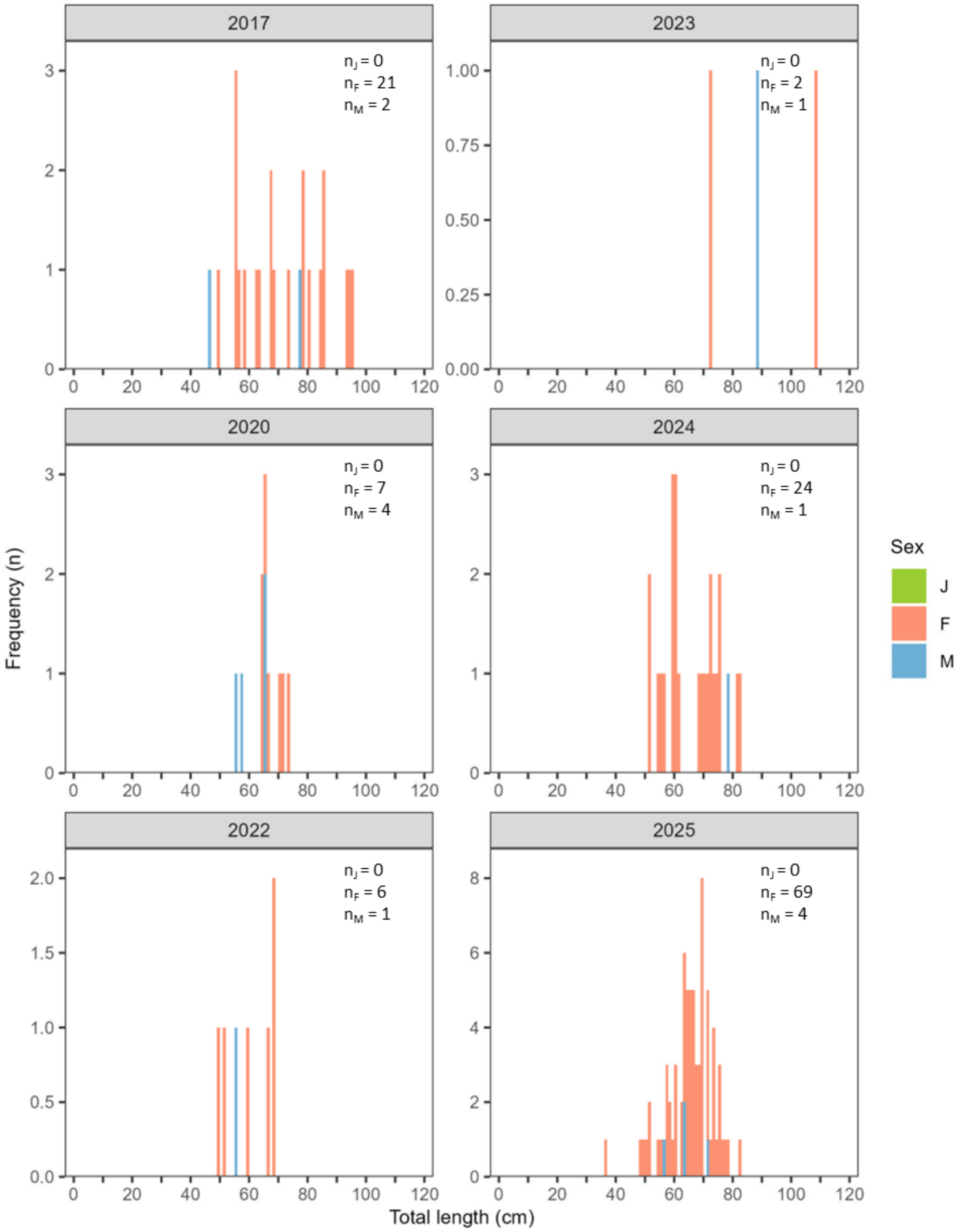

Fig. 34. Length-frequency of southern hake (*Merluccius australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters. n_J) Number of juveniles sampled; n_F) Number of females sampled; n_M) Number of males sampled. Bars are stacked.

5. Conclusions

1. Biomass analyses from July parallel demersal surveys (2017, 2020, 2022–2025) suggest the increase in abundance of the Argentine shortfin squid, common hake, and Patagonian toothfish, and the decline of hoki and Patagonian squid.

2. Survey limitations, particularly depth coverage, the short time series of July parallel demersal surveys (2017, 2020, 2022–2025), and gaps between years, reduce the statistical power to detect biomass trends.

3. The July 2020 groundfish survey was modified for a demographic study of common hake and included only 33 stations in the survey area, rather than the 84 stations typically planned for standard groundfish surveys. The smaller number of stations, and therefore the limited spatial coverage, of this modified survey may have an effect on biomass calculations, which can be noted by the wide confidence intervals of banded whiptail grenadier, Patagonian toothfish, red cod, and southern blue whiting.

4. Some of the species assessed are not abundant in Falkland Islands waters during July (e.g., Argentine shortfin squid, hoki, southern blue whiting) or they may be under-represented due to the surveyed area (e.g., Patagonian toothfish, red cod) and due to the fishing gear used for the surveys (i.e., bottom trawl, whereas the Argentine shortfin squid is mainly caught by jiggers, and the adult portion of the Patagonian toothfish stock is caught by longlines).

5. Argentine shortfin squid biomass increased sharply in the July 2025 compared with previous July surveys (2017, 2024, and the 2022–2024 mean), driven partly by higher densities of small individuals. However, it must be noted that this species is not abundant in Falkland Islands waters at this time of the year, and its July biomass patterns should be interpreted with caution.

6. Banded whiptail grenadier biomass showed significant fluctuations in July surveys from 2017 to 2025, and with wide confidence intervals. Information on the species in the region is limited.

7. Common hake abundance remains high in Falkland Islands waters during austral winter, with July 2025 biomass being the second highest in the 2017–2025 series. However, declines in modal length suggest demographic changes.

8. Hoki biomass had an overall declining trend in July parallel demersal surveys from 2017 to 2025; however, this trend should be interpreted cautiously due to wide confidence intervals in 2017 and 2020.

9. Kingclip showed an apparent upward biomass trend in July parallel demersal surveys from 2017 to 2025; however, this trend should be interpreted cautiously due to wide confidence intervals in recent years. The presence of large individuals in surveys suggests potential for recovery if size-selective management measures are implemented.

10. Patagonian squid exhibited a declining biomass trend in July parallel demersal surveys from 2017 to 2025, although this trend was marginally not significant.

11. Patagonian toothfish biomass peaked in 2025, and length-frequency distribution suggests recruitment in 2022–2023, with the subsequent increase in body size of those recruits likely contributing to the recent increase of biomass. It must be noted that bottom trawl demersal surveys are not representative of the adult component of the stock, which is caught by longlines.

12. Red cod biomass declined for the second consecutive year in 2025, aligning with February survey trends and declining commercial CPUE. Persistent low biomass in local spawning grounds and historical declines beyond the FICZ highlight region-wide vulnerability.

13. Rock cod reached its highest biomass level in July 2025 surveys compared with previous July surveys since 2017. Nevertheless, abundance remains at low levels, consistent with February surveys and with commercial data. Extremely high discard rates in the commercial fishery since 2016 coupled with low discard survival threatens stock sustainability.

14. Southern blue whiting biomass in July 2025 was the lowest in the series, reflecting long-term regional depletion. It must be noted that southern blue whiting is not abundant in Falkland Islands waters during austral winter, and its July biomass patterns should be interpreted with caution.

15. Southern hake assessments remain highly uncertain, as Falkland Islands fisheries contribute ≤12% of total catch in the Southwest Atlantic. Moreover, limited local data restricts the capacity to evaluate the status of this stock.

6. Recommendations

1. Ensure a long-term time series of July parallel demersal surveys. July parallel demersal surveys have been conducted only in 2017, 2020 (with modifications of the groundfish survey for a common hake demographic study), and 2022–2025, limiting the capacity to detect robust biomass trends. A continuous long-term time series is essential for improving trend detection.

2. Given the characteristics of the July 2020 groundfish survey, which was modified for a demographic study of common hake and included only 33 stations in the survey area, rather than the 84 stations typically planned for standard groundfish surveys, it is recommended to assess the potential impact of the number of stations and the spatial coverage on biomass estimates. This analysis would allow to determine whether the inclusion of 2020 biomasses in the comparisons of biomass across years is appropriate.

3. Re-assess the coverage of the groundfish survey. Biomasses estimates for deep-water species exhibited wide confidence intervals, likely in part due to the limited number of survey stations in areas where these species occur. Expanding the spatial coverage of the groundfish survey may improve biomass estimates for these species. As noted by Soeth et al. (2025), deep-shelf species typically associated with depths of 250–350 m are likely under-represented in the current groundfish survey area.

4. Assess the population structure of common hake. To inform potential management measures and ensure sustainable fishing practices, it is crucial to assess the population

structure of common hake. Regional collaboration would increase accuracy of stock assessments and the development of targeted management strategies.

5. Maintain a precautionary approach for Patagonian squid. A precautionary management approach should continue for Patagonian squid, with adaptive decision-making throughout the fishing season. The recent decline in biomass and body size, along with the distributional shift observed in 2024 and the low catches during the 2025 second fishing seasons, highlights the need for continuous in-season monitoring. Close collaboration with the fishing industry and the flexibility to close the fishing season when biomass thresholds are not met are essential. Additionally, enhancing the understanding of environmental drivers may improve predictions of recruitment variability.

6. Implement conservation measures for finfish stocks in poor state. The poor state of several finfish stocks (i.e., hoki, red cod, rock cod, and southern blue whiting) in Falkland Islands waters calls for immediate conservation action. The following options should be considered to reduce fishing pressure on these stocks:

   6.1. Inclusion into the daily by-catch limit for finfish licences (A, G, and W licences), which triggers a move-on rule and no fishing during 10 days in the grid square where the by-catch limit was reached. The 10% proportion of the by-catch limit and the 10-day duration of the move-on rule could be re-assessed.

   6.2. Temporary closure of high-catch grid squares.

   6.3. Protection of spawning grounds. For instance, continue the protection of spawning grounds for southern blue whiting and red cod to the south-west of the Falkland Islands, and protect the spawning grounds for hoki and rock cod.

