Variability in the distribution of Antarctic krill (*Euphausia superba*) during austral winter



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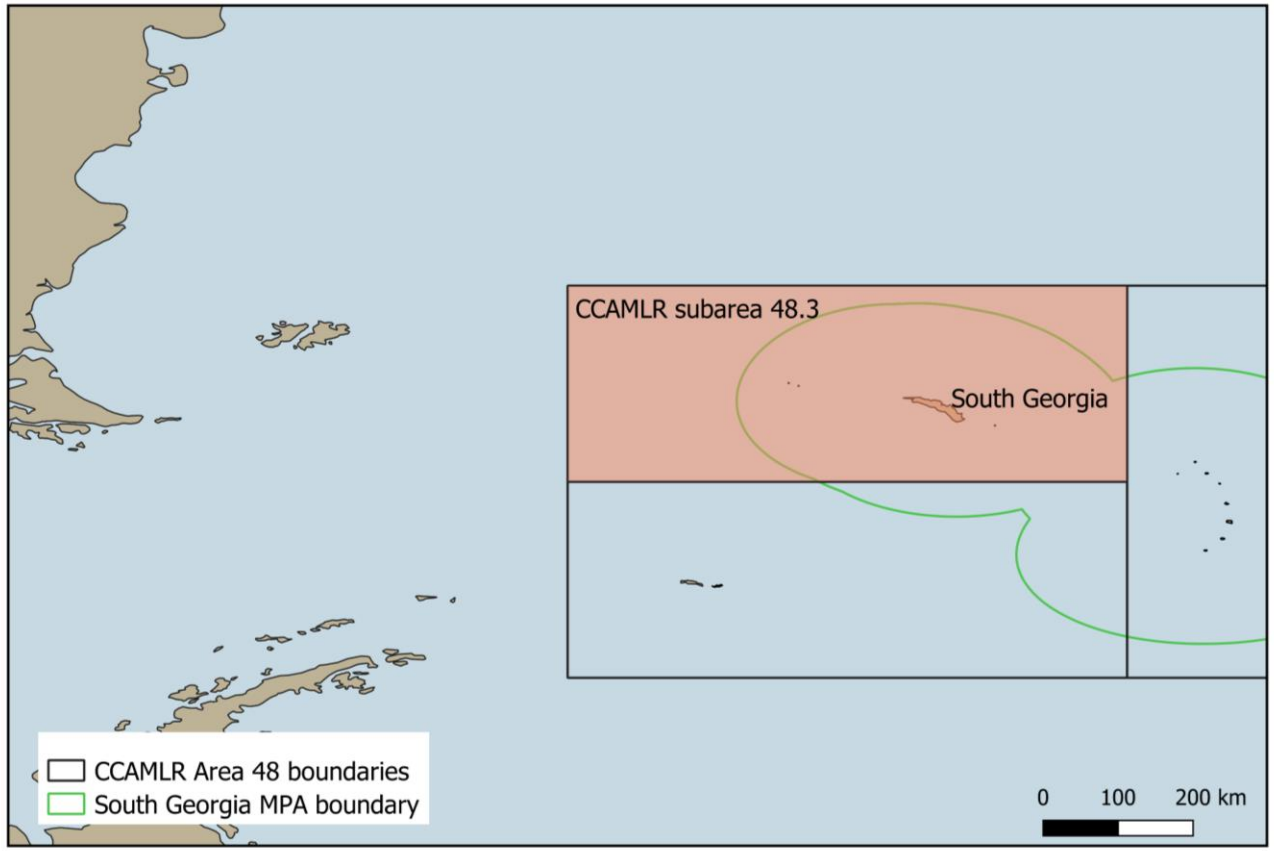
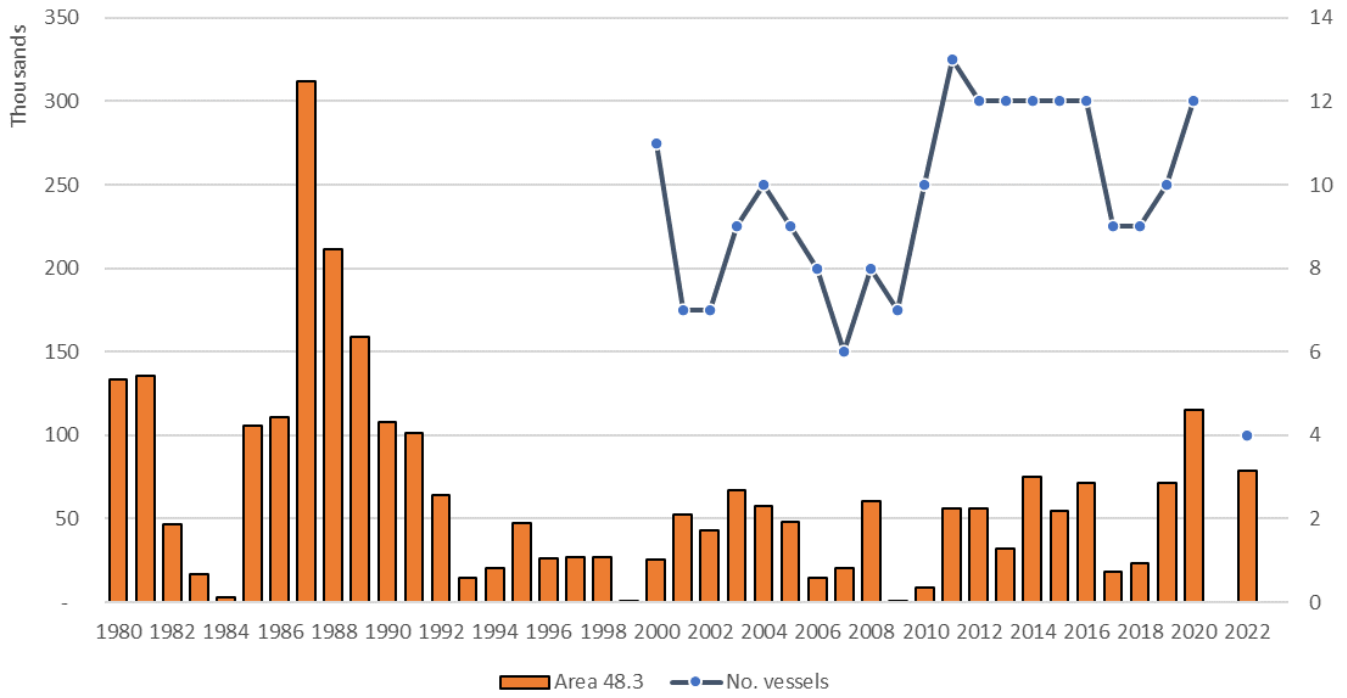
Krill fishery at South Georgia



- Managed by GSGSSI within CCAMLR framework
- 279,000 t catch limit
- Enhanced spatial and temporal restrictions in SG MPA to protect predator populations
  - Restricted to winter (May-Sept)
  - No fishing within 30 km No-Take Zone

Krill fishery at South Georgia

- Lack of winter data
- Fishery concentrated on SG shelf
- Potential overlap with predators
- Catches/ vessels on increasing trend?



