SGSSI MPA Review Science Symposium

13-14 June 2023
Aurora Conference Centre
Cambridge, UK

Hosted by the Government of South Georgia & the South Sandwich Islands

Pelagic & Benthic Ecosystems

- **Temporal patterns in South Georgia zooplankton: insights from a moored echosounder.** *Tracey Dornan (BAS)*
- **Cephalopods of the South Georgia & South Sandwich Islands regions: relevance from a MPA perspective.** *José Quieros (University of Coimbra)*
- **Biodiversity of South Georgia's Seaweeds: unique, charismatic and essential.** *Juliet Brodie (Natural History Museum)*
- **Connectivity patterns are species dependent in Southern Ocean deep-sea corals.** *Michelle Taylor (University of Essex)*
- **Overview and first results of the RV *Polarstern* expedition PS133-2 "Island Impact" to South Georgia in Nov/Dec 2022.** *Sabine Kasten (Alfred Wegener Institute)*
- **From Bubbles to Biology: South Georgia's Methane Seep Communities.** *Madeline Anderson (BAS)*

Tracey Dornan

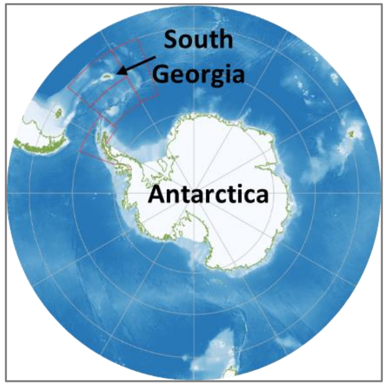
British Antarctic Survey

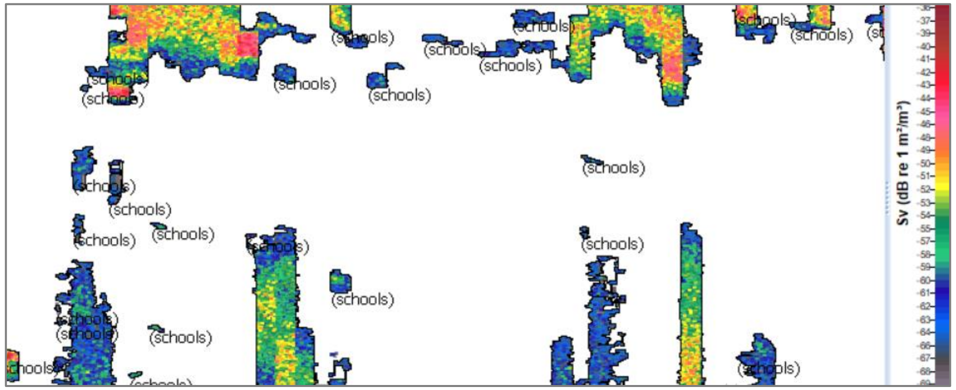
Temporal patterns in South Georgia zooplankton:

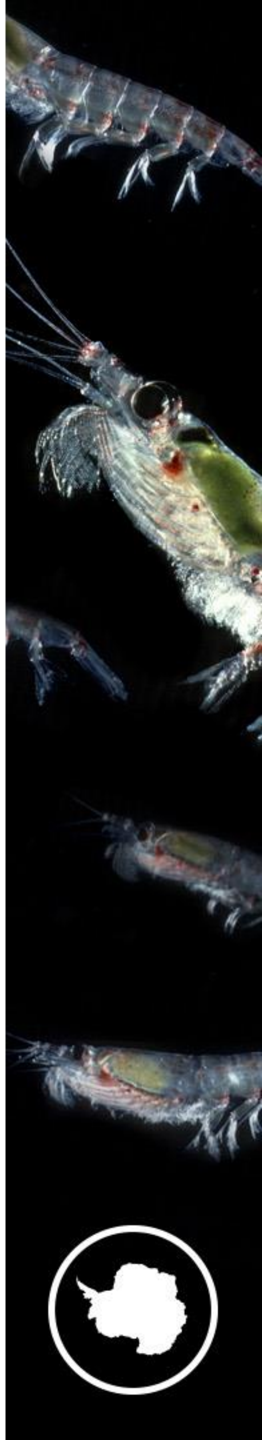
Insights from a moored echosounder

Tracey Dornan (British Antarctic Survey)

Sophie Fielding, Geraint Tarling







nature COMMUNICATIONS

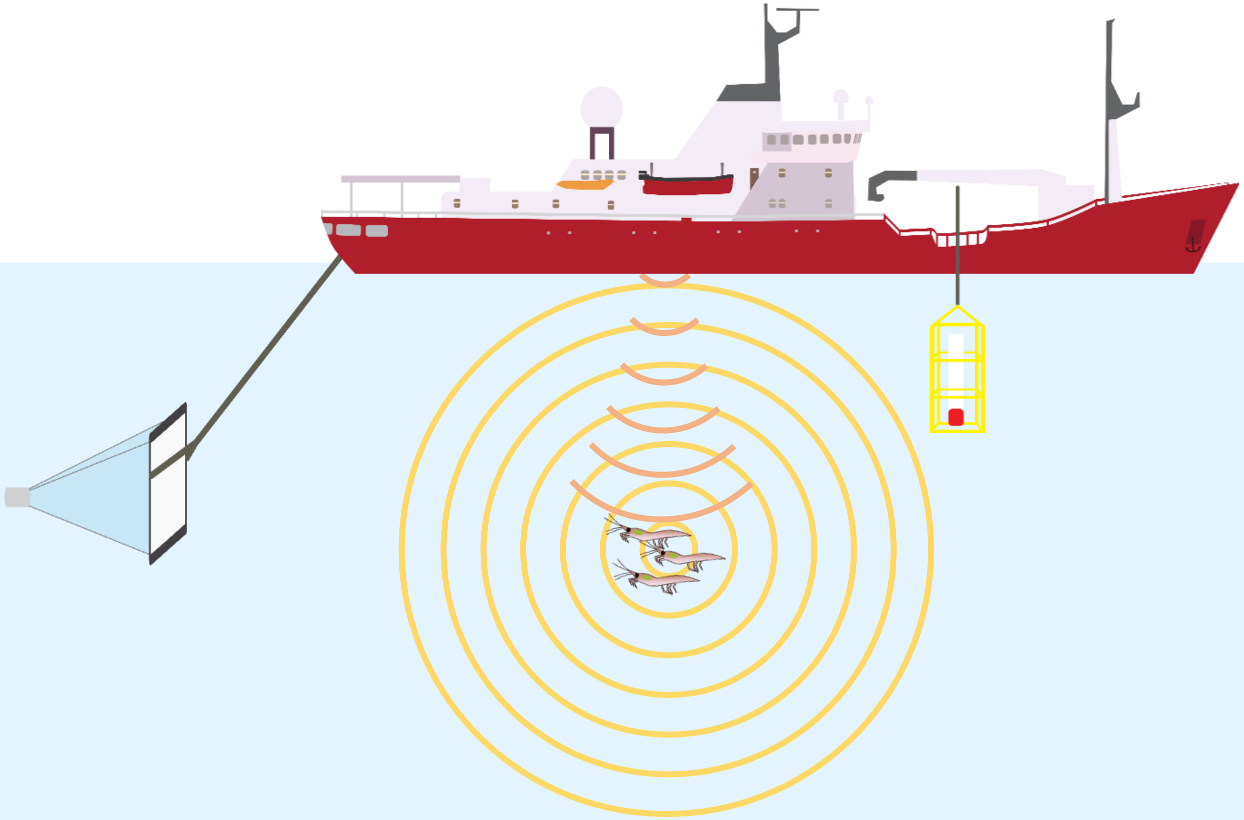
REVIEW ARTICLE

https://doi.org/10.1038/s41467-019-12668-7 OPEN

The importance of Antarctic krill in biogeochemical cycles

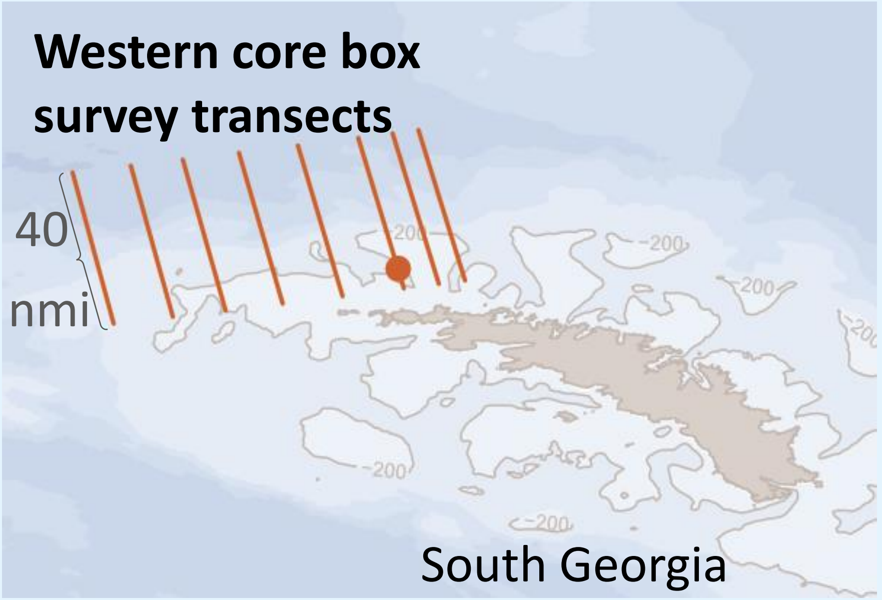
E.L. Cavan[1,12*], A. Belcher[2], A. Atkinson[3], S.L. Hill[2], S. Kawaguchi[4], S. McCormack[1,5], B. Meyer[6,7,8], S. Nicol[1], L. Ratnarajah[9], K. Schmidt[10], D.K. Steinberg[11], G.A. Tarling[2] & P.W. Boyd[1,5]