7. Reduce catch rates of juveniles. High juvenile catch rates pose significant risk to future biomass and recruitment. Measures to reduce juvenile catch rates could include:

   7.1. Increase observer coverage and improve catch reporting, essential to support more reliable stock assessments.

7.2. Implement spatial or temporal closure of areas with high juvenile abundance to help protect vulnerable life stages and reduce discard mortality, and

7.3. Implement modifications to the fishing gear to reduce the by-catch of juveniles.

8. Include biomass calculations in stock assessments where commercial fisheries catch, fishing effort, and biological data are available and appropriate. The lack of biomass calculations from commercial data for several species since 2019 limits the understanding of their current stock status and trends.

9. Refine biomass estimation approaches. Current biomass estimation models should be refined to account for the effect of environmental variables on biomass. Incorporating these factors into models would improve understanding of the drivers behind inter-annual fluctuations and provide more accurate predictions of future biomass trends.

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Appendix I. July surveys summary

July groundfish (gf) and calamari pre-season (pr) surveys information. Catches per survey and combined total include Argentine shortfin squid, banded whiptail grenadier, common hake, hoki, kingclip, Patagonian squid, Patagonian toothfish, red cod, rock cod, southern blue whiting, and southern hake.

Year	Vessel		No. of trawls			Stations excluded		Catch (t)		
	gf	pr	gf	pr	total	gf	pr	gf	pr	total
2017	Castelo (ZDLT1)	Igueldo (ZDLE1)	74	59	133	NA	930–933	37.65	460.61	498.26
2020	Castelo (ZDLT1)	Beagle (ZDLZ)	33	55	88	3179–3195	NA	32.43	643.92	676.35
2022	Castelo (ZDLT1)	Argos Pereira (ZDLO1)	63	59	122	NA	NA	79.28	488.19	567.47
2023	Castelo (ZDLT1)	Montelourido (ZDLC4)	70	56	126	NA	NA	71.65	358.45	430.10
2024	Castelo (ZDLT1)	Robin M Lee (ZDLZ1)	76	47	123	NA	NA	109.58	146.52	256.10
2025	Argos Vigo (ZDLU1)	Prion (ZDLS4)	82	60	140	NA	NA	144.84	368.86	513.70

Appendix II. July surveys catches

Catch (t) of main commercial species during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

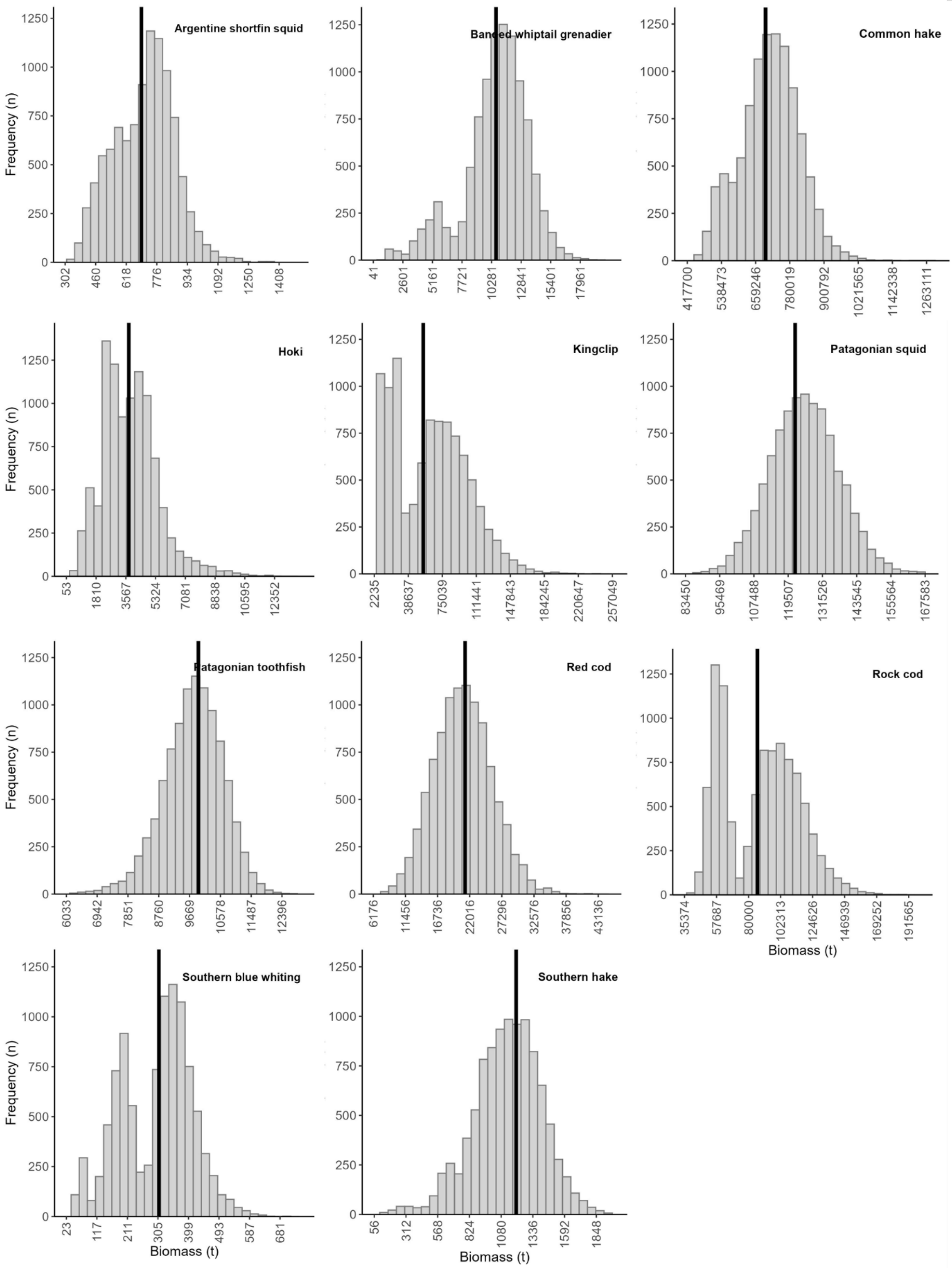
Year	Argentine shortfin squid	Banded whiptail grenadier	Common hake	Hoki	Kingclip	Patagonian squid	Patagonian toothfish
2017	0.022	0.017	26.653	114.718	4.158	315.804	0.650
2020	0.014	0.728	85.652	1.954	2.546	580.078	0.606
2022	0.016	0.930	92.214	0.237	1.905	446.925	0.287
2023	0.016	0.034	102.292	0.200	4.738	301.047	0.297
2024	0.044	0.341	161.374	0.919	6.101	54.809	1.012
2025	0.199	1.098	250.907	0.49	12.418	205.812	3.842
Total	0.31	3.15	719.09	118.52	31.87	1904.47	6.69
Mean	0.05	0.52	119.85	19.75	5.31	317.41	1.12

Appendix II. *continued*

Year	Red cod	Rock cod	Southern blue whiting	Southern hake
2017	2.563	32.910	0.700	0.061
2020	2.586	1.507	0.662	0.021
2022	4.498	20.091	0.354	0.010
2023	8.905	10.716	1.846	0.011
2024	5.439	25.802	0.198	0.063
2025	6.904	31.798	0.044	0.191
Total	30.9	122.82	3.8	0.36
Mean	5.15	20.47	0.63	0.06

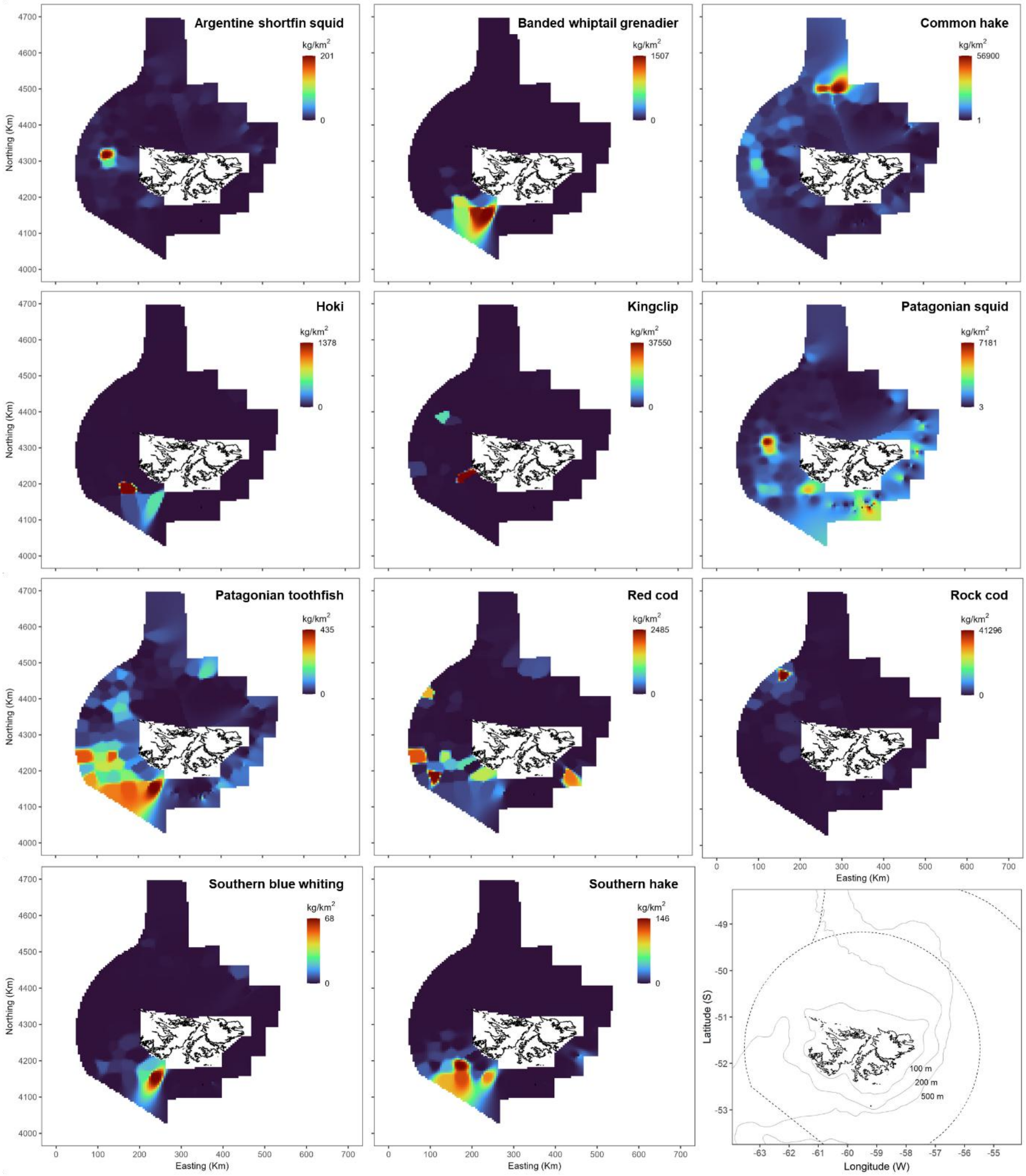
Appendix III. July 2025 biomass bootstrap histograms

Deterministic biomass (t, indicated by the vertical black line) and 10,000 bootstrap iterations.