The Winter Krill project

Resolving ecosystem effects of the South Georgia winter krill fishery

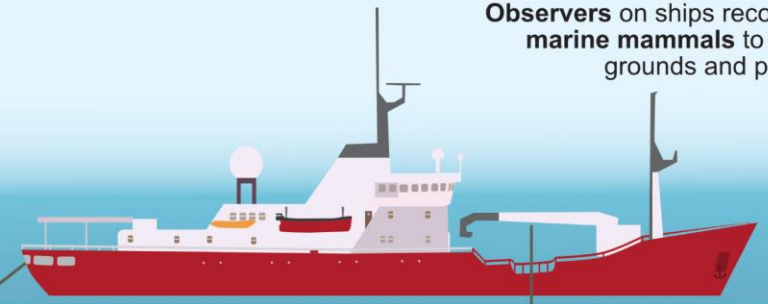
The productive waters surrounding South Georgia support large populations of krill-dependent seabirds, seals and whales, as well as a commercial fishery for Antarctic krill

To understand the effects of the krill fishery on the South Georgia ecosystem, the **Winter Krill** project aims to:

- Collect data on the abundance and distribution of krill stocks over the fishing season
- Understand the overlap between predators and krill within the fishery area

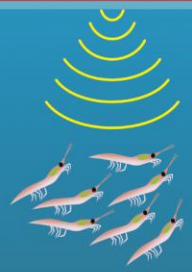
Penguin foraging trips are monitored using **satellite tracking** tags

Observers on ships record **sightings** of **seabirds** and **marine mammals** to identify important foraging grounds and predator populations



Plankton nets are used to measure the size and condition of krill throughout the fishing season

Conductivity Temperature Depth sensor measures oceanographic conditions



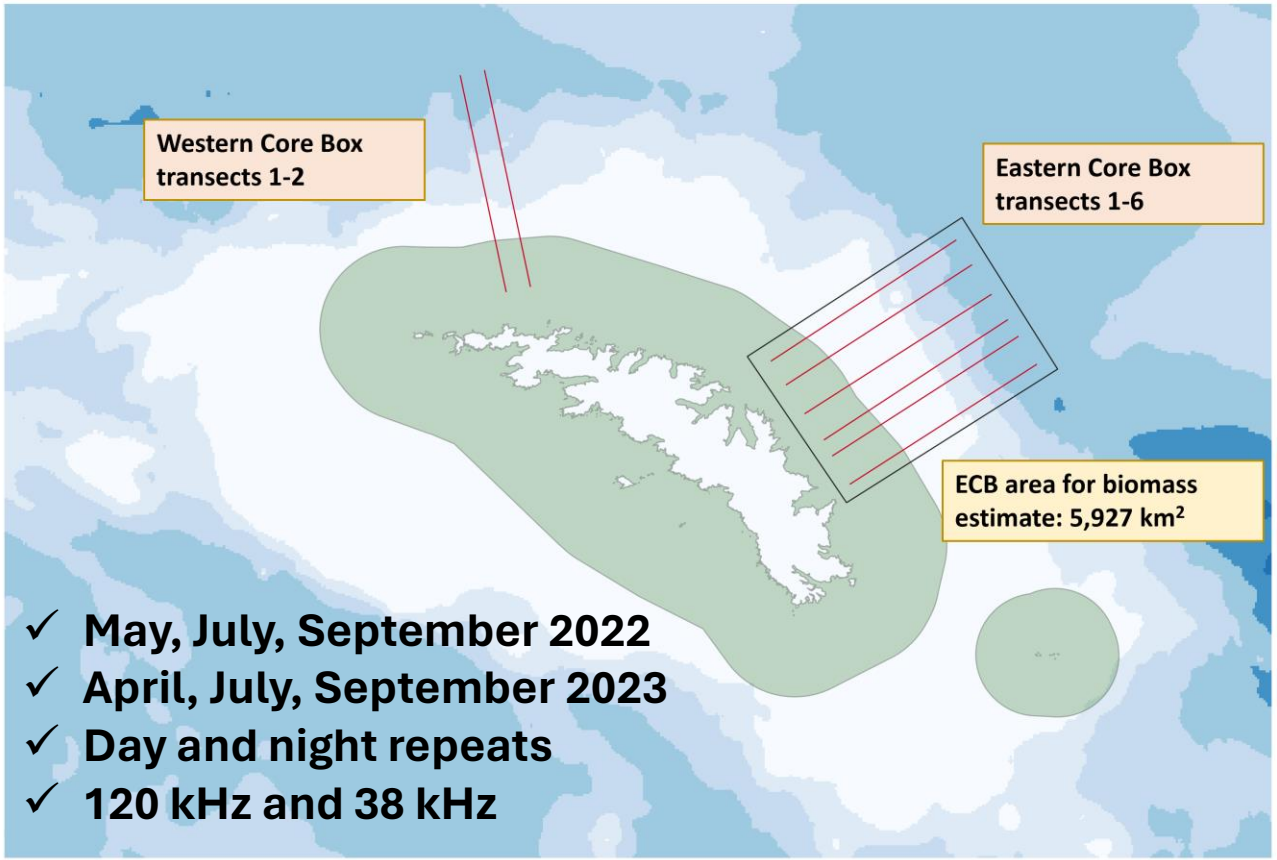
Regular acoustic surveys using ships **echosounders** estimate the biomass of krill and how this changes with time

Passive acoustic monitoring is used to help detect **whales** underwater

The winter krill project is funded by Darwin Plus and delivered by the British Antarctic Survey in partnership with the Antarctic Research Trust and the Governement of South Georgia and the South Sandwich Islands.

Image credit: Tracey Dornan

Krill acoustic surveys



Acoustic data processing methodology

Data collection

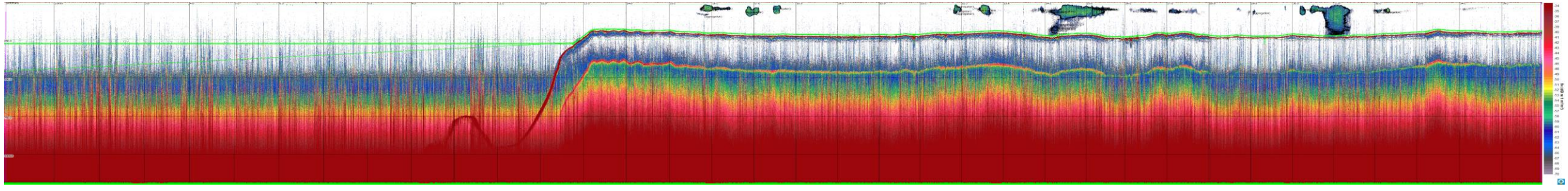
- 38 and 120 kHz data collected with EK80
- *In-situ* sphere calibration
- Day & night transect repeats
- CTDs inshore & offshore
- Plankton tows for krill LF