Antarctic krill surveys – ship

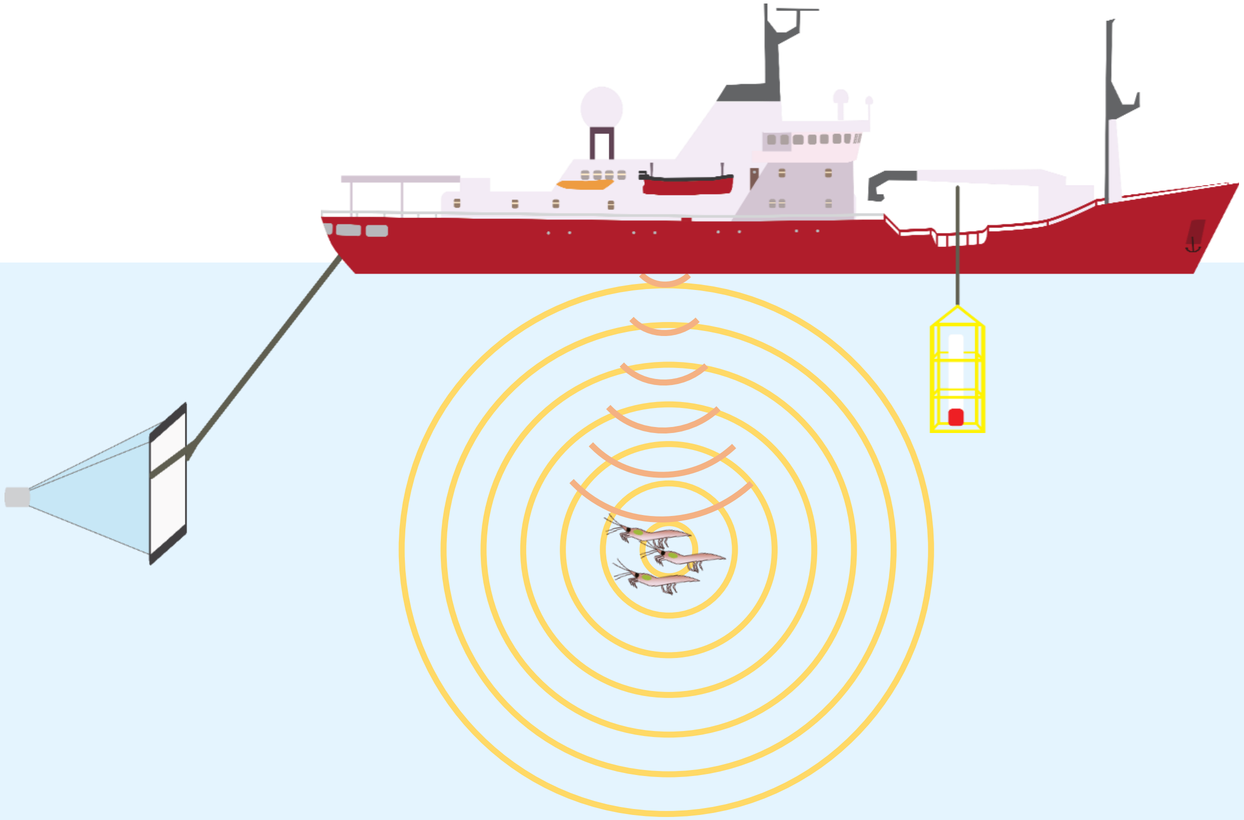


Benefits

- Multiple frequencies
- Good spatial coverage
- Lots of data storage
- Additional sampling



Antarctic krill surveys – ship



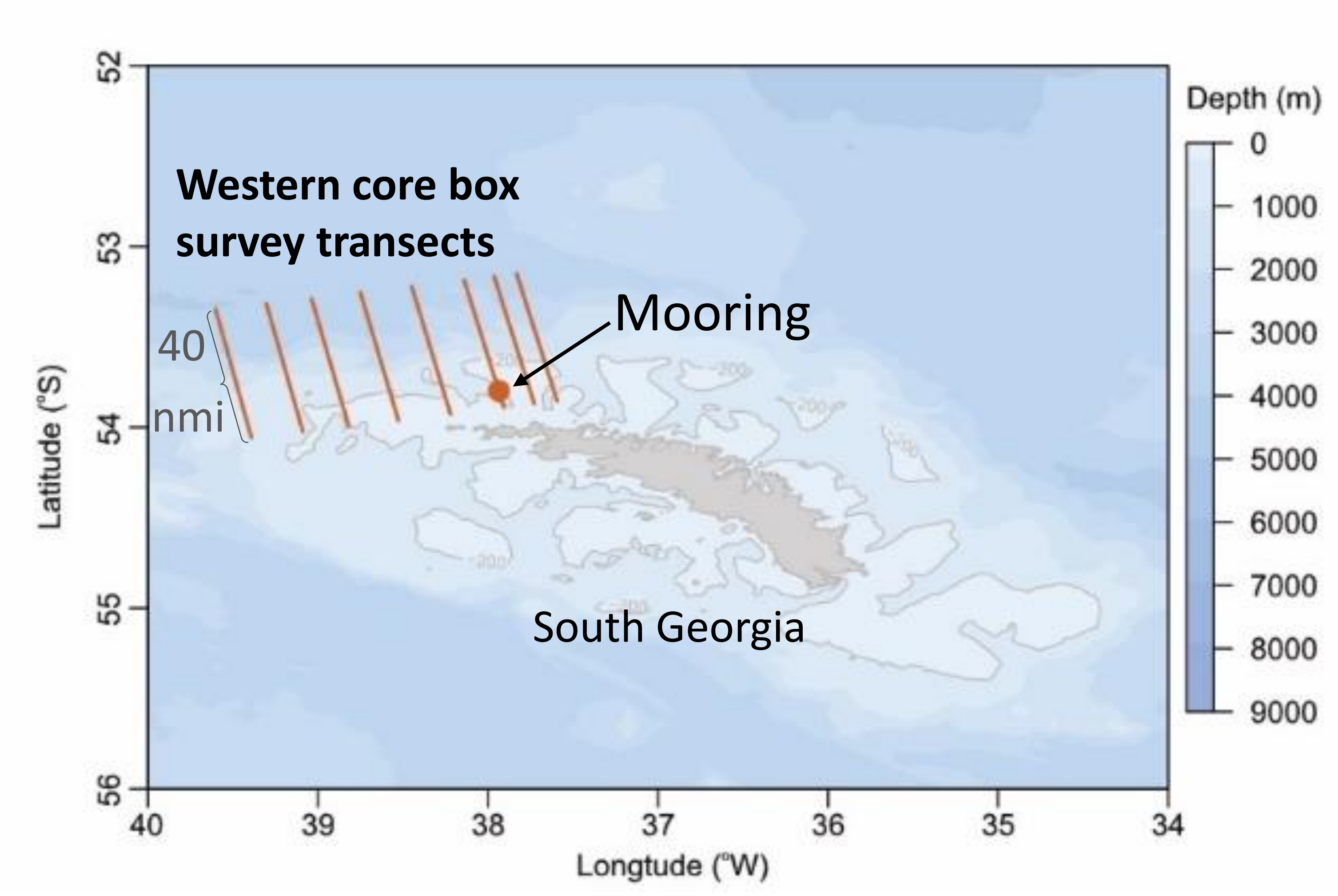
Benefits

- Multiple frequencies
- Good spatial coverage
- Lots of data storage
- Additional sampling

Challenges

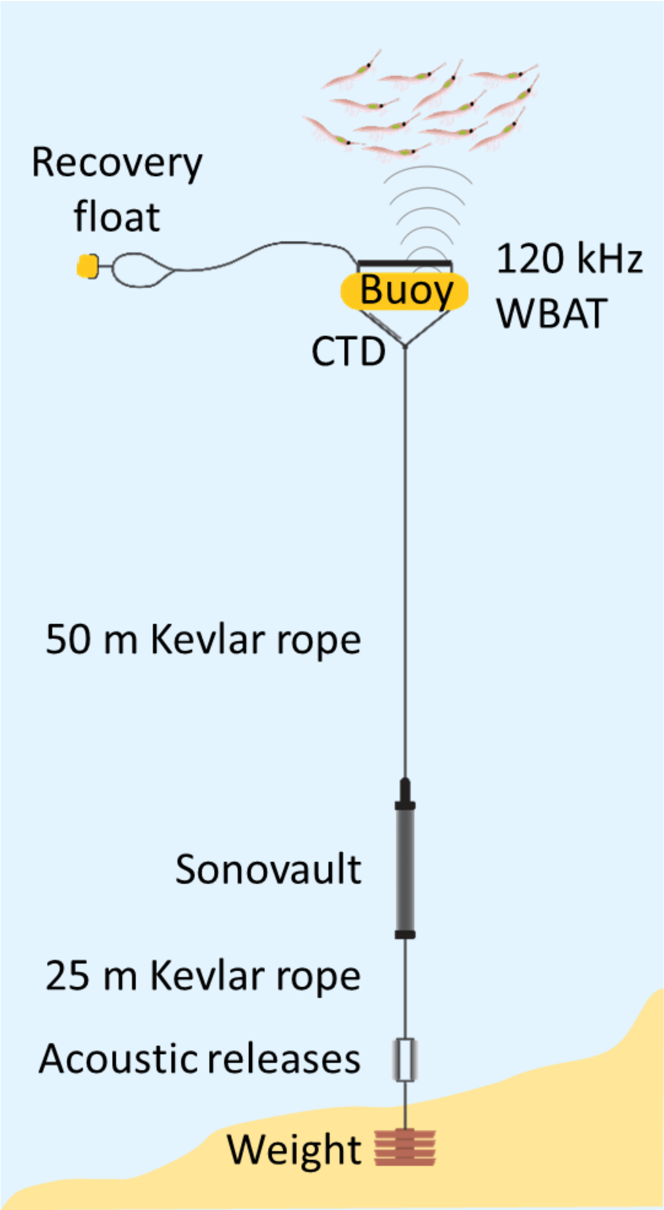
- Expensive
- Polluting
- Time limited
- Mismatch with fishery