Appendix IV. July 2025 species distribution

Comparative density (kg/km^2) distribution of commercial species during the July 2025 groundfish and calamari pre-season surveys in Falkland Islands waters. Note the 100 m, 200 m, and 500 m isobaths in the bottom-right panel.

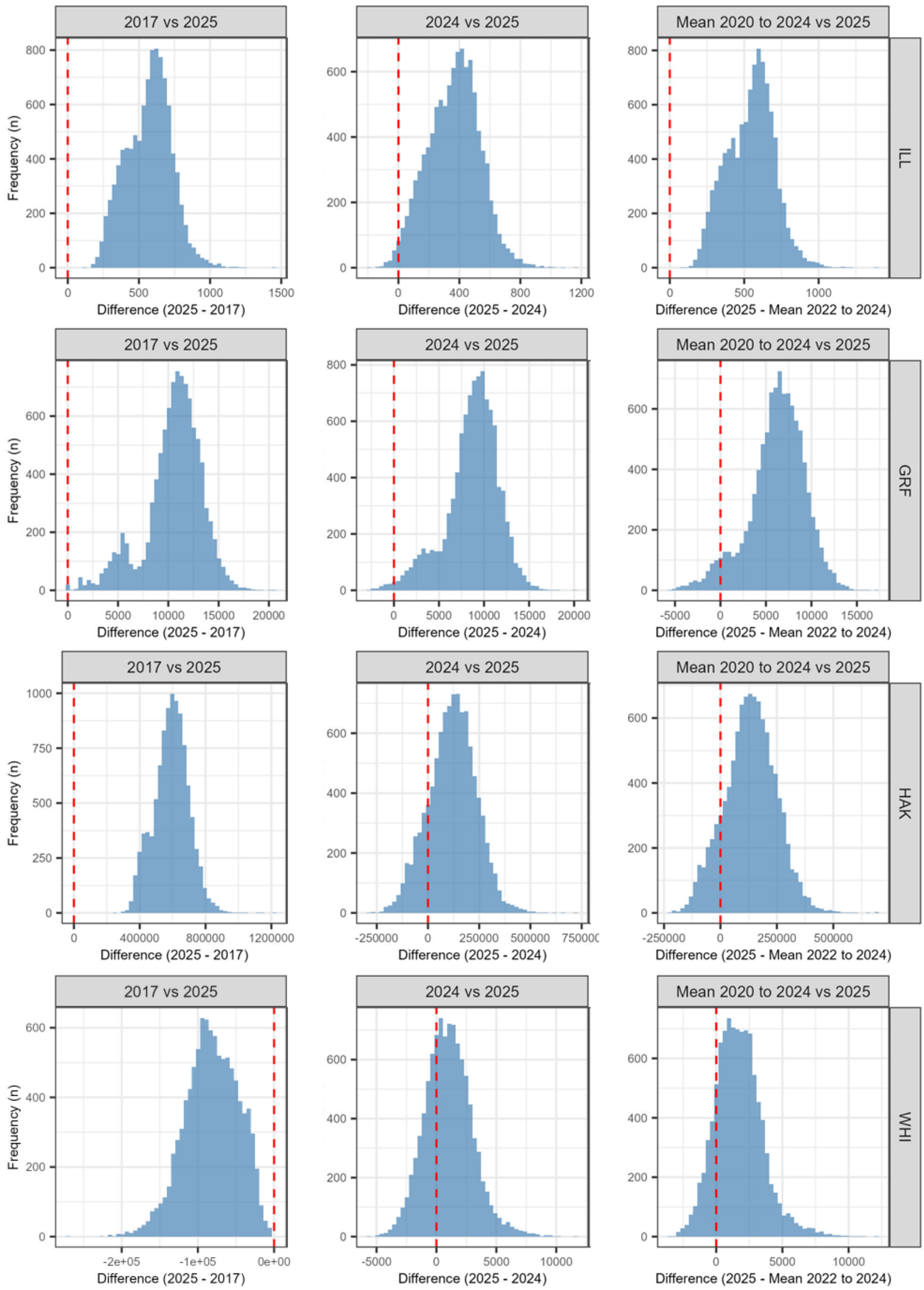


Appendix V. Selected year-to-year biomass differences
L95) Lower 95% confidence interval; U95) Upper 95% confidence interval; p positive) p value of biomass increase at 95% significance; p negative) p value of biomass decrease at 95% significance. Argentine shortfin squid (ILL); Banded whiptail grenadier (GRF); Common hake (HAK); Hoki (WHI); Kingclip (KIN); Patagonian squid (LOL); Patagonian toothfish (TOO); Red cod (BAC); Rock cod (PAR); Southern blue whiting (BLU); Southern hake (PAT). Bold font indicates significant changes (p adjusted threshold = 0.017).

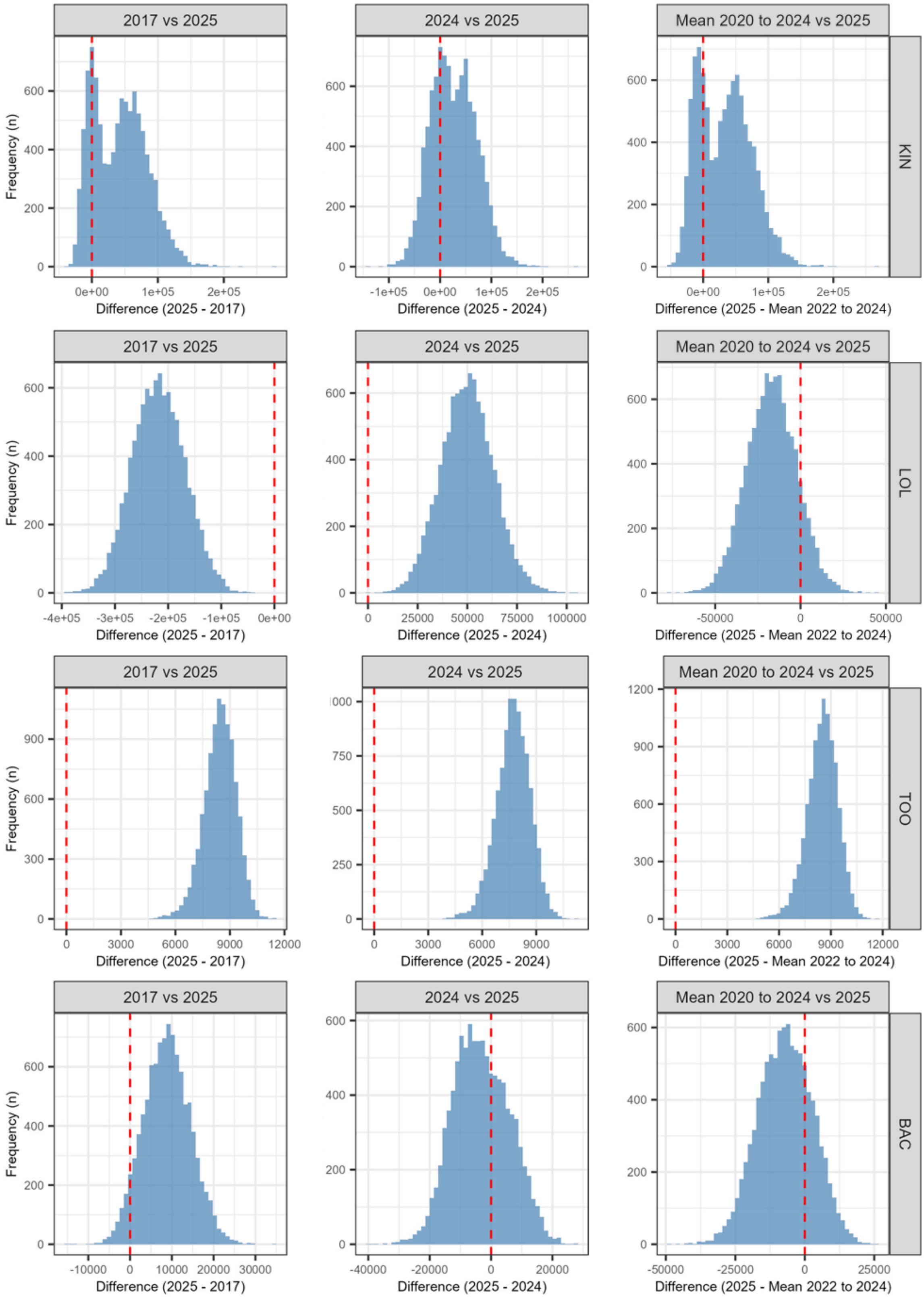
Species	Comparison	Mean difference	L95	U95	p positive	p negative	Change
ILL	2017 vs 2025	569.39	270.01	872.47	0.000	1.000	**Increase**
ILL	2024 vs 2025	362.84	31.80	689.96	0.015	0.986	**Increase**
ILL	Mean vs 2025	541.78	241.20	844.78	0.000	1.000	**Increase**
GRF	2017 vs 2025	10529.68	3740.12	15146.15	0.000	1.000	**Increase**
GRF	2024 vs 2025	8678.81	1551.95	13584.58	0.009	0.991	**Increase**
GRF	Mean vs 2025	6206.07	-1064.47	11525.50	0.048	0.952	None
HAK	2017 vs 2025	591806.82	386439.81	791747.62	0.000	1.000	**Increase**
HAK	2024 vs 2025	118215.63	-113555.73	338063.58	0.160	0.841	None
HAK	Mean vs 2025	131959.97	-95289.73	350205.24	0.135	0.865	None
WHI	2017 vs 2025	-82336.47	-156682.48	-22472.34	1.000	0.000	**Decrease**
WHI	2024 vs 2025	1013.50	-2656.12	5315.89	0.311	0.690	None
WHI	Mean vs 2025	1697.91	-1471.58	5851.31	0.164	0.836	None
KIN	2017 vs 2025	42114.28	-17997.47	123400.44	0.186	0.814	None
KIN	2024 vs 2025	26262.40	-52121.97	112747.55	0.307	0.693	None
KIN	Mean vs 2025	33173.88	-27717.25	114695.34	0.273	0.727	None
LOL	2017 vs 2025	-217873.49	-313146.62	-120329.64	1.000	0.000	**Decrease**
LOL	2024 vs 2025	50057.31	24500.42	76660.53	0.000	1.000	**Increase**
LOL	Mean vs 2025	-16823.38	-45472.88	11866.14	0.875	0.125	None
TOO	2017 vs 2025	8449.17	6559.81	10065.12	0.000	1.000	**Increase**
TOO	2024 vs 2025	7714.88	5749.51	9447.89	0.000	1.000	**Increase**
TOO	Mean vs 2025	8502.23	6615.73	10110.65	0.000	1.000	**Increase**
BAC	2017 vs 2025	8791.86	-2013.90	19933.41	0.058	0.942	None
BAC	2024 vs 2025	-3178.14	-19924.84	14744.90	0.635	0.365	None
BAC	Mean vs 2025	-7011.74	-26179.66	11626.85	0.751	0.249	None
PAR	2017 vs 2025	37793.40	-6982.00	91159.63	0.077	0.924	None
PAR	2024 vs 2025	41474.07	-9965.19	97797.71	0.086	0.915	None
PAR	Mean vs 2025	44974.41	390.05	97267.44	0.024	0.976	Increase
BLU	2017 vs 2025	-1056.77	-2396.35	26.70	0.966	0.034	None
BLU	2024 vs 2025	-23.37	-270.95	209.03	0.548	0.452	None
BLU	Mean vs 2025	-387.41	-762.75	-37.63	0.987	0.013	**Decrease**
PAT	2017 vs 2025	636.19	-1.85	1208.94	0.026	0.975	None
PAT	2024 vs 2025	849.43	237.25	1386.89	0.007	0.993	**Increase**
PAT	Mean vs 2025	826.25	200.78	1385.01	0.009	0.991	**Increase**