Data processing

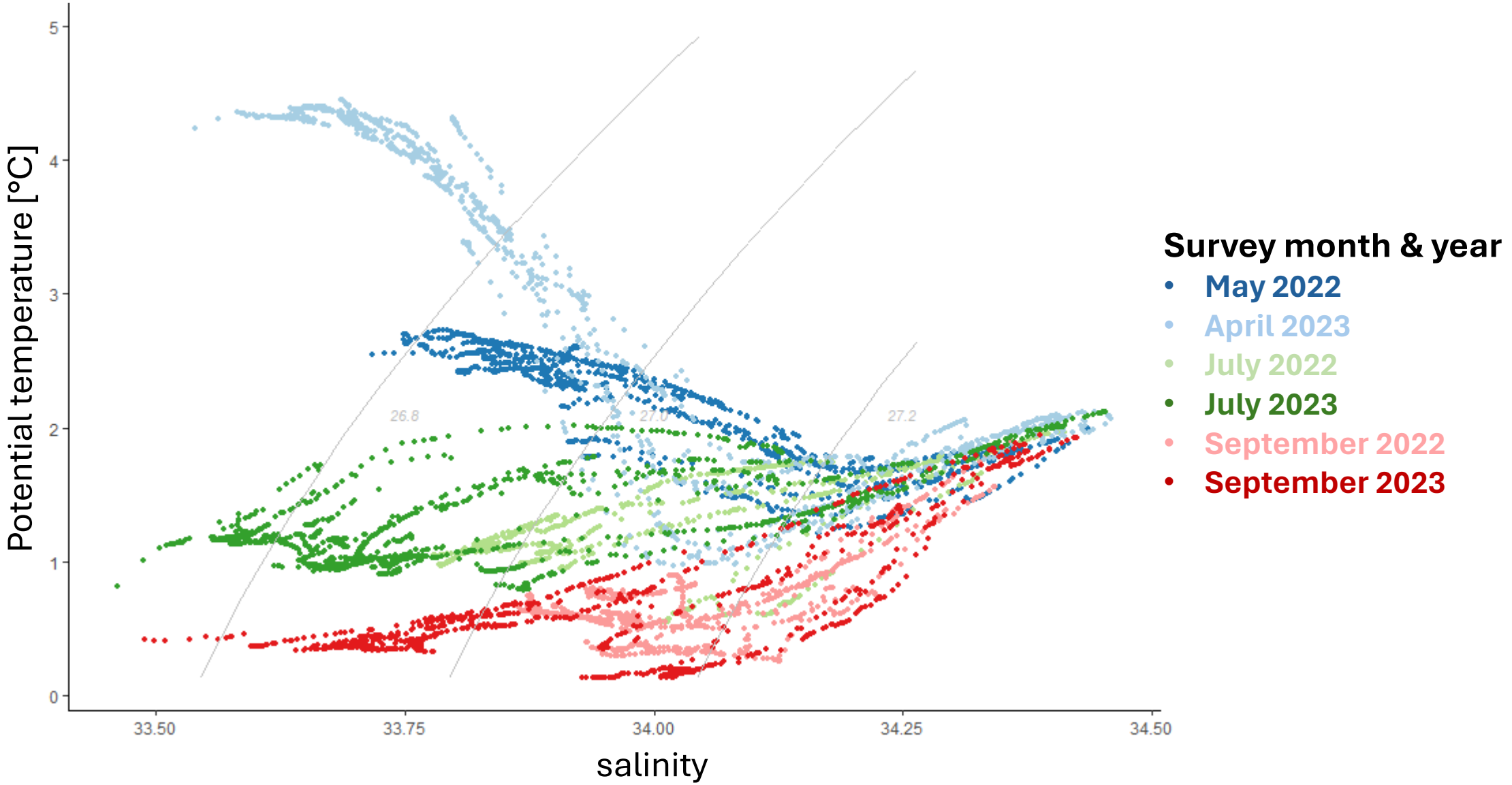
- Data calibration with in-situ T, S, sound-speed
- Off-effort regions applied, background noise removed, surface exclusion
- CCAMLR swarms algorithm run on 120 kHz data
  - → NASC integrated over 1 nm x 250 m bins
  - → Swarm metrics exported
- NASC to biomass conversion using TS model and krill LF from surveys & fishery

Data analysis

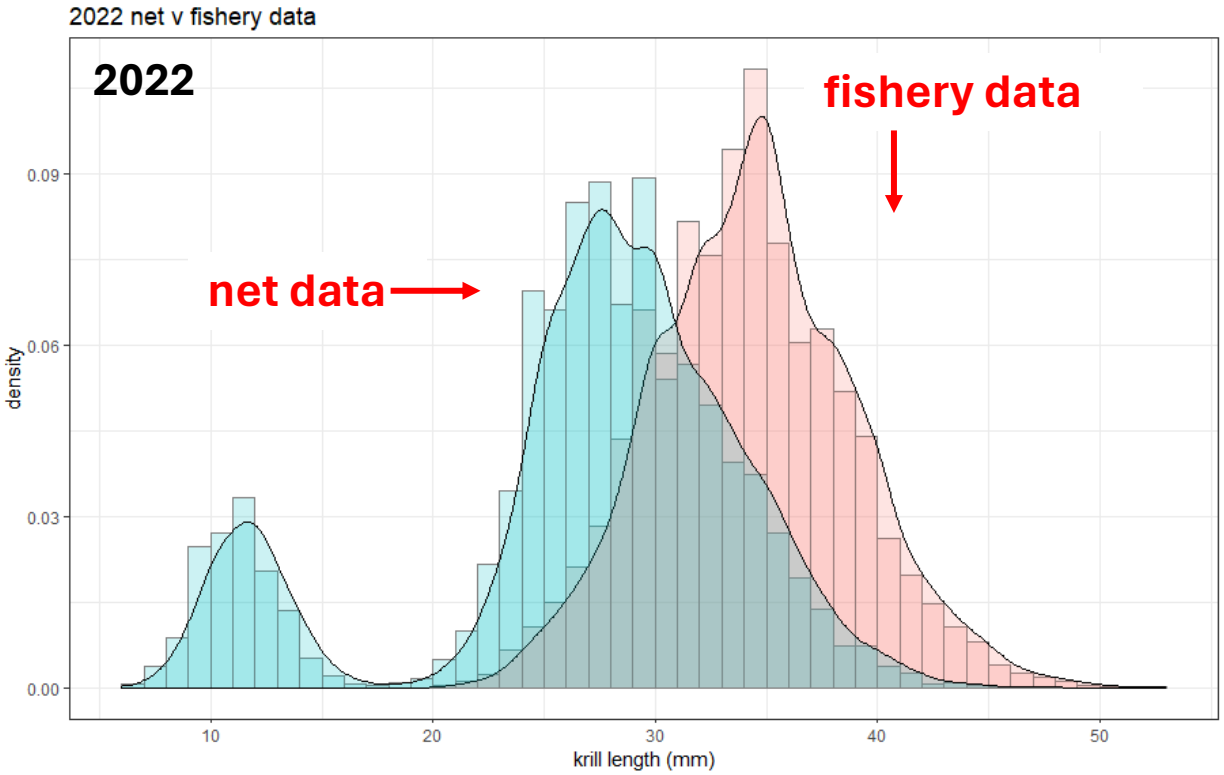
- ECB areal biomass (tonnes)
- ECB average density (g m^{-2})
- Krill distribution through season and day/night
- Krill swarm metrics evaluated e.g. number, size, depth, density, location…
- Sensitivity analyses:
  - → Short-term temporal variation
  - → Day vs night
  - → Integration depth