South Georgia study location



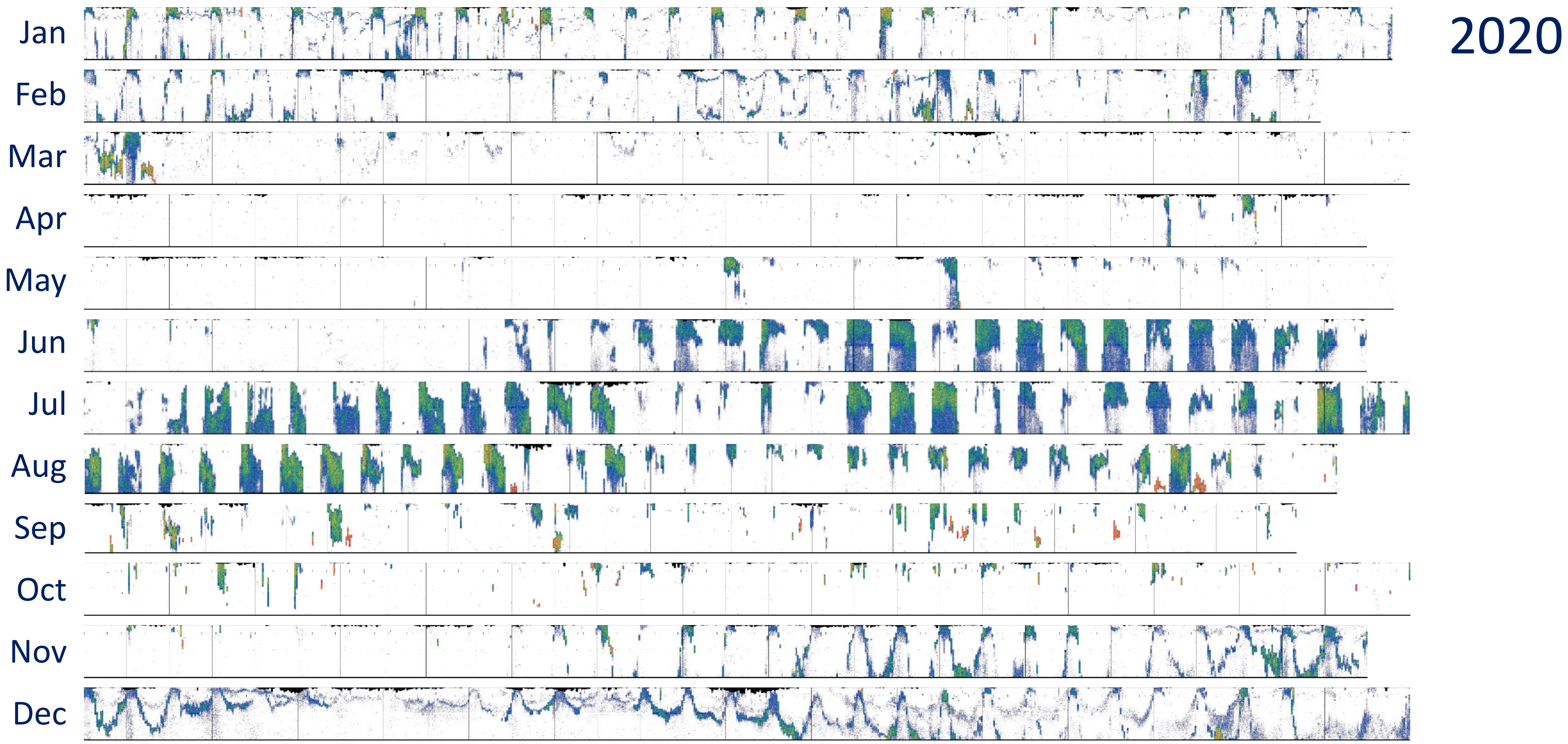
South Georgia mooring setup

- Jan 2018 – Jan 2022
- Annual deployments
- Samples surface 175 m
- Wideband Autonomous Transceiver (WBAT)
- Upwards facing 120 kHz transducer
- Hourly ping cycle
    - 15 pings (4 s ping interval)
    - 1 min each of CW then FM (chirp)