Appendix VI. Selected year-to-year biomass differences histograms

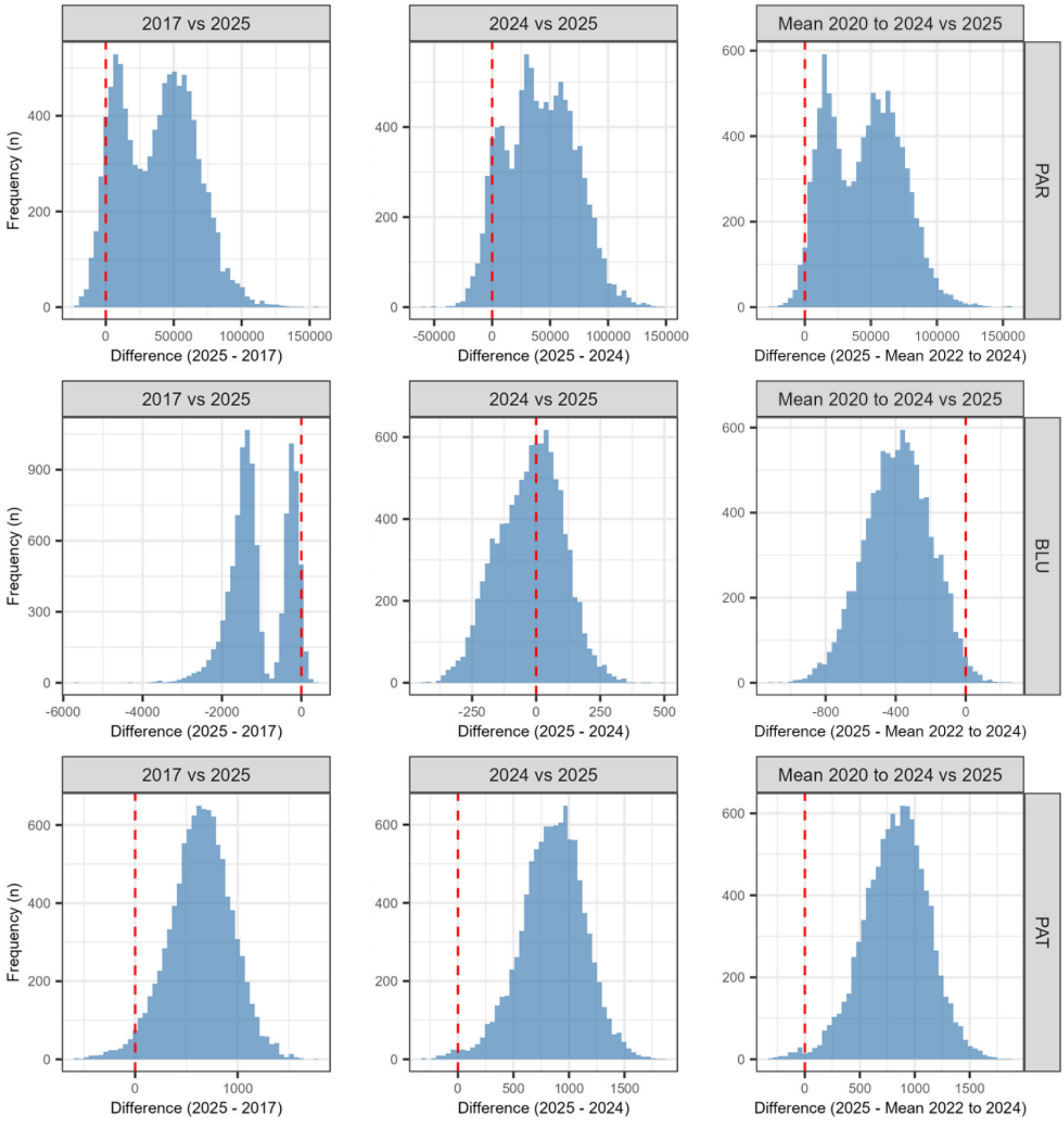
Biomass differences calculated from the year-to-year paired 10,000 bootstrap iterations. Zero represents equality and is indicated by the dashed red line. Argentine shortfin squid (ILL); Banded whiptail grenadier (GRF); Common hake (HAK); Hoki (WHI); Kingclip (KIN); Patagonian squid (LOL); Patagonian toothfish (TOO); Red cod (BAC); Rock cod (PAR); Southern blue whiting (BLU); Southern hake (PAT).