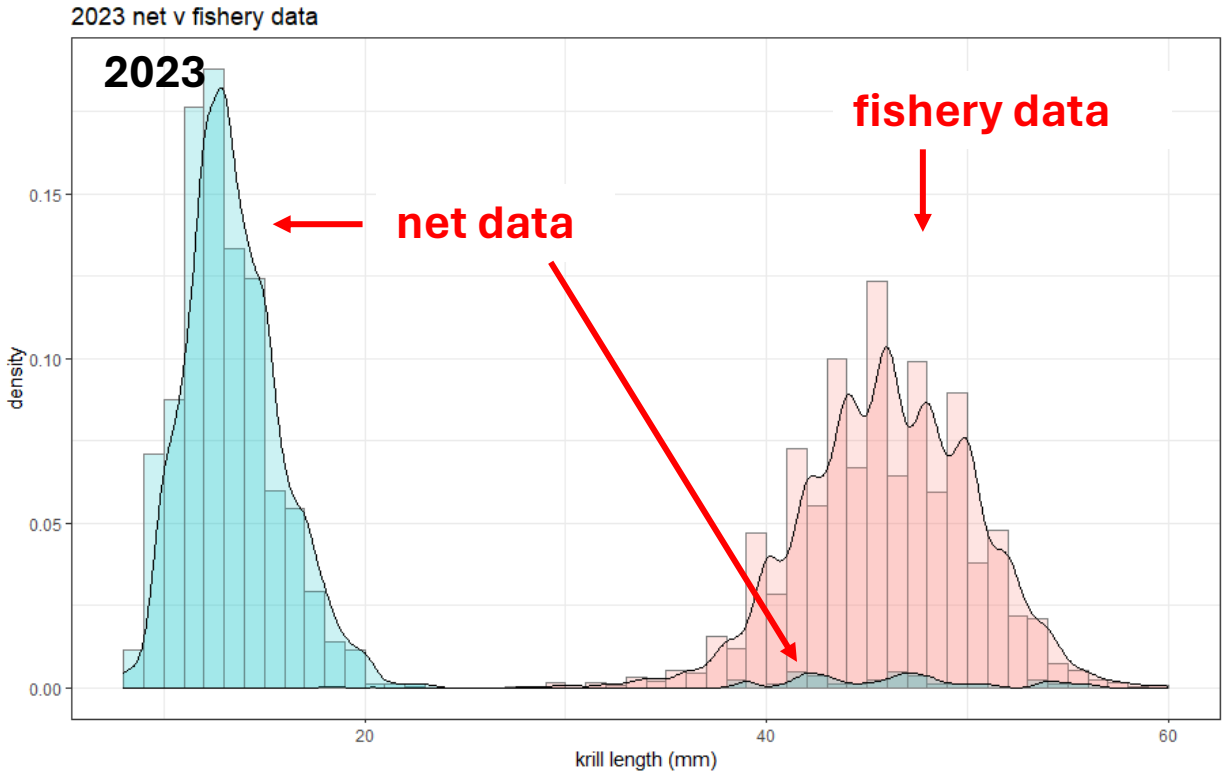


Environmental context



Length-frequency: net vs fishery data



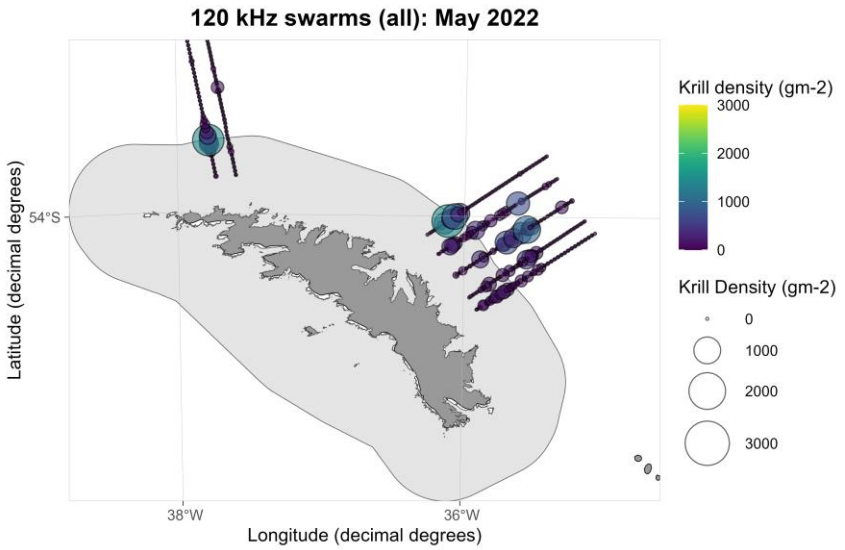


Data type	Mean (mm)	SD	Median (mm)
fishery	34.5	4.52	34
Net	27.1	7.39	28

Data type	Mean (mm)	SD	Median (mm)
fishery	46.1	4.30	46
net	14.7	6.56	13

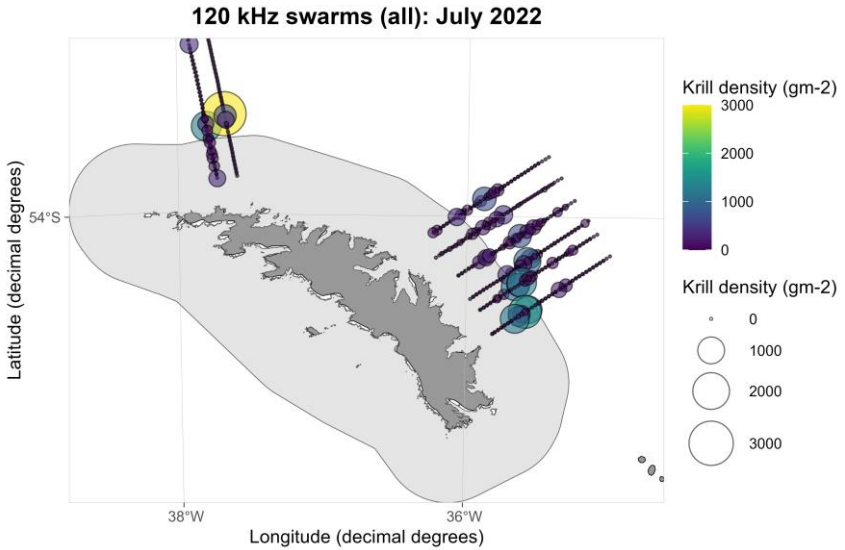
Krill density distribution & areal biomass: 2022

May



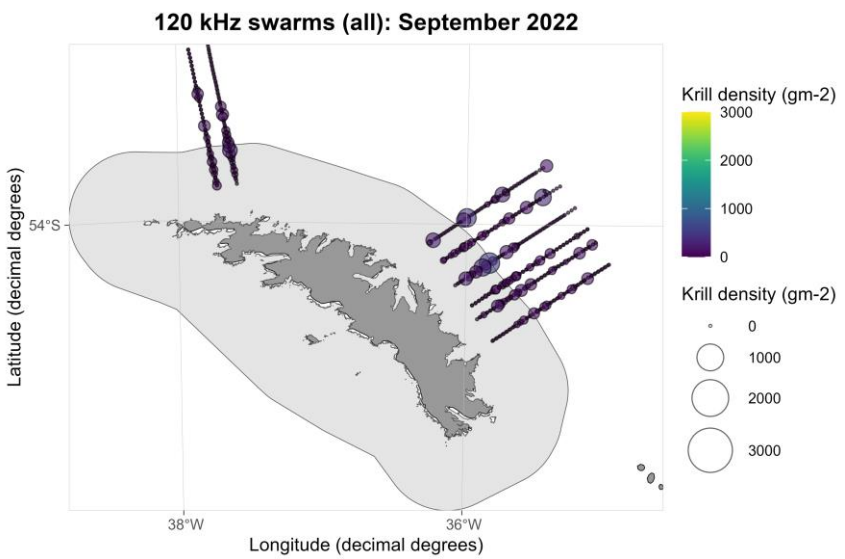
ECB mean krill density	45.3 g m^{-2}
Biomass (1000 tonnes)	269