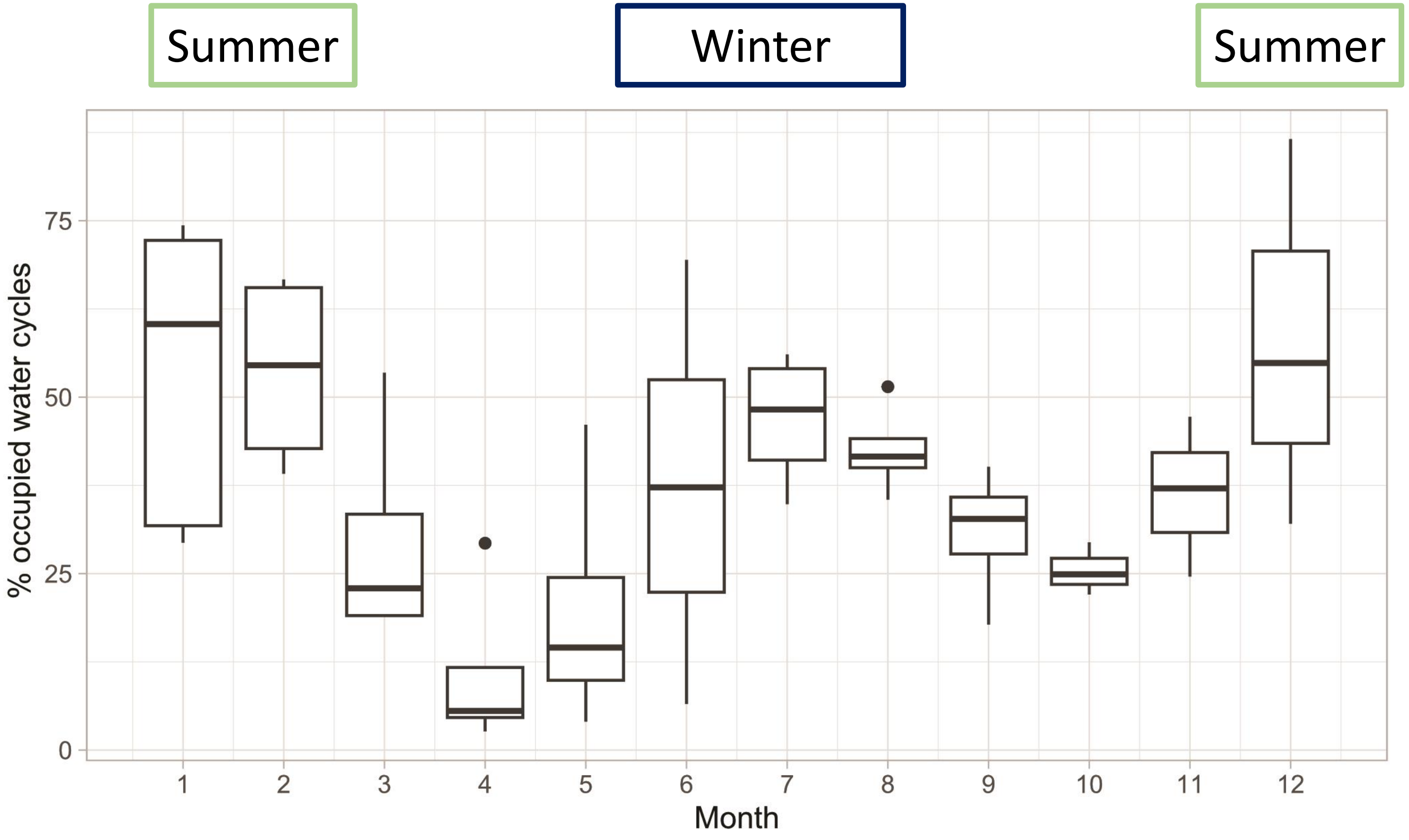


Western Corebox Mooring 2019

Annual data

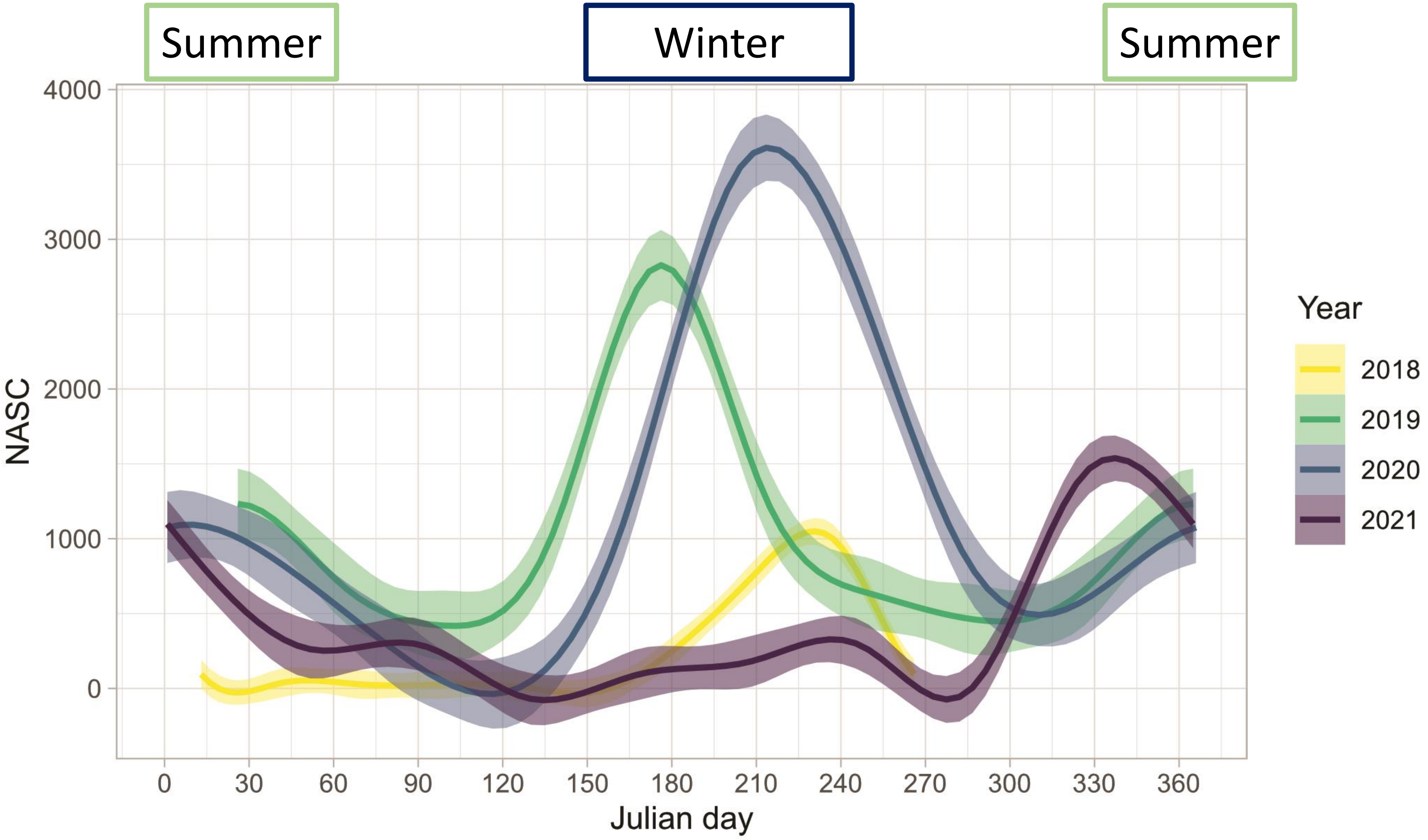


Temporal variation in water occupation

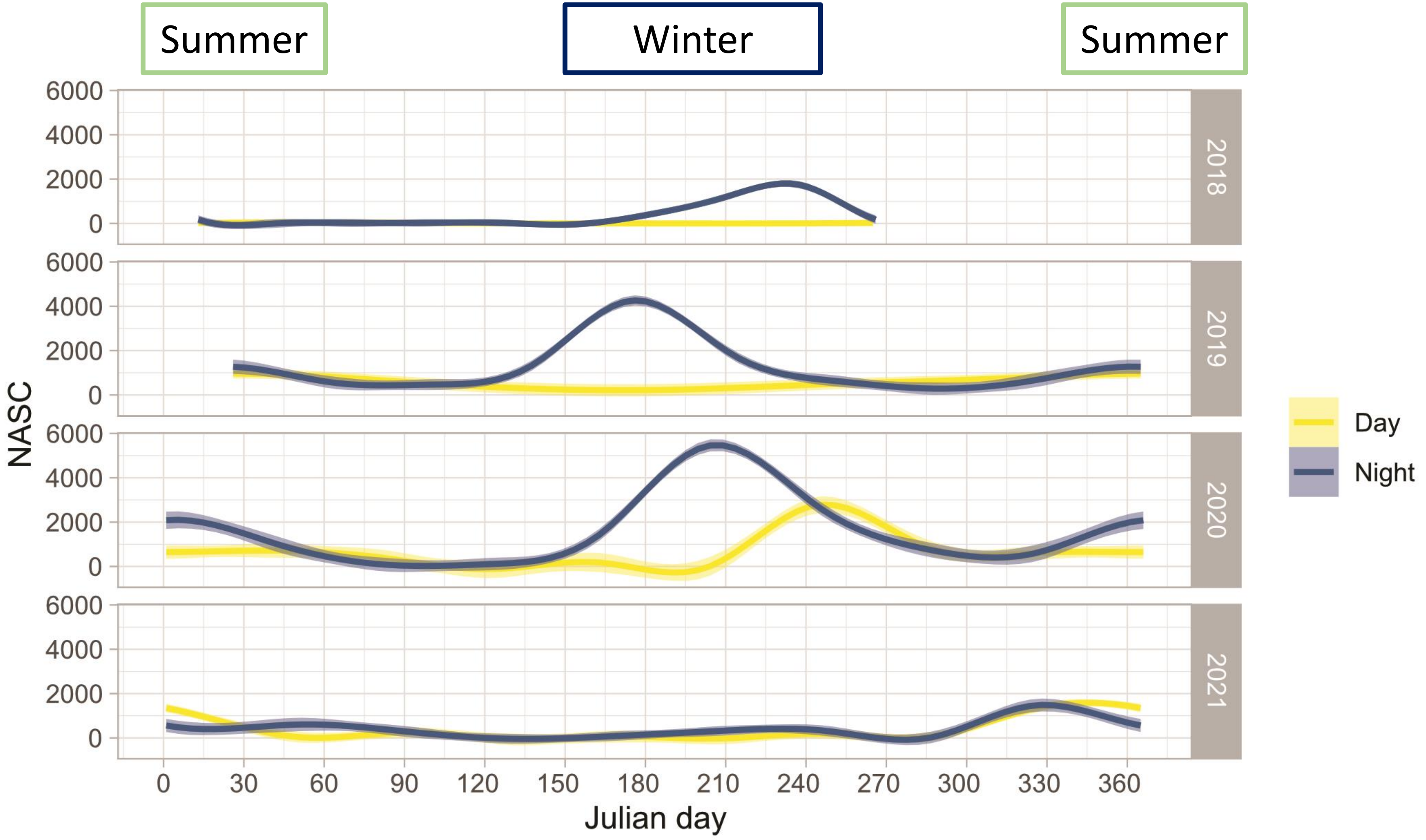


Temporal variation in total water column NASC

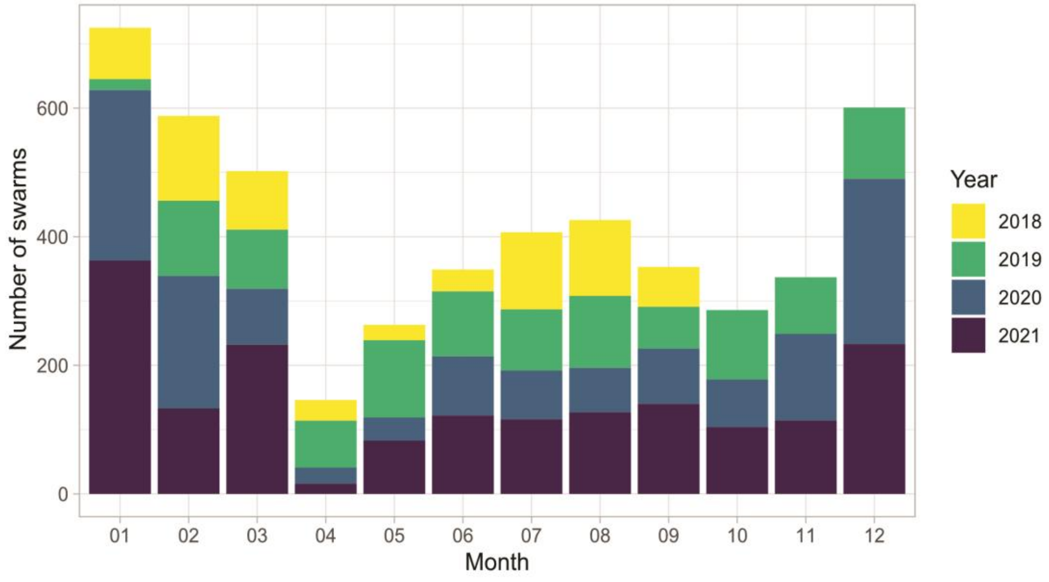
Proxy for biomass

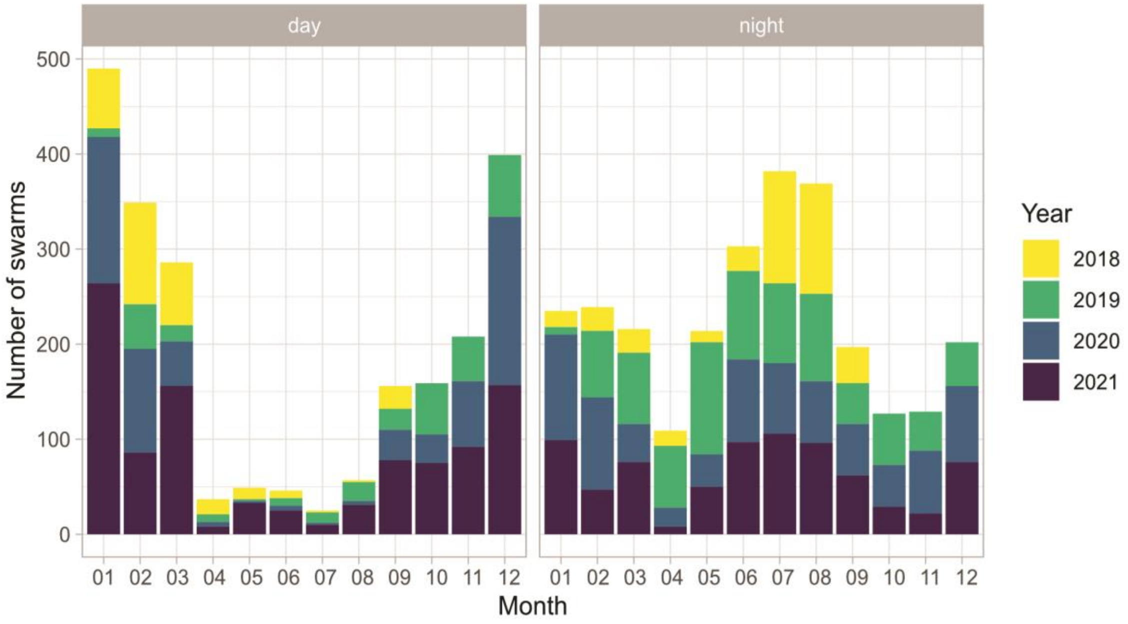


Day-night effects in total water column NASC

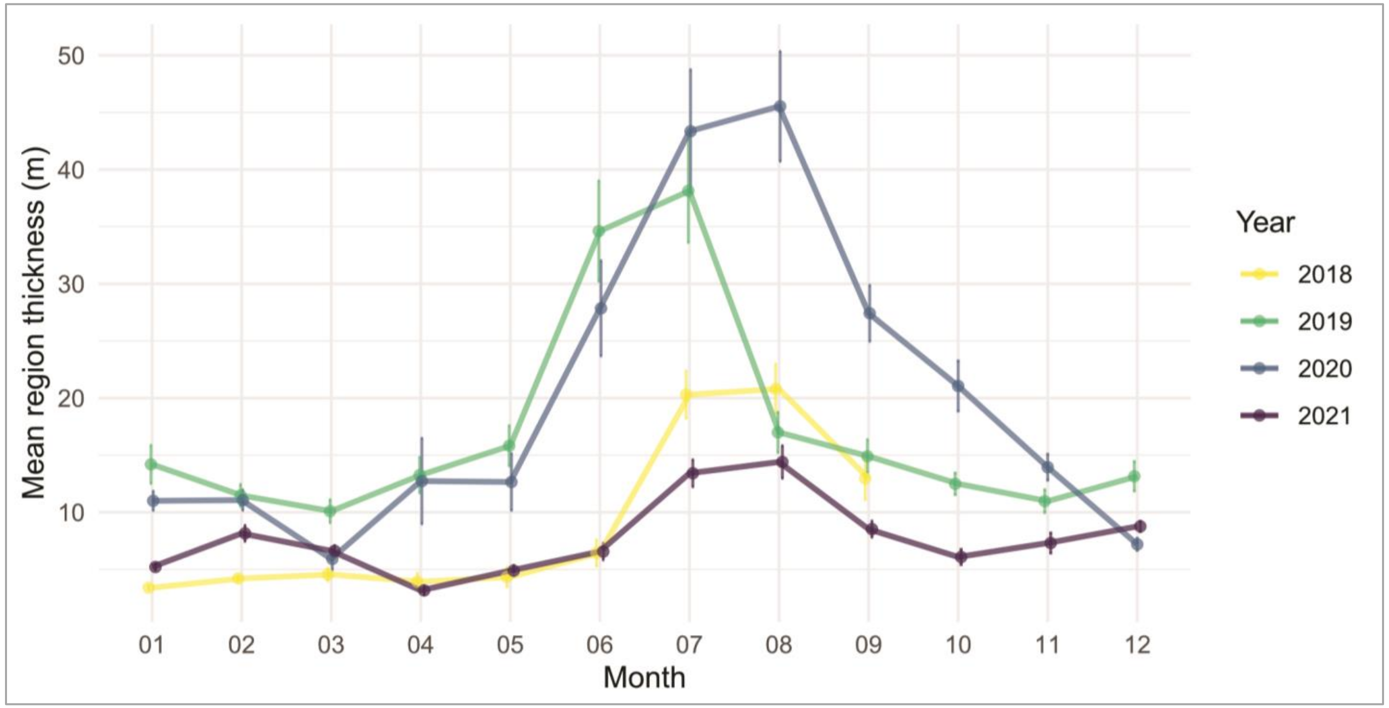


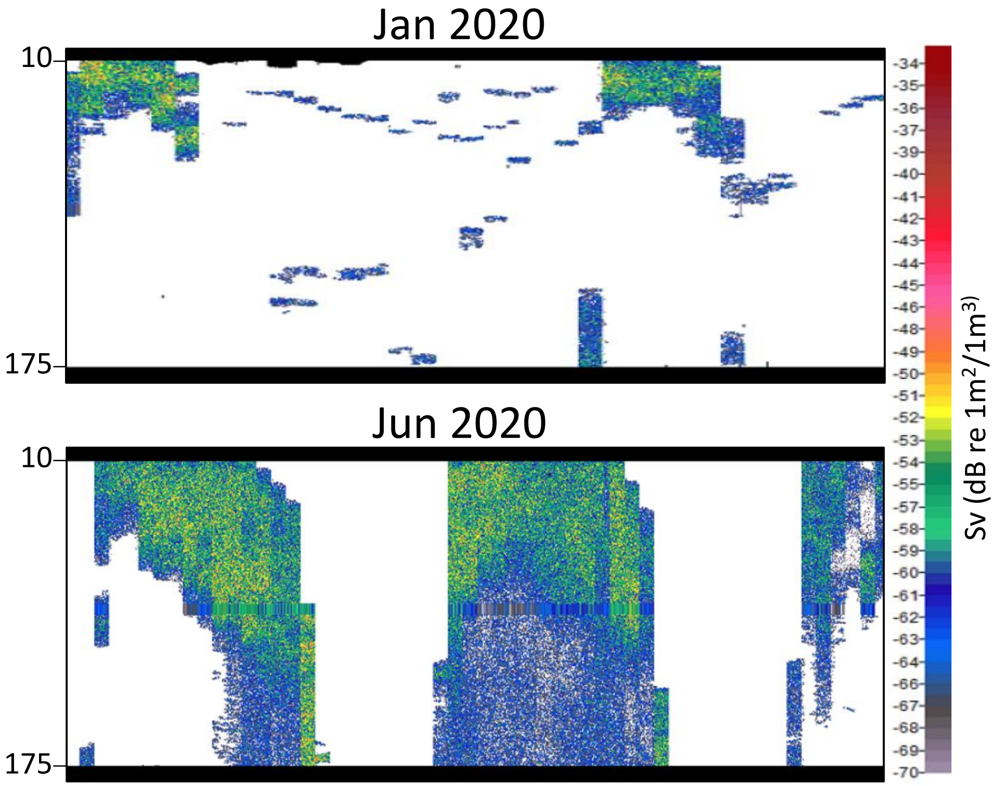
Temporal swarm patterns – Number of swarms





Temporal swarm patterns – Thickness of swarms



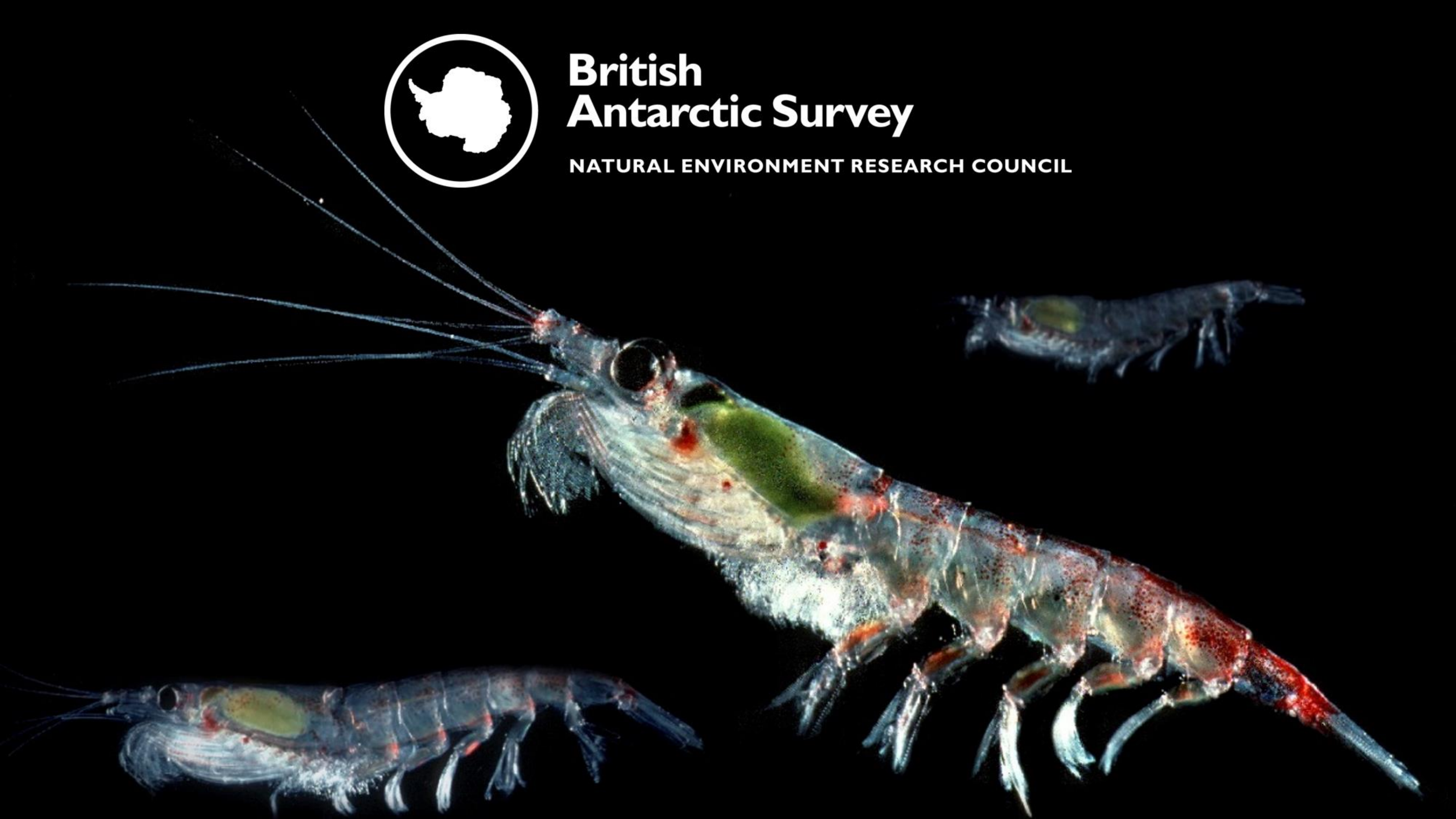


Summary

- Clear seasonal and day-night trends in backscatter
- Excellent temporal data to study behaviour and abundance
- Moorings are cost effective
- Opportunities for interdisciplinary studies

But

- Challenges remain on species ID
- Ships for deployment and recovery
- Point source that could be addressed with mooring arrays


British
Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

José Quieros

University of Coimbra


ESA


Sue G


Rod Long

Cephalopods of the South Georgia & South Sandwich Islands regions

José P. Queirós, José Abreu, Lucas Bastos, Débora Carmo, Joana Fragão, Hugo R. Guímaro, Mariana Quitério, Sara Santos, José Seco, José C. Xavier and many BAS colleagues