Appendix VI. *continued*

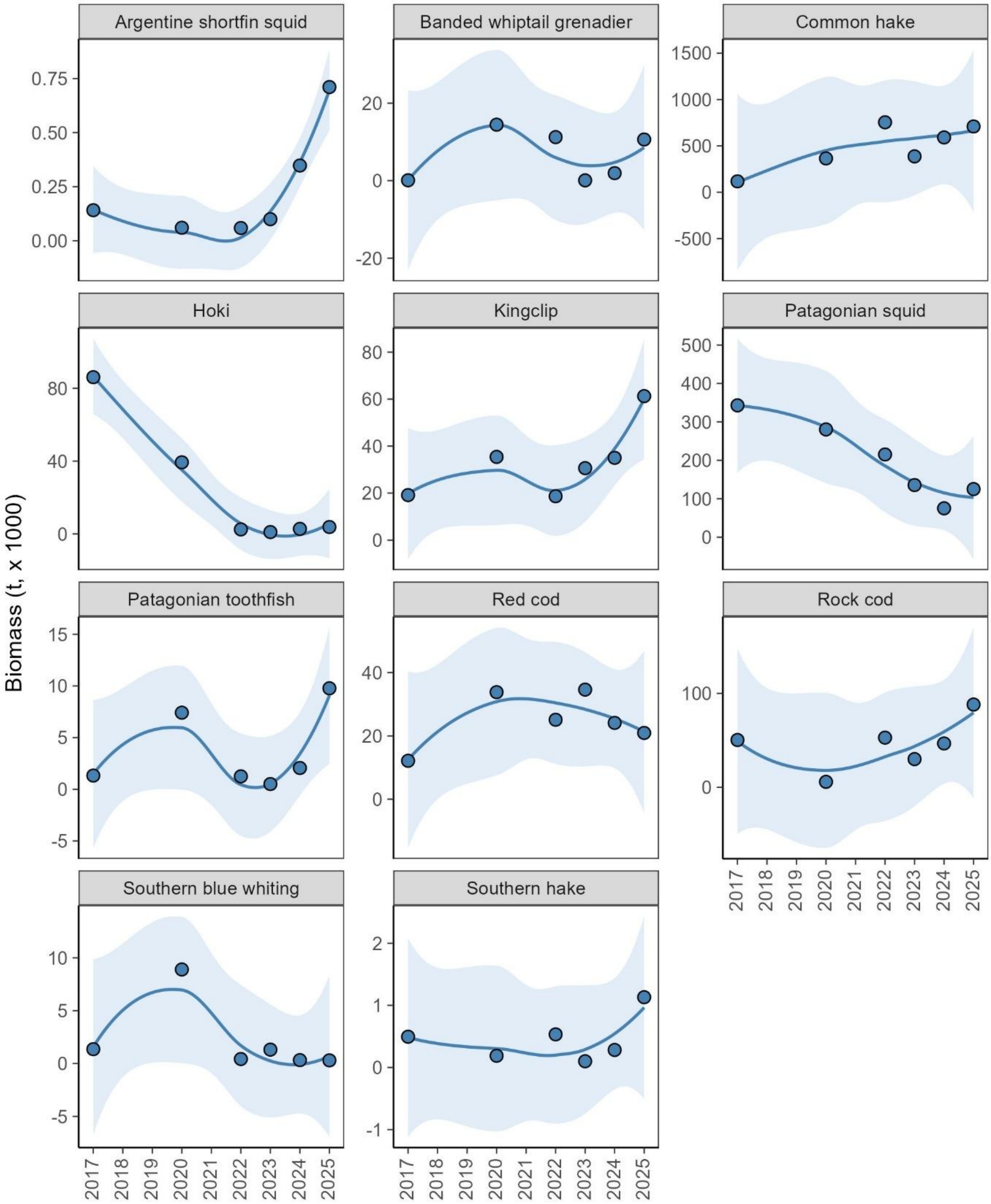


Appendix VI. *continued*



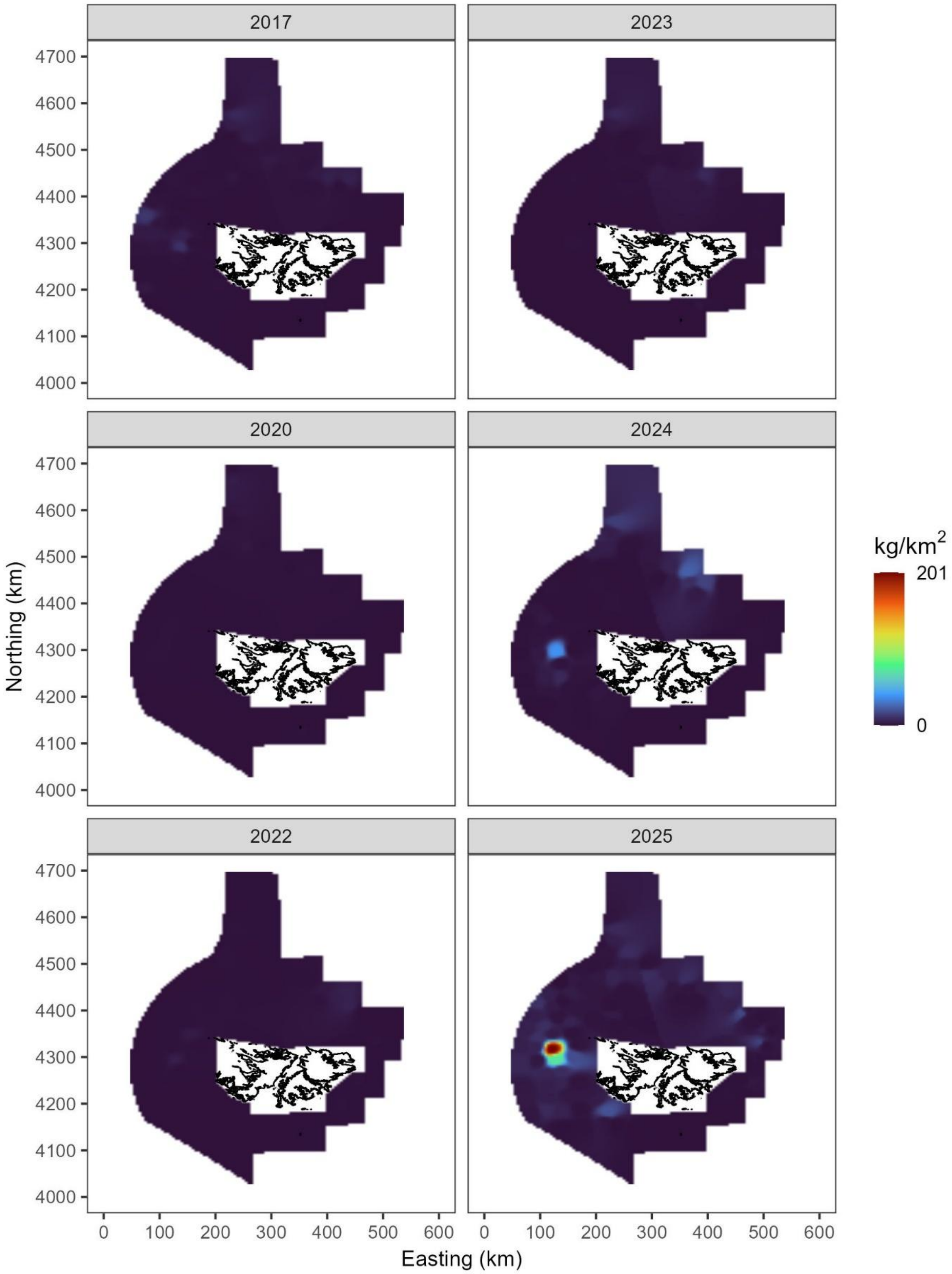
Appendix VII. July surveys biomass trends

Biomass (t) of commercial species in July groundfish and calamari pre-season surveys during 2017, 2020, and 2022–2025. The points indicate the calculated biomass per year. LOESS smooth ± 95% confidence intervals.



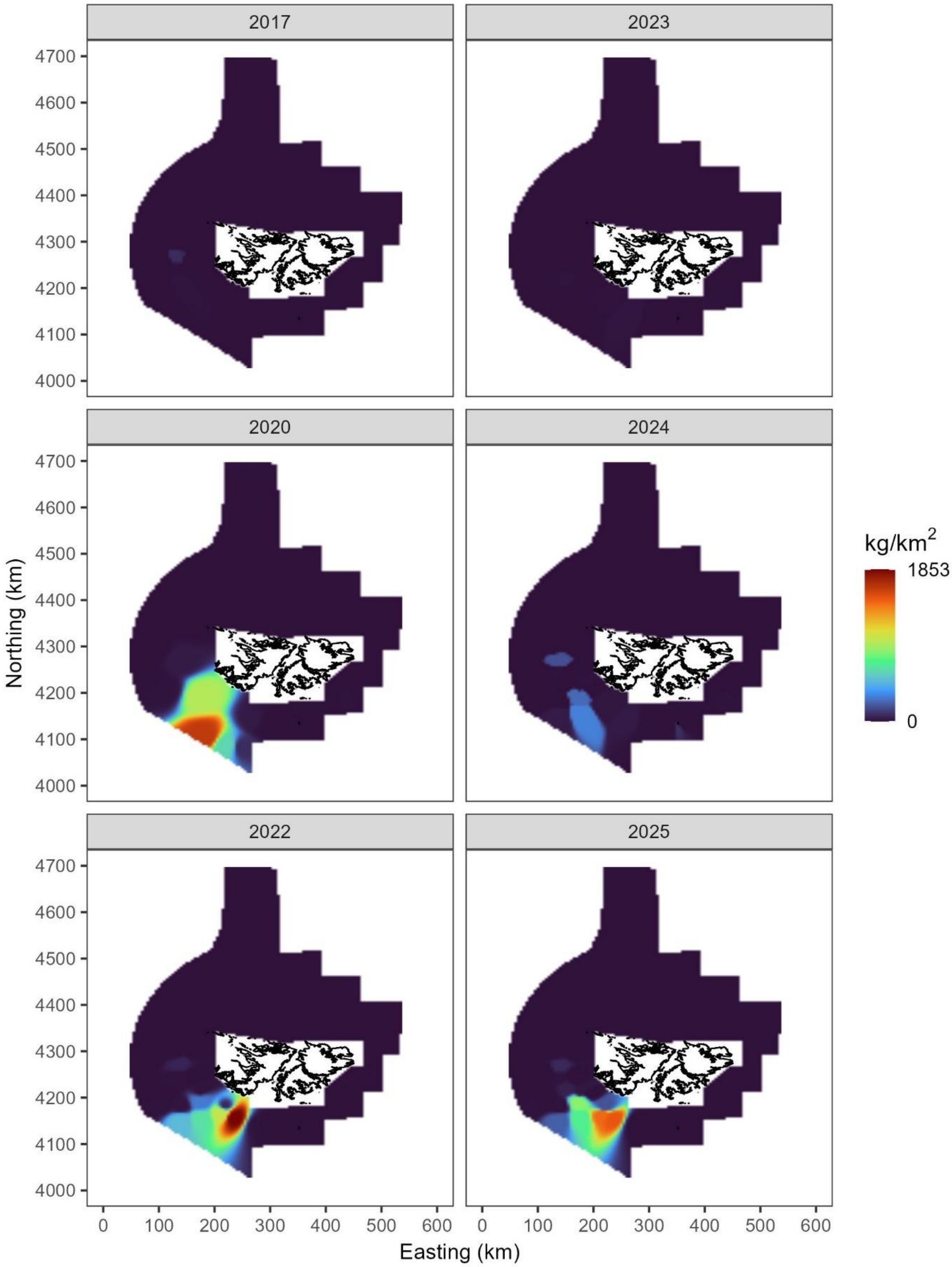
Appendix VIII. Argentine shortfin squid inter-annual distribution

Comparative density (kg/km^2) distribution of the Argentine shortfin squid (*Illex argentinus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