July



ECB mean krill density	41.5 g m^{-2}
Biomass (1000 tonnes)	246

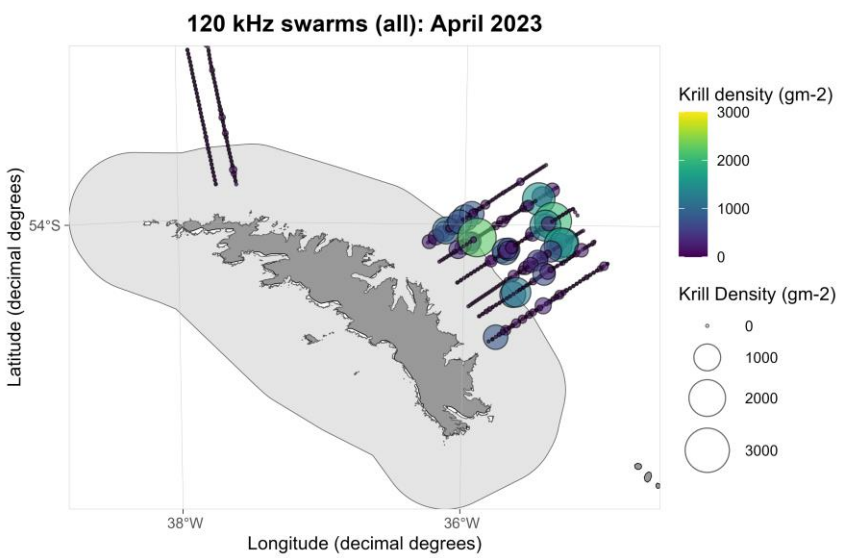
September



ECB mean krill density	12.8 g m^{-2}
Biomass (1000 tonnes)	76

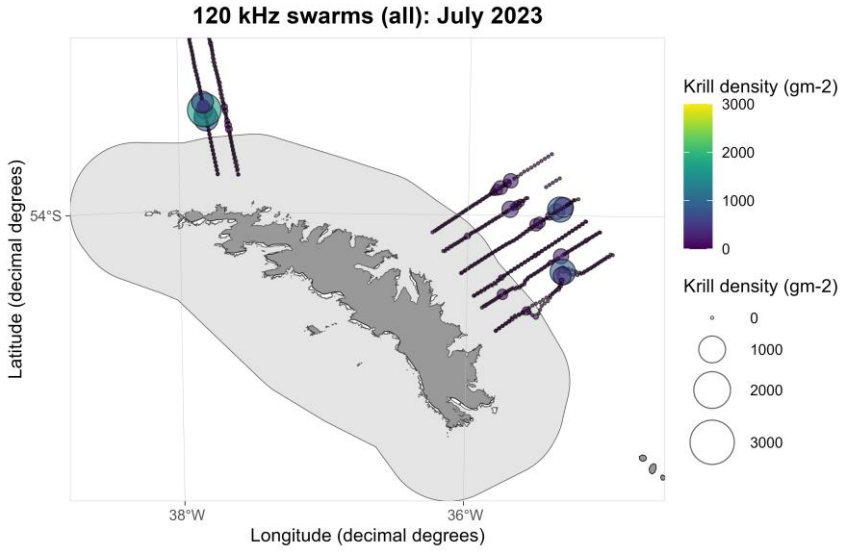
Krill density distribution & areal biomass: 2023

April



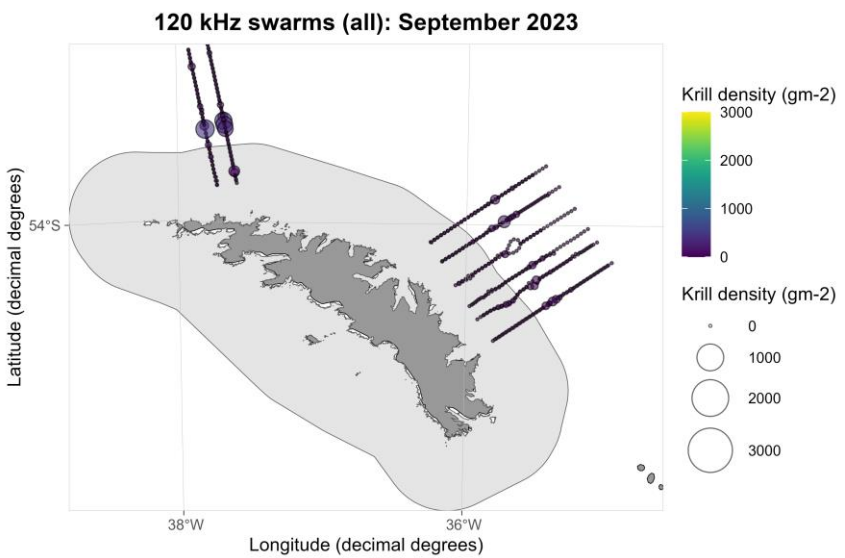
ECB mean krill density	96.9 g m^{-2}
Biomass (1000 tonnes)	574