1290 FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE DE COIMBRA

MARE ecology and conservation of top predators UCoimbra

AR NET

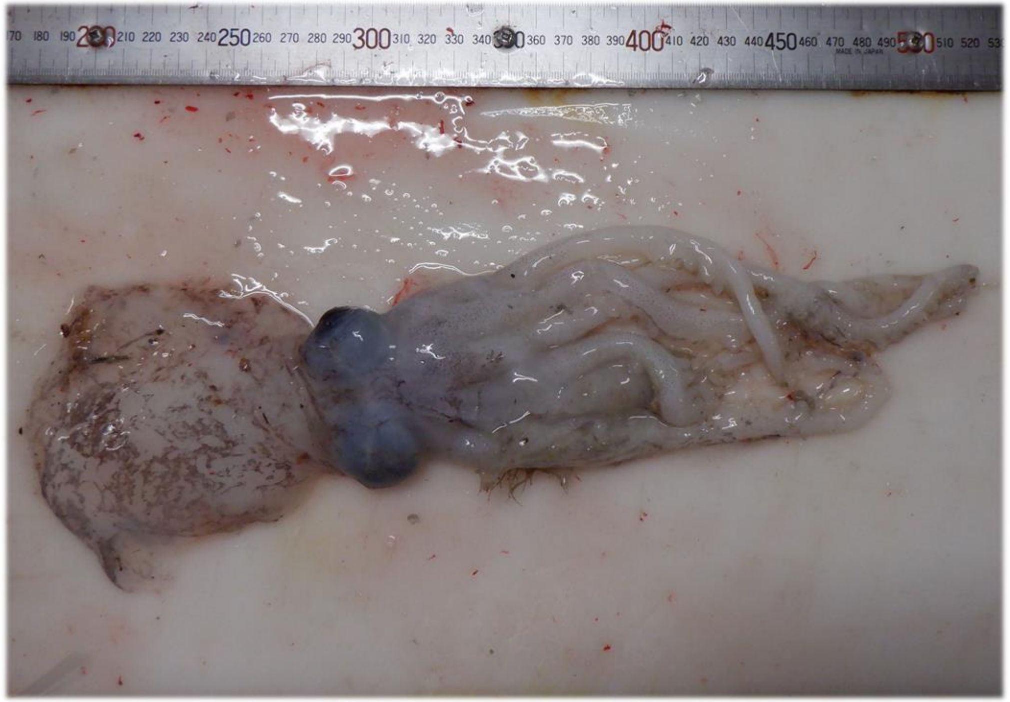
British Antarctic Survey NATURAL ENVIRONMENT RESEARCH COUNCIL

Contents

- What we know about cephalopods in the region
- What we've done since 2017
  - Cephalopods as prey of top predators
  - Cephalopods' ecology
- What we are doing

What we knew?

- Squid and octopods

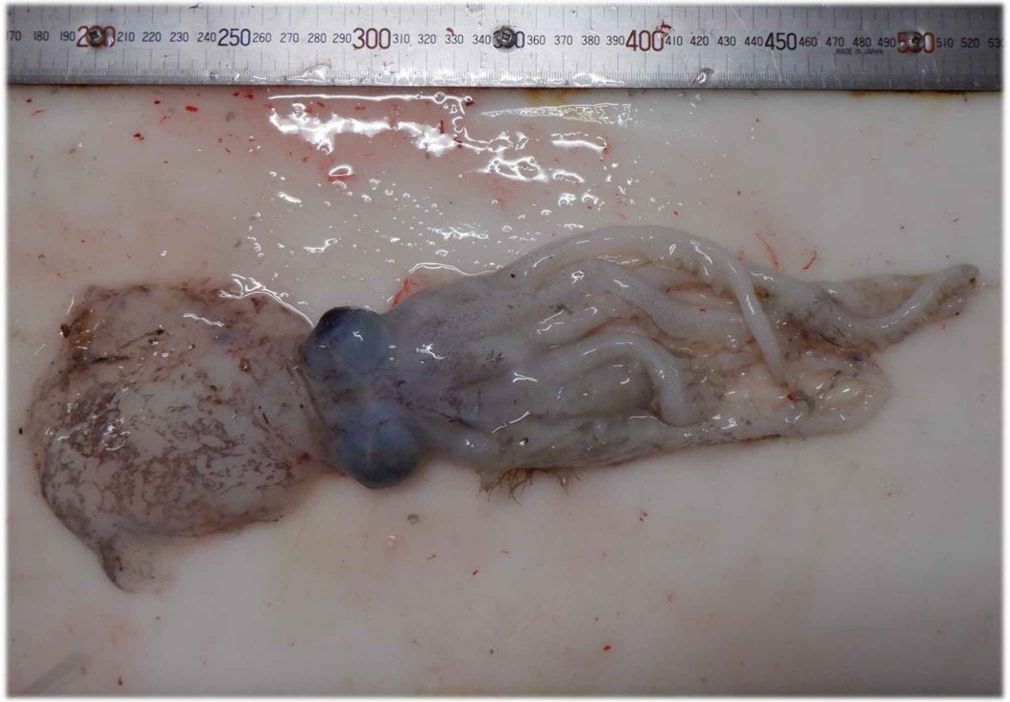


Pareledone turqueti sampled at South Georgia

Collins et al 2004, Collins & Rodhouse et al 2006, Roberts et al 2011, Rodhouse et al 2014

What we knew?

- Squid and octopods
    - 20 species at South Georgia
    - 7 species at South Sandwich Islands

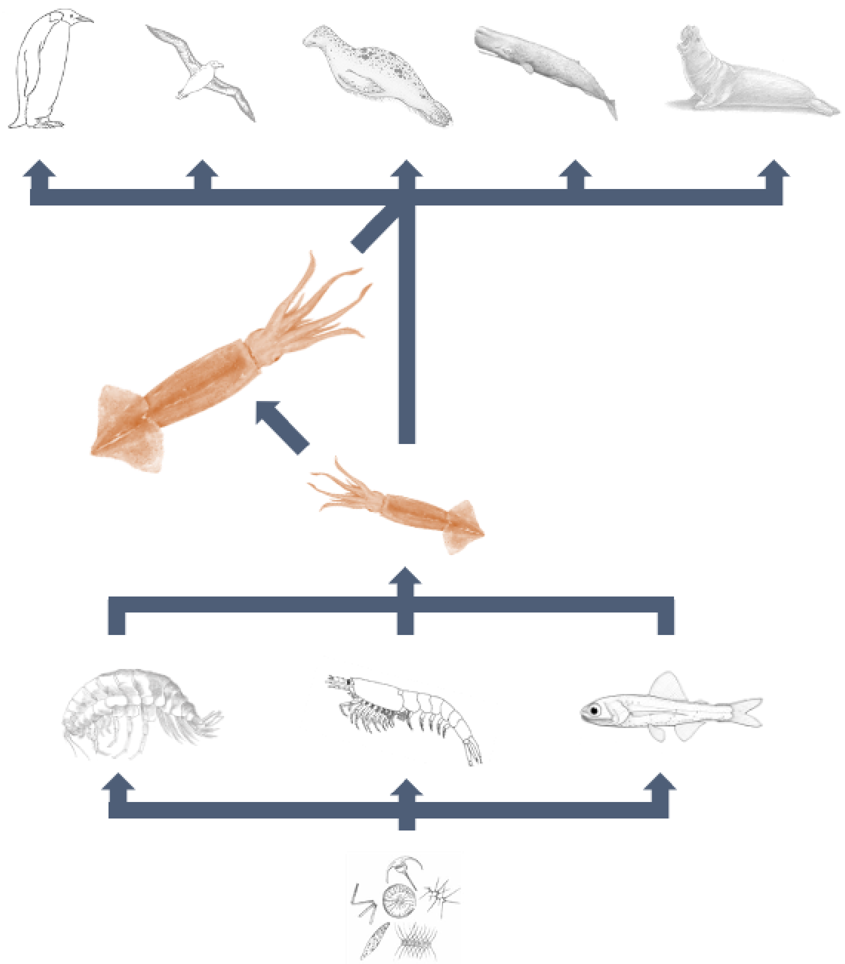


Pareledone turqueti sampled at South Georgia

Collins et al 2004, Collins & Rodhouse et al 2006, Roberts et al 2011, Rodhouse et al 2014, Xavier et al 2018

What we knew?

- Squid and octopods
- Important role in the food-web



Collins et al 2004, Collins & Rodhouse et al 2006, Roberts et al 2011, Rodhouse et al 2014, Xavier et al 2018

What we knew?

- Squid and octopods
- Important role in the food-web
  - Predators of zooplankton and small fish
  - Prey of several top predators

Mirounga leonina

Diomedea exulans

Dissostichus eleginoides (top) and *D. mawsoni* (bottom)

Arctocephalus gazella

Rodhouse et al 1987, Rodhouse et al 1992, Xavier et al 2005, Roberts et al 2011, Seco et al 2016, Xavier et al 2017.

What we knew?

- Squid and octopods
- Important role in the food-web

Important pathways in the ecosystem:

Energy

Trace elements (e.g. mercury)

What we knew?

- Squid and octopods
- Important role in the food-web
- Potential for commercial exploitation

Martialia hyadesi © Rodhouse et al 2014

Rodhouse 1989, Rodhouse 1997, Agnew 2004, Collins & Rodhouse 2006, Rodhouse 2013

What is important to know?

- Squid and octopods
- Important role in the food-web
- Potential for commercial exploitation
    - → Cephalopods as prey
    - → Cephalopods’ ecology

What is important to know?

- Squid and octopods
- Important role in the food-web
- Potential for commercial exploitation

  - Cephalopods as prey
  - Cephalopods’ ecology
    - Biogeography
    - Life-history
    - Trace elements/ Contaminants

Cephalopods as prey

PLOS | ONE

Sexual and individual foraging segregation in Gentoo penguins *Pygoscelis papua* from the Southern Ocean during an abnormal winter

José C. Xavier[1,2]*, Philip N. Trathan[2], Filipe R. Ceia[1], Geraint A. Tarling[2], Stacey Adlard[2], Derren Fox[2], Ewan W. J. Edwards[2], Rui P. Vieira[1a], Renata Medeiros[3], Claude De Broyer[4], Yves Cherel[5]

Vol. 567: 257–262, 2017
https://doi.org/10.3354/meps12020
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published March 13

Using seabirds to map the distribution of elusive pelagic cephalopod species

Jorge M. Pereira[1,*], Vítor H. Paiva[1], José C. Xavier[1,2]

Vol. 628: 211–221, 2019
https://doi.org/10.3354/meps13100
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published October 10

Squid in the diet of Antarctic fur seals: potential links to oceanographic conditions and Antarctic krill abundance

José Abreu[1,2,*], Iain Staniland[3], Clara F. Rodrigues[2], José P. Queirós[1], Jorge M. Pereira[1], José C. Xavier[1,3]