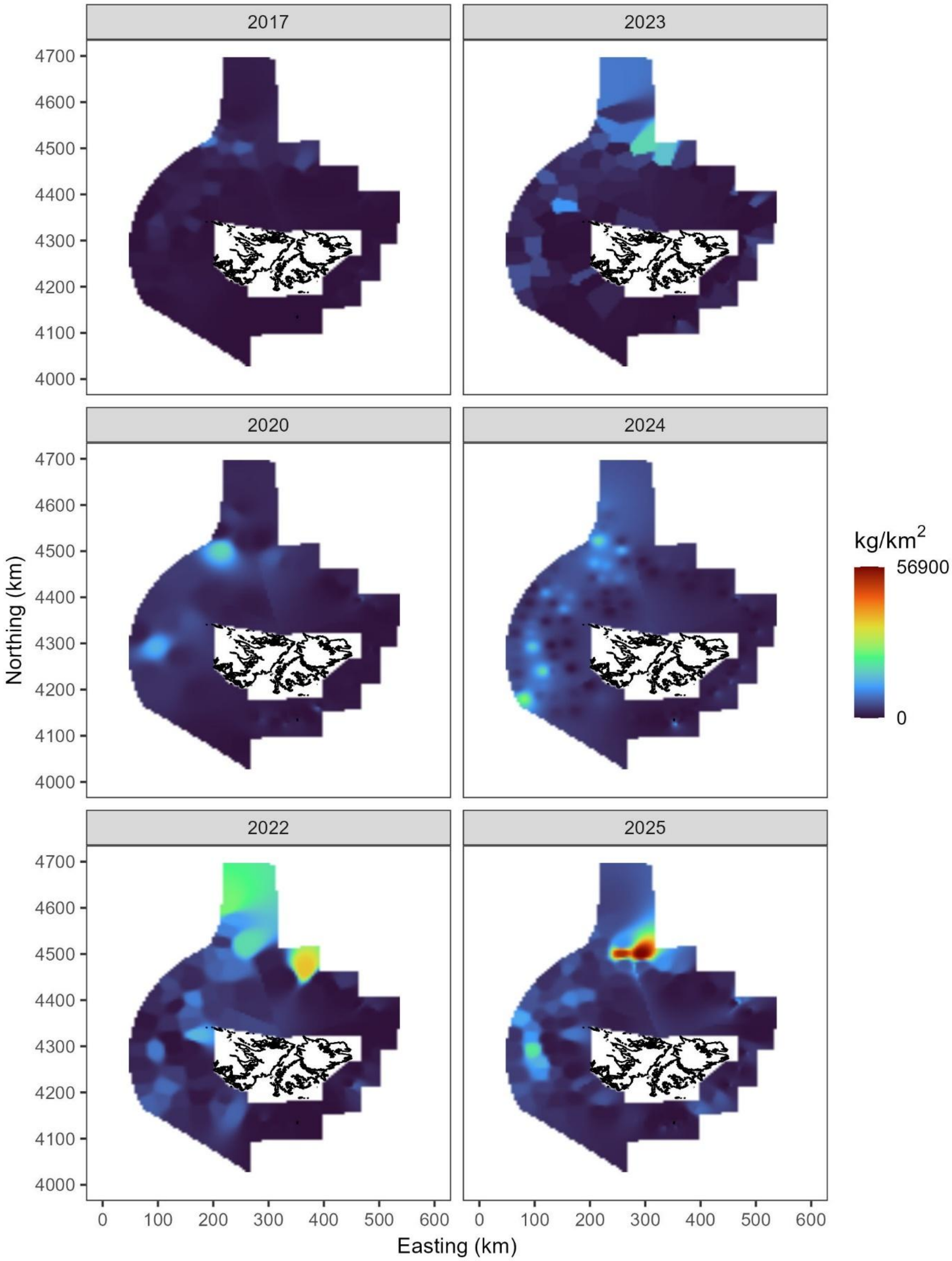


Appendix IX. Banded whiptail grenadier inter-annual distribution

Comparative density (kg/km^2) distribution of banded whiptail grenadier (*Coelorinchus fasciatus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

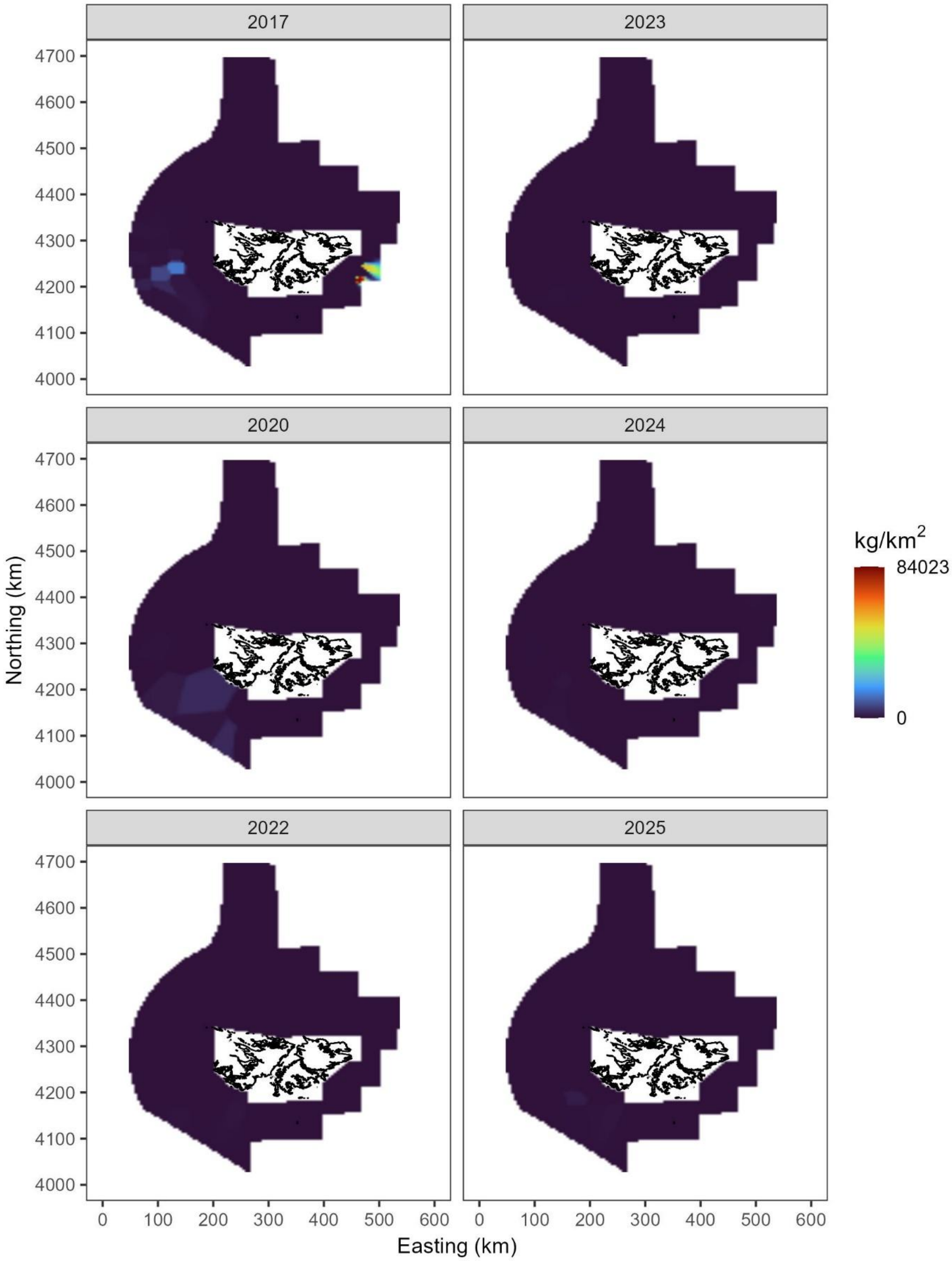


Appendix X. Common hake inter-annual distribution
Comparative density (kg/km^2) distribution of common hake (*Merluccius hubbsi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.



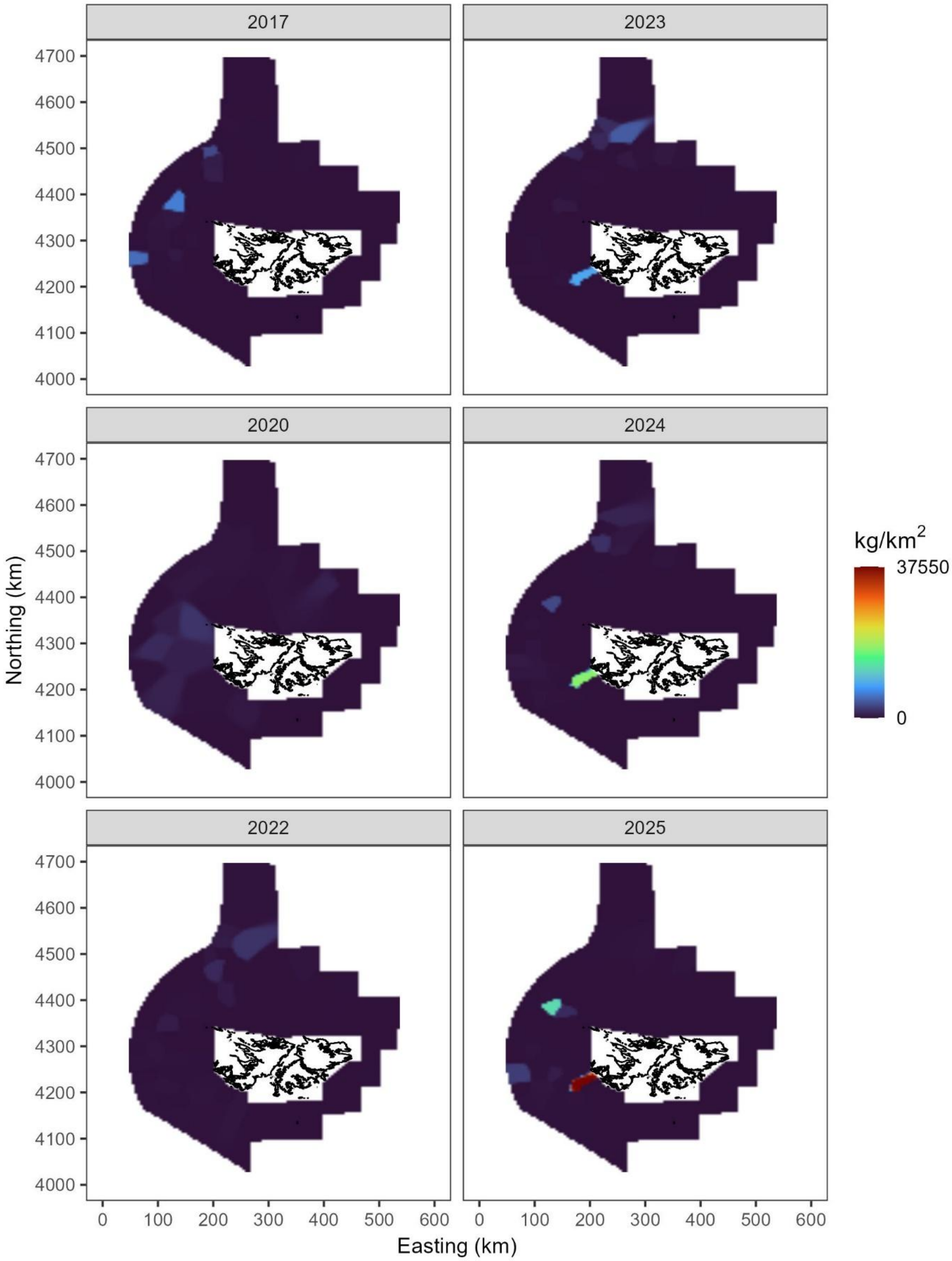
Appendix XI. Hoki inter-annual distribution

Comparative density (kg/km^2) distribution of hoki (*Macruronus magellanicus*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.