July

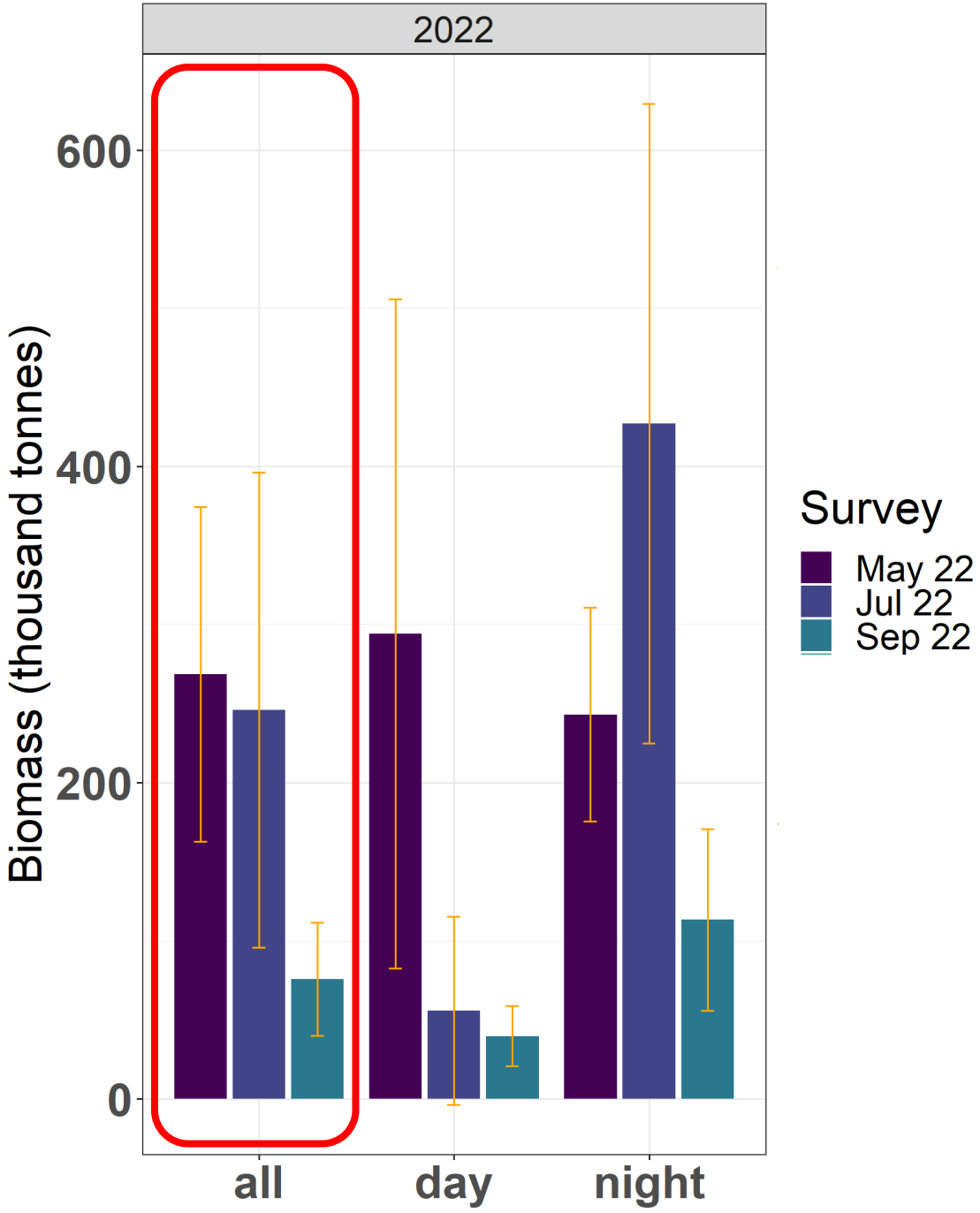


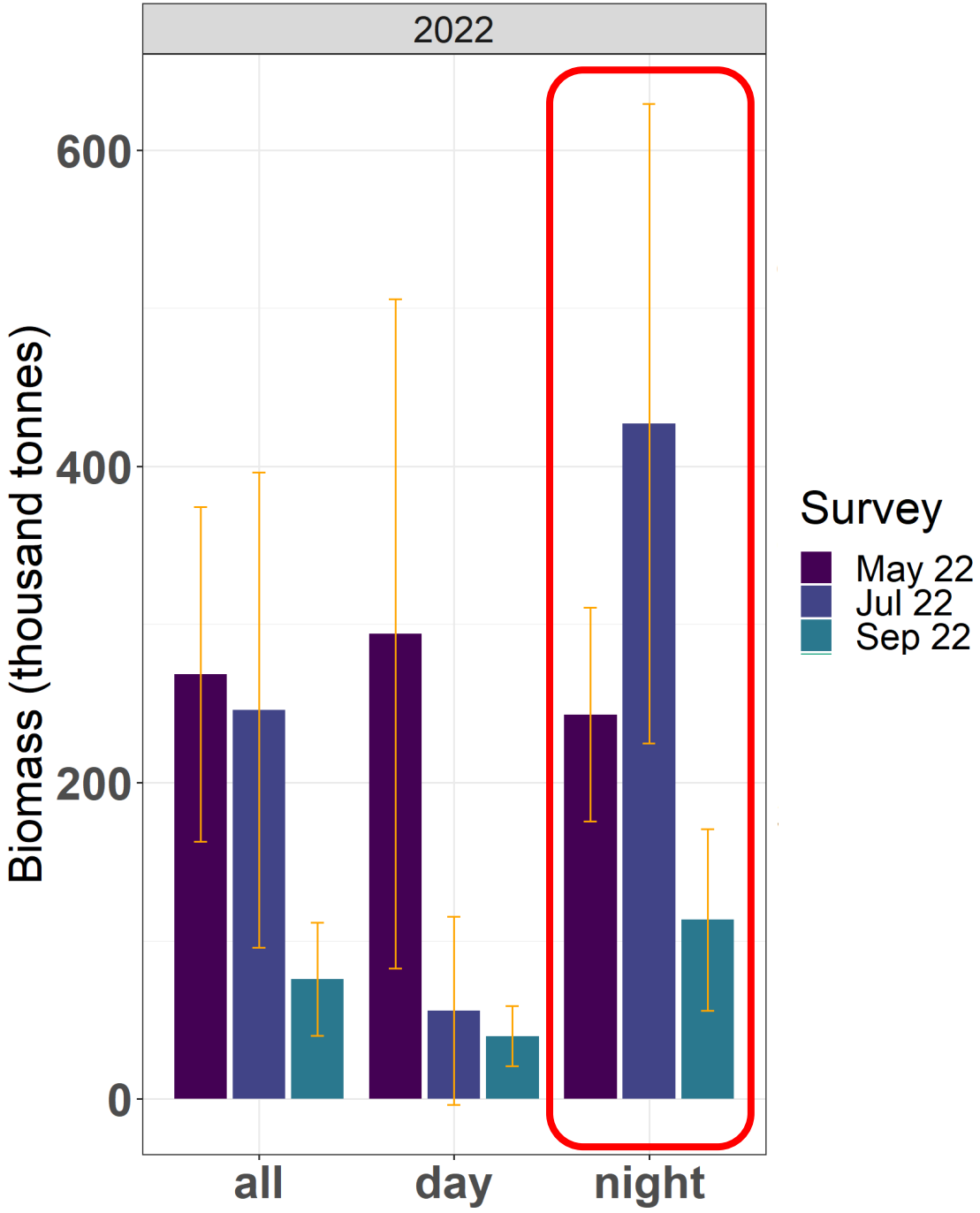
ECB mean krill density	10.7 g m^{-2}
Biomass (1000 tonnes)	63