Cephalopods as prey

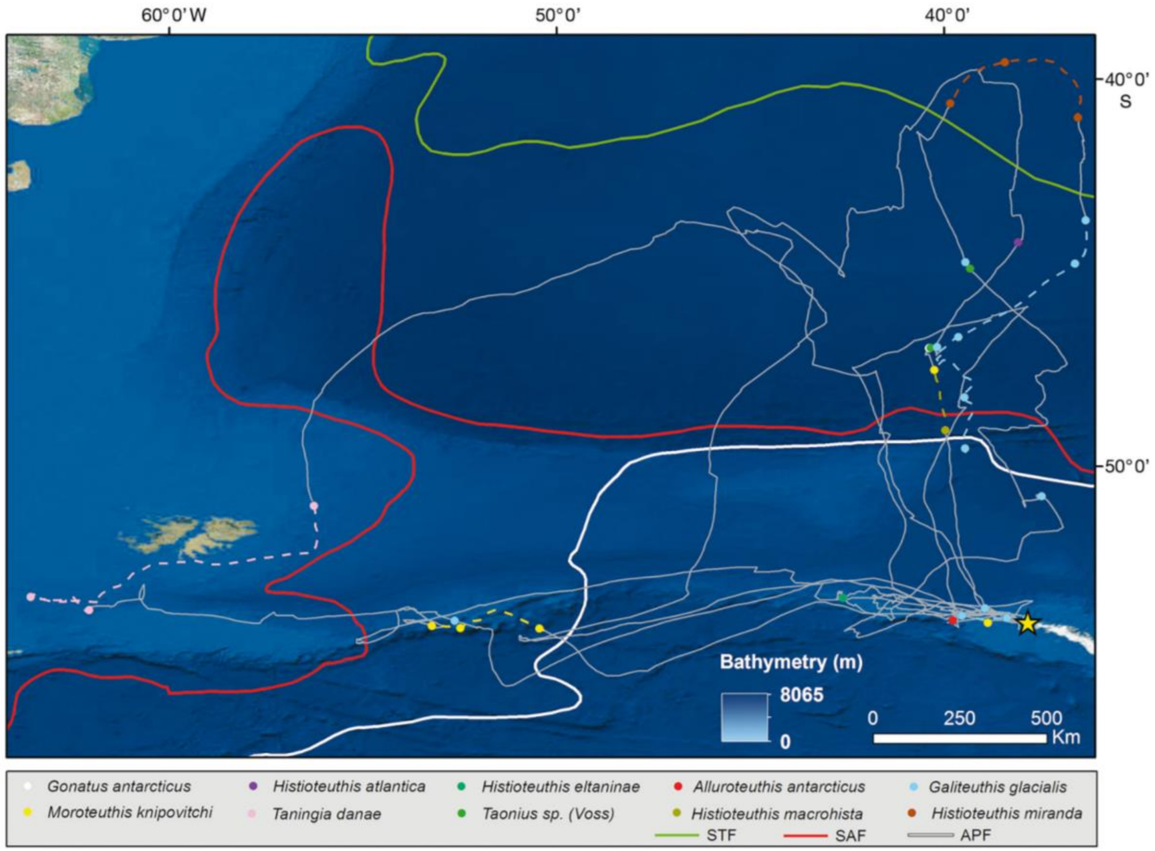
- Gentoo penguins feed on juveniles

Cephalopods			LRL Mean (range)	ML Mean (range)	Mass Mean (range)
Kondakovia longimana	F	1	1.1	18.7	2.5
	M	yes (upper beak)			
	F+M	2	1.1	18.7	2.5
Slosarczykovia circumantarctica	F	2	0.7	30.4	1.0
	M	2	1.4 (1.0–1.8)	44.6 (36.5–52.6)	2.9 (1.7–4.0)
	F+M	4	1.1 (0.7–1.8)	37.5 (30.4–52.6)	1.9 (1.0–4.0)

Xavier et al 2017

Cephalopods as prey

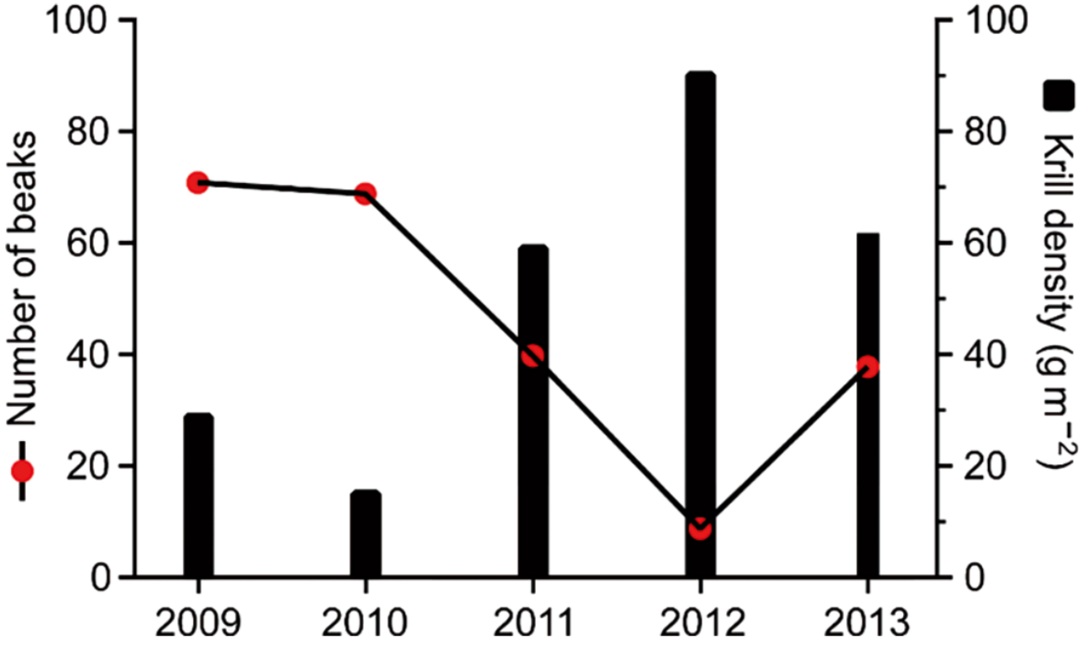
- Gentoo penguins feed on juveniles
- Wandering albatrosses feed in Subtropical and Antarctic squids



Pereira et al 2017

Cephalopods as prey

- Gentoo penguins feed on juveniles
- Wandering albatrosses feed in Subtropical and Antarctic squids
- Antarctic fur seals feed in squid when Antarctic krill is not available



Abreu et al 2017

Cephalopods as prey

British Antarctic Survey • Centre d'Etudes Biologiques de Chizé • Centro de Ciências do Mar e do Ambiente

CEPHALOPOD BEAK GUIDE
FOR THE SOUTHERN OCEAN:
an update on taxonomy

J. C. Xavier & Y. Cherel

FAMILY ONYCHOTEUTHIDAE Figure 21 | pages 70 & 99

Some species of this family are well known, but some beaks probably belong to undescribed species (e.g. *Moroteuthopsis* sp. B (Imber)).

Family identification:

» Distinct jaw angle ridge
» Fold or a ridge on lateral wall (*Moroteuthopsis ingens, Moroteuthopsis* sp. B (Imber), and *Onychoteuthis banksii* complex)
» Beaks are often large, particularly *Moroteuthopsis longimana*

The species likely to be found are:

Moroteuthopsis longimana
ML=-22.348+37.318LRL; M=0.713LRL$^{3.152}$ (n=13 for ML; n=22 for M) (Brown & Klages 1987)

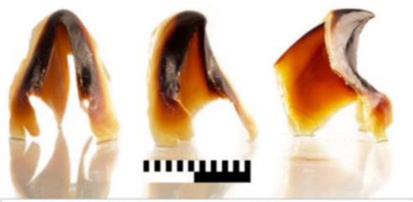
Moroteuthopsis ingens
It is provided the mean value between estimates obtained using equations for males and females (Jackson 1995):
Males: ML= 98.59+24.40LRL (n=82); females: ML=-27.84+44.63LRL (n=68)
Males: logM= 1.22+1.80logLRL (n=82); females: logM= 0.15+3.25logLRL (n=68)

***Moroteuthis* sp . B (Imber) (no specific equations)**

Filippovia knipovitchi
ML=-105.707+62.369LRL; ln M=-0.881+3.798lnLRL (n=7 for ML, n=5 for M) (Cherel, unpublished data)

Onykia robsoni
ML=-652.91+151.03LRL; ln M= -9.15+8.07lnLRL (n=8 for ML, n=6 for M, using total weight of preserved specimens) (Lu & Ickeringill 2002)

FAMILY ONYCHOTEUTHIDAE Figure 21 | pages 37 & 99



Moroteuthopsis longimana | adult | Wandering albatross, South Georgia, 11.3 mm LRL

Moroteuthopsis longimana | juvenile | Patagonian toothfish, Kerguelen, 3.7 mm LRL

Xavier & Cherel 2021

Cephalopods' ecology

- Biogeography and adaption to environmental changes

Polar Biology (2018) 41:2409–2421
https://doi.org/10.1007/s00300-018-2376-4

Ontogenic changes in habitat and trophic ecology in the Antarctic squid *Kondakovia longimana* derived from isotopic analysis on beaks

José P. Queirós[1,2] · Yves Cherel[3] · Filipe R. Ceia[2] · Ana Hilário[1,4] · Jim Roberts[5] · José C. Xavier[2,6]