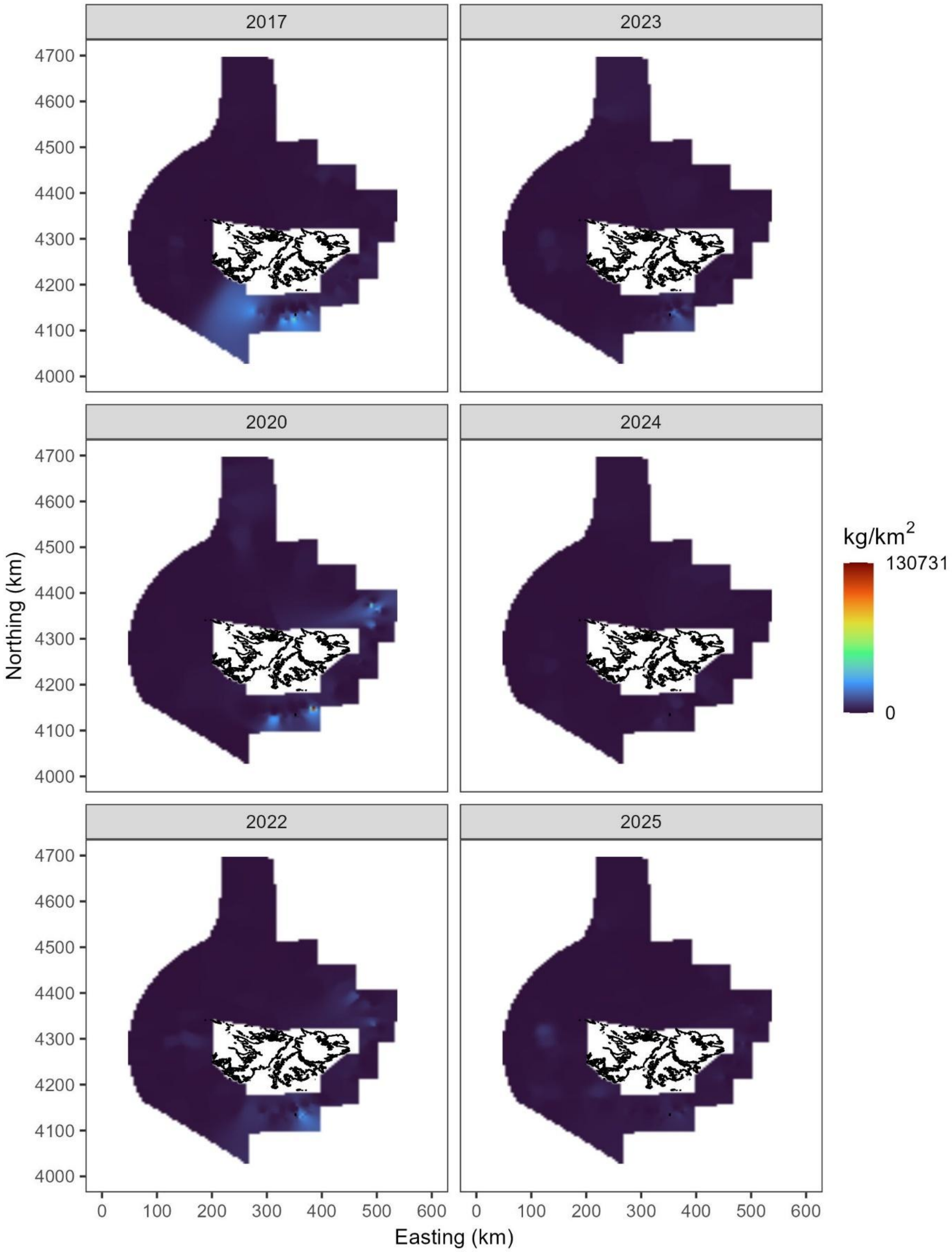
Appendix XII. Kingclip inter-annual distribution

Comparative density (kg/km^2) distribution of kingclip (*Genypterus blacodes*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.



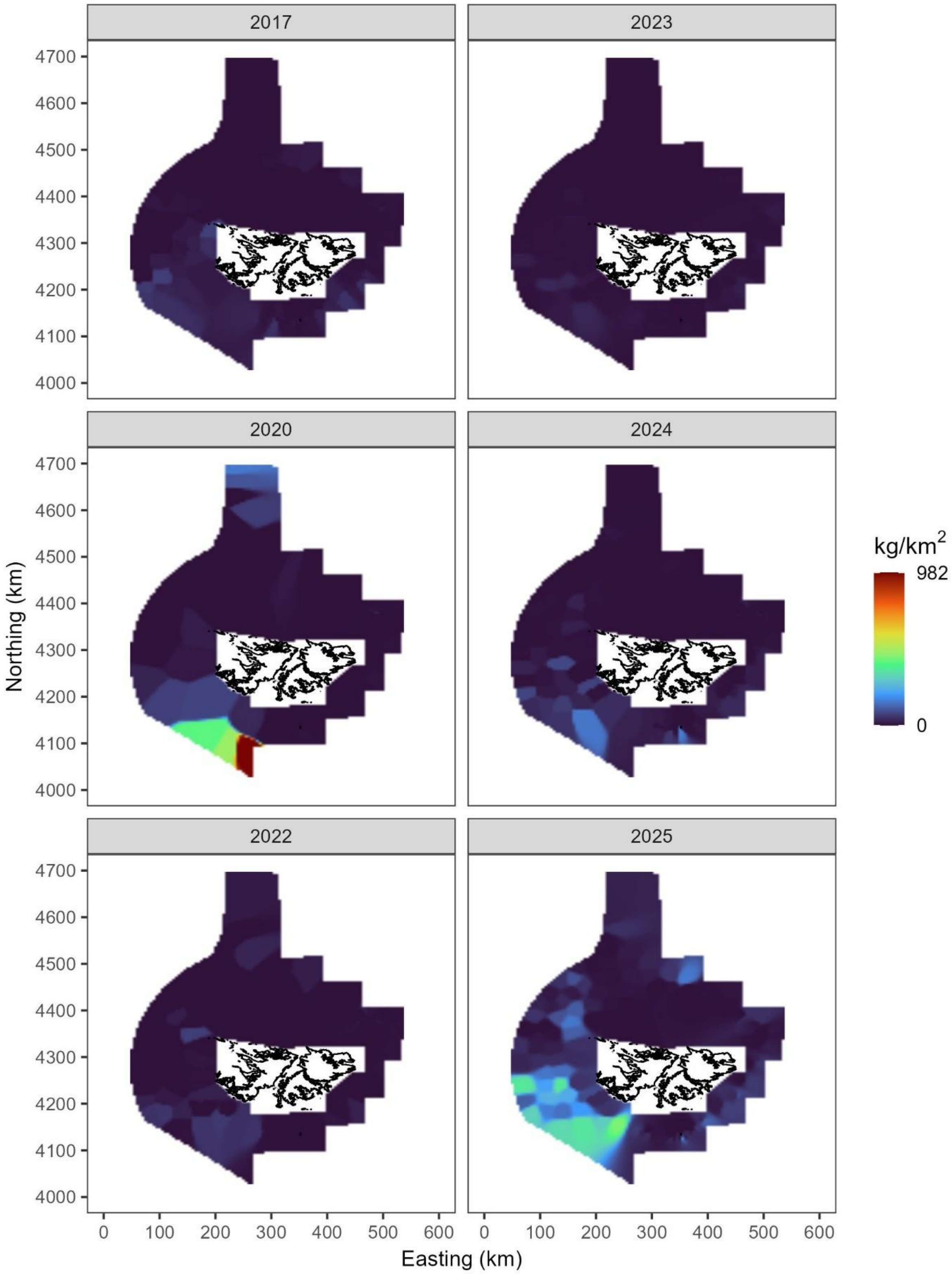
Appendix XIII. Patagonian squid inter-annual distribution

Comparative density (kg/km²) distribution of the Patagonian squid (*Doryteuthis gahi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