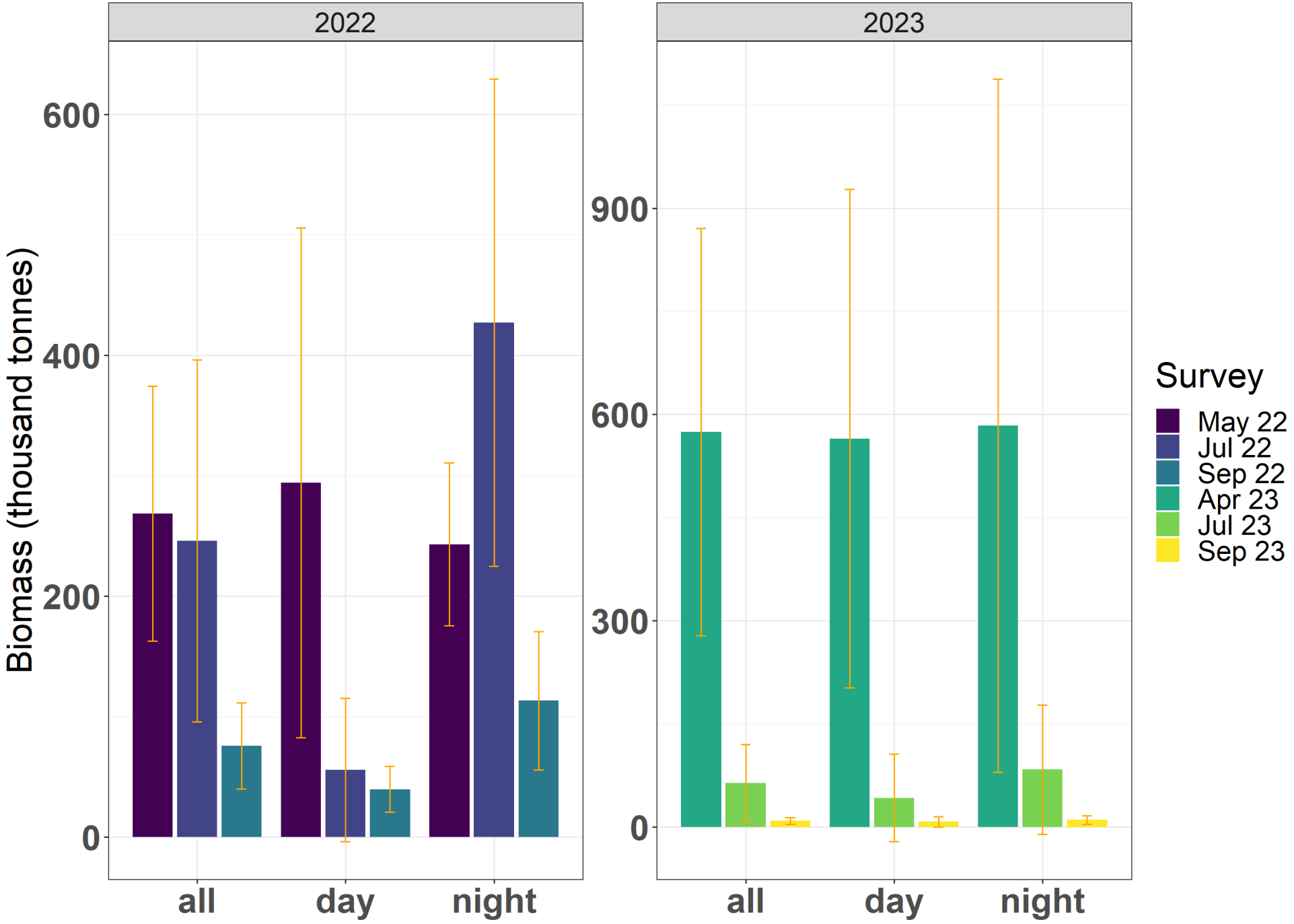
September



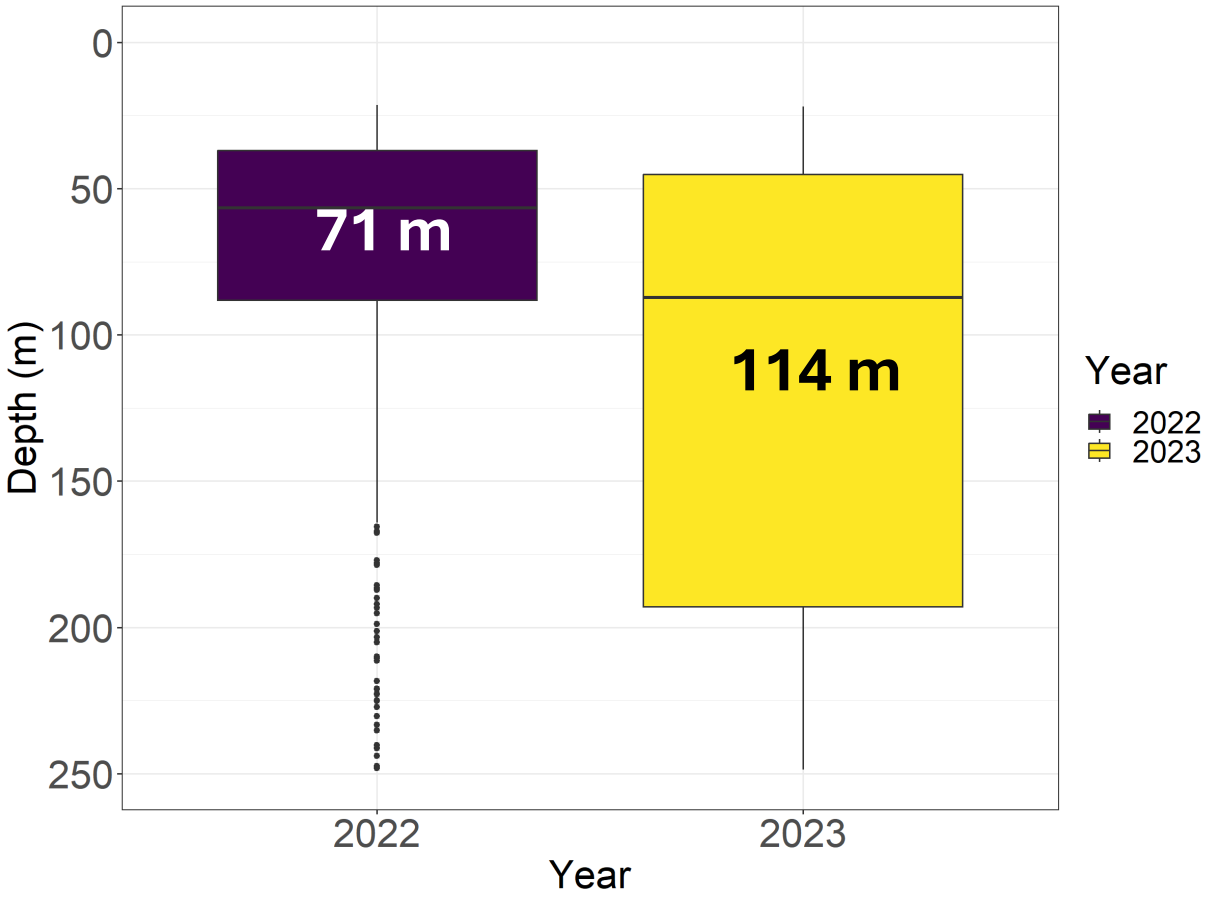
ECB mean krill density	1.5 g m^{-2}
Biomass (1000 tonnes)	9


2022
600
400
200
0
Biomass (thousand tonnes)
all
day
night
Survey
May 22
Jul 22
Sep 22

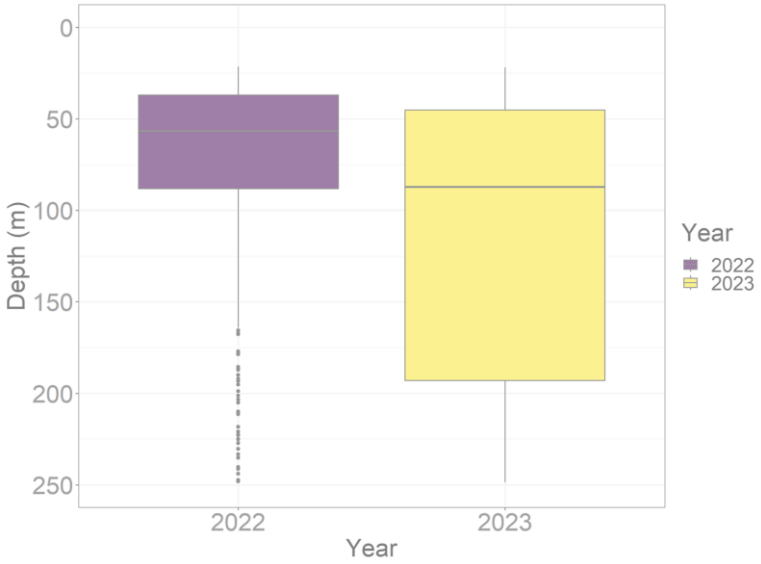

2022
600
400
200
0
Biomass (thousand tonnes)
all
day
night
Survey
May 22
Jul 22
Sep 22

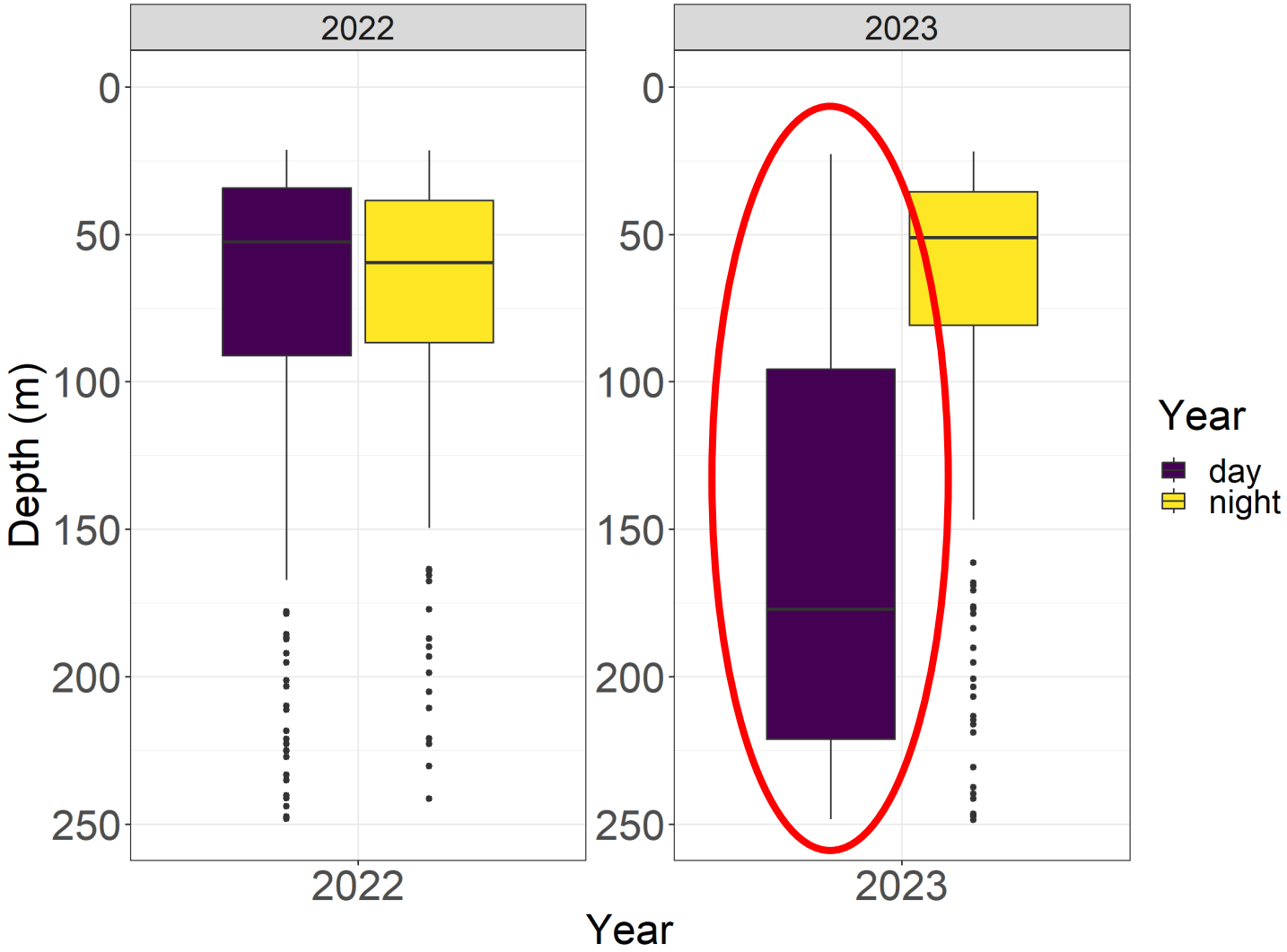

2022
2023
Biomass (thousand tonnes)
600
400
200
0
900
600
300
0
all
day
night
Survey
May 22
Jul 22
Sep 22
Apr 23
Jul 23
Sep 23

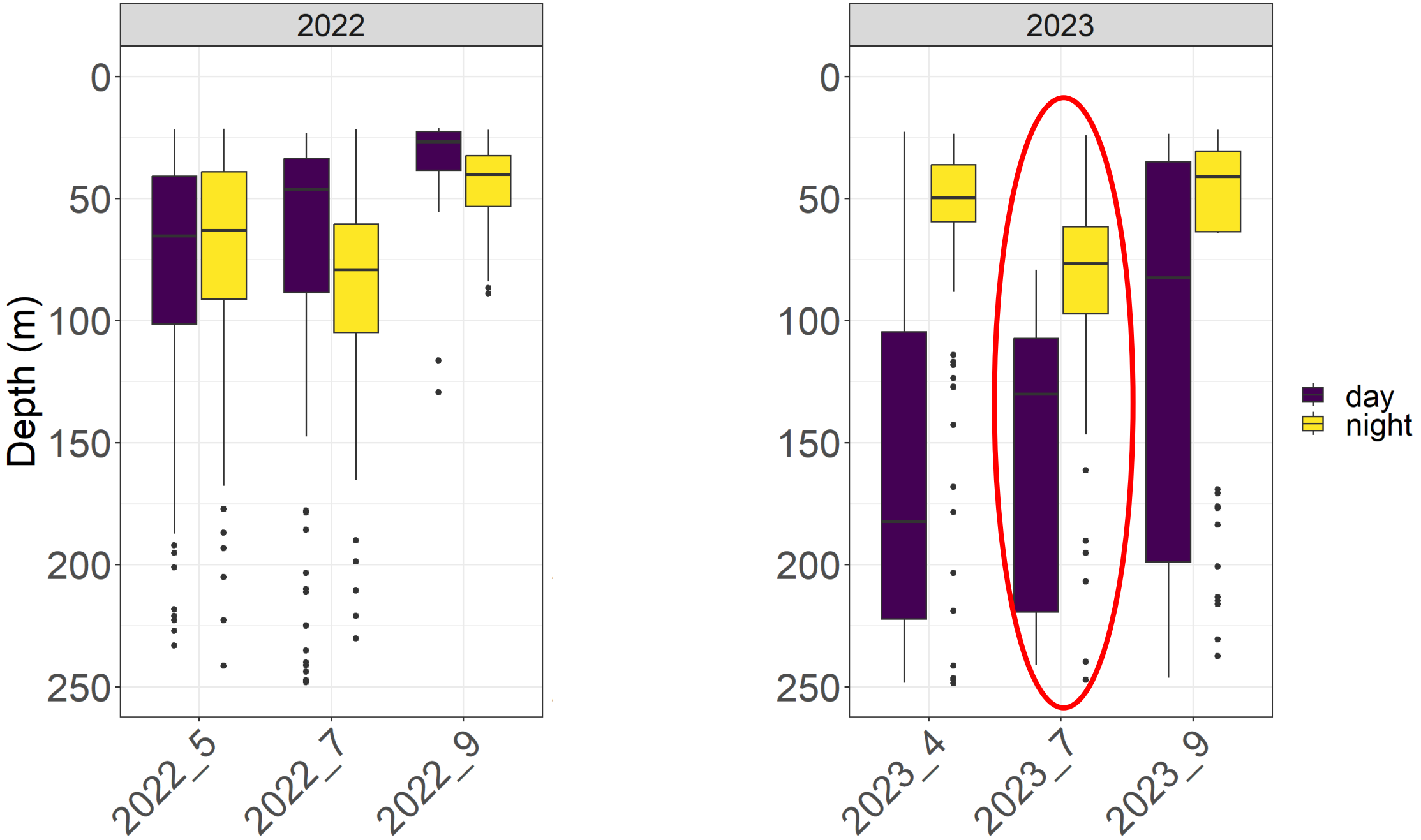
Swarm depth - difference between years



Swarm depth – diurnal difference






2022
2023
Depth (m)
0
50
100
150
200
250
2022_5
2022_7
2022_9
2023_4
2023_7
2023_9
day
night

Summary

- Krill density and biomass decreased in the ECB throughout winter
- Winter biomass estimates are subject to diurnal variability but generally higher using night-time transects
- Diurnal variability was evident in swarm depth but the pattern reversed between years

? Are deeper swarms and/or lower biomass in 2023 related to local effects of icebergs?

Thanks to:

Darwin Plus, Government of South Georgia & South Sandwich Islands, Antarctic Research Trust, Captain & crew of MV *Pharos SG,* Norman Ratcliffe, Klemens Putz, Kate Owen, Megan Goggins, Carrie Gunn, George Perry, Susannah Calderan, Russell Leaper, Paula Olson, Ryan Irvine, Garry Taylor, Paul French, Conor Ryan and many others.