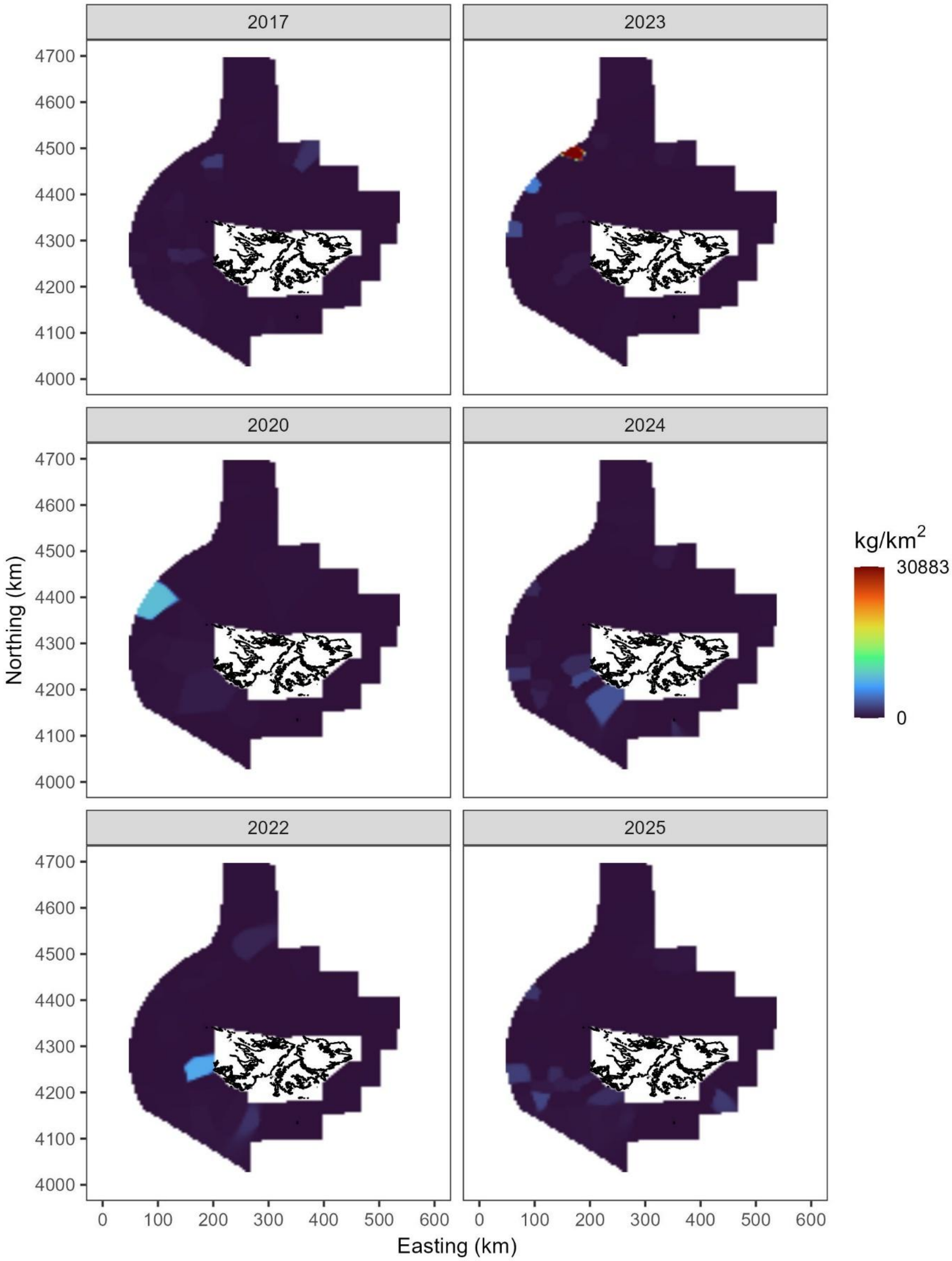


Appendix XIV. Patagonian toothfish inter-annual distribution

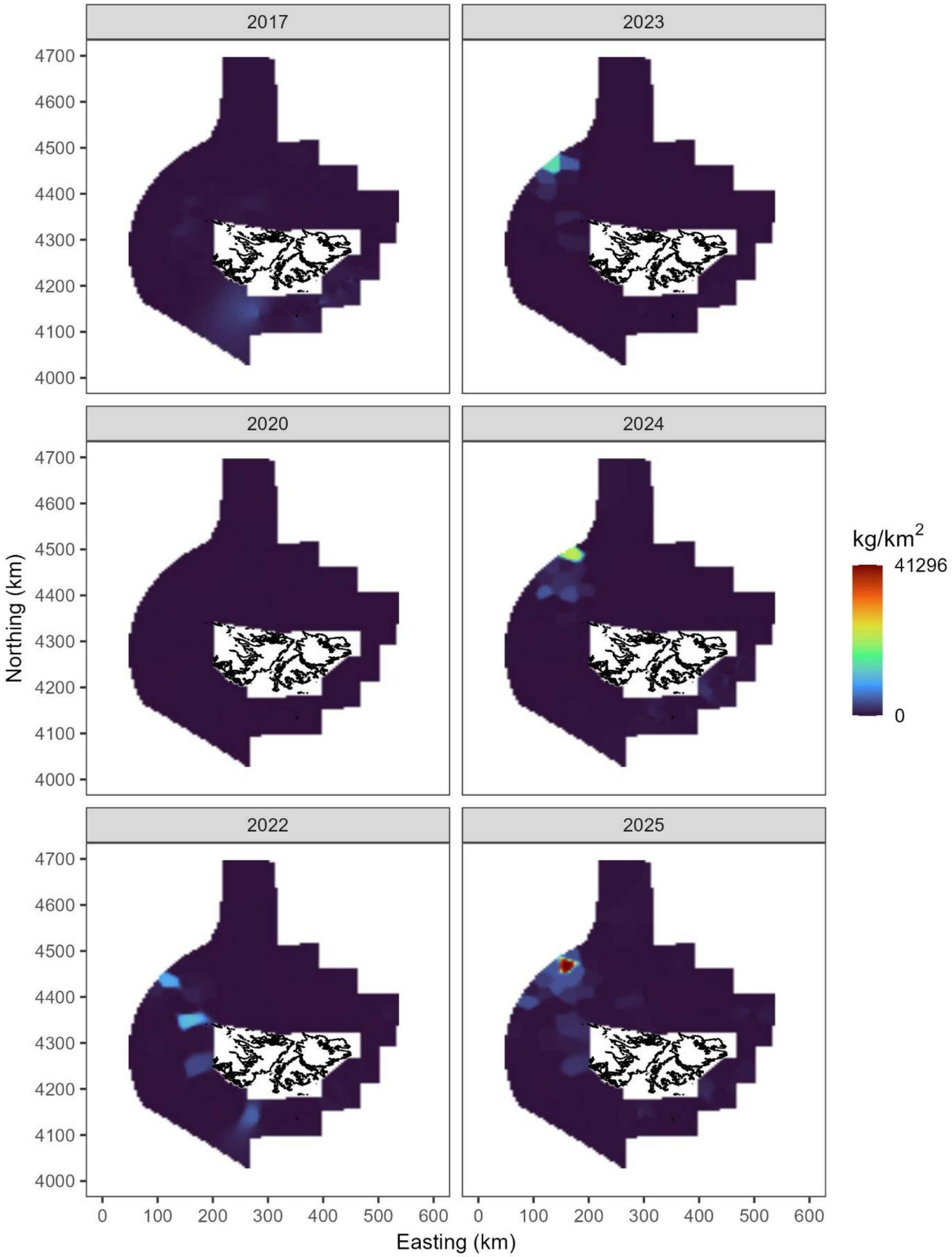
Comparative density (kg/km^2) distribution of Patagonian toothfish (*Dissostichus eleginoides*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.



Appendix XV. Red cod inter-annual distribution
Comparative density (kg/km^2) distribution of red cod (*Salilota australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.

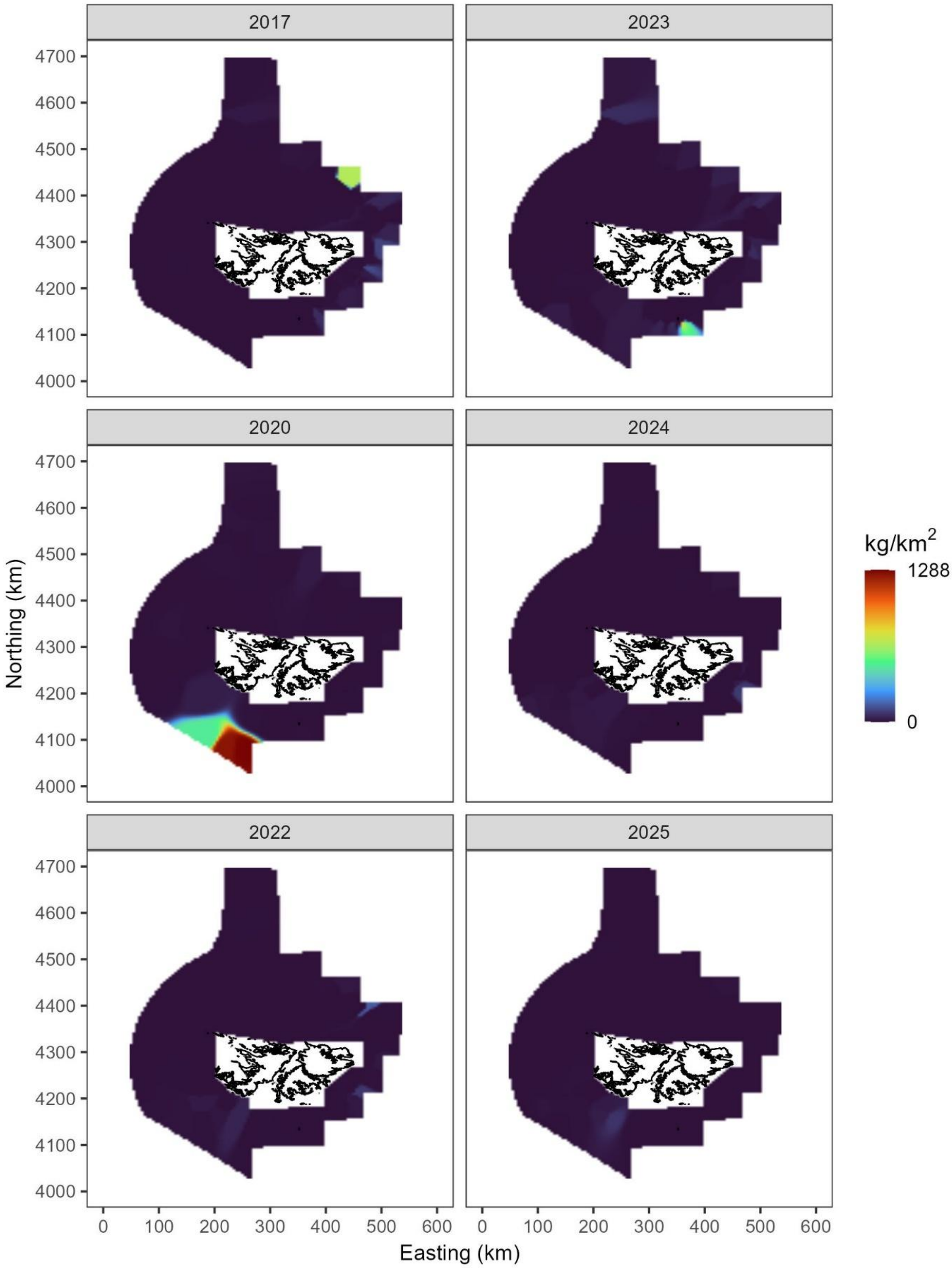


Appendix XVI. Rock cod inter-annual distribution
Comparative density (kg/km^2) distribution of rock cod (*Patagonotothen ramsayi*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.



Appendix XVII. Southern blue whiting inter-annual distribution

Comparative density (kg/km²) distribution of southern blue whiting (*Micromesistius australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.



Appendix XVIII. Southern hake inter-annual distribution
Comparative density (kg/km^2) distribution of southern hake (*Merluccius australis*) during the July 2017, 2020, and 2022–2025 groundfish and calamari pre-season surveys in Falkland Islands waters.