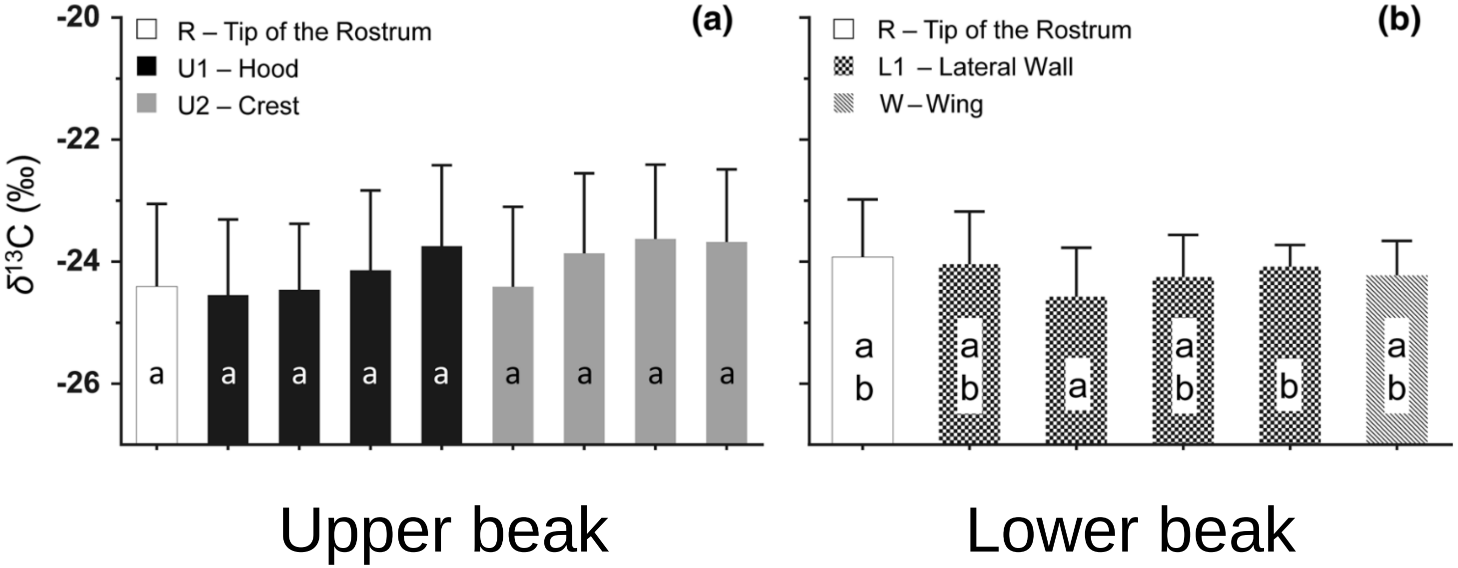
Long-term changes in habitat and trophic level of Southern Ocean squid in relation to environmental conditions

SCIENTIFIC REPORTS
natureresearch

José Abreu[1], Richard A. Phillips[2], Filipe R. Ceia[1], Louise Ireland[2], Vítor H. Paiva[1] & José C. Xavier[1,2]

Cephalopods' ecology

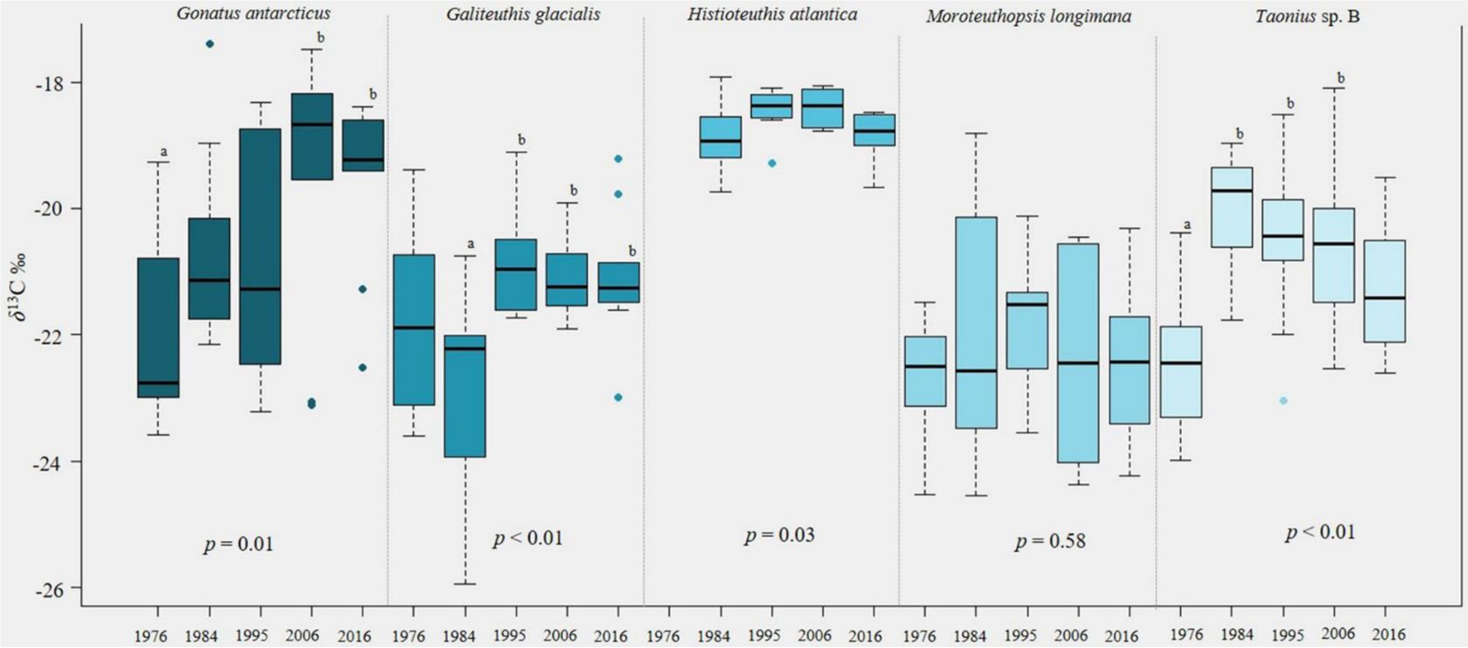
- Biogeography and adaption to environmental changes
  - *M. longimana* spends its entire life in the region



Queirós et al 2018

Cephalopods’ ecology

- Biogeography and adaption to environmental changes
    - *M. longimana* spends its entire life in the region
    - Potential habitat shifts with climate change



Abreu et al 2020

Cephalopods’ ecology

Trophic ecology

Polar Biology (2018) 41:2409–2421
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Marine Environmental Research 150 (2019) 104757

Contents lists available at ScienceDirect

Marine Environmental Research

journal homepage: www.elsevier.com/locate/marenvrev

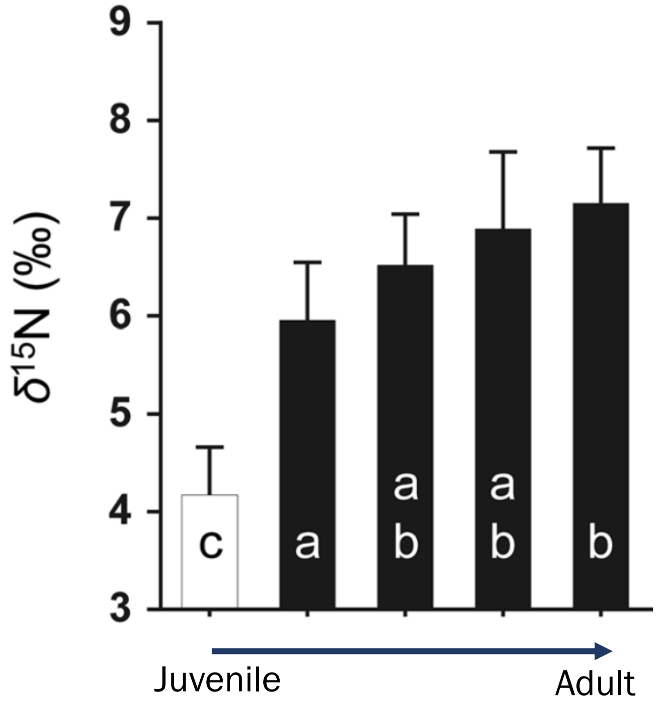
ELSEVIER

Show your beaks and we tell you what you eat: Different ecology in sympatric Antarctic benthic octopods under a climate change context

Ricardo S. Matias[a,*], Susan Gregory[b,c], Filipe R. Ceia[a], Alexandra Baeta[a], José Seco[d,e], Miguel S. Rocha[f,g], Emanuel M. Fernandes[f,g], Rui L. Reis[f,g,h], Tiago H. Silva[f,g], Eduarda Pereira[d], Uwe Piatkowski[i], Jaime A. Ramos[a], José C. Xavier[a,b]

Cephalopods' ecology

- Trophic ecology
  - *M. longimana* increase >1 trophic level with grow



Queirós et al 2018

Cephalopods' ecology

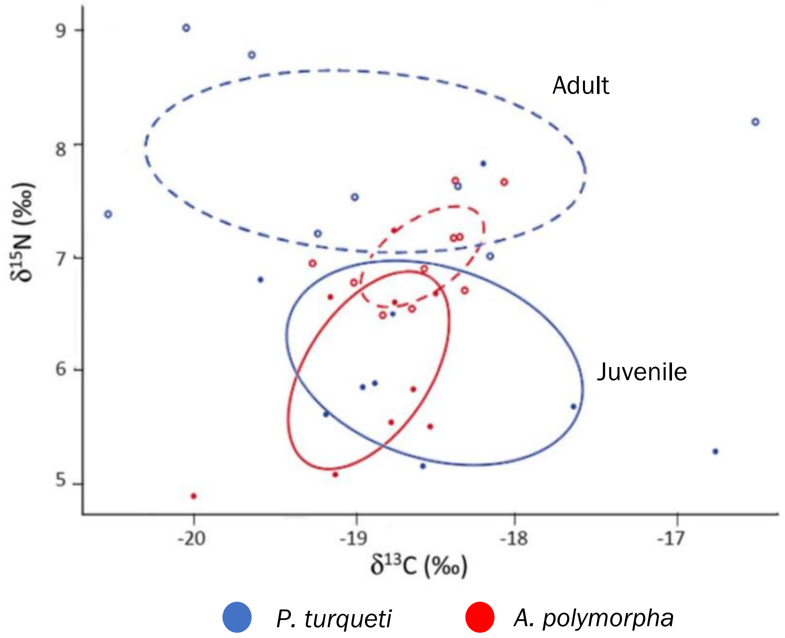
- Trophic ecology
  - *M. longimana* increase >1 trophic level with grow
  - No influence of environmental conditions on the trophic position

Year	$\delta^{15}N$ (‰)				
	Moroteuthopsis longimana	*Taonius sp. B*	*Gonatus antarcticus*	*Galiteuthis glacialis*	*Histioteuthis atlantica*
1976	6.1 ± 0.38	10.54 ± 0.72	9.52 ± 0.80	7.05 ± 1.32	--
1984	6.49 ± 1.07	10.91 ± 0.97	9.74 ± 0.95	6.89 ± 0.79	10.53 ± 0.66
1995	6.3 ± 0.38	10.78 ± 0.61	10.21 ± 0.87	6.73 ± 0.84	10.89 ± 0.39
2006	6.54 ± 0.42	10.39 ± 0.80	10.2 ± 0.89	6.42 ± 0.75	11.18 ± 0.55
2016	5.94 ± 0.60	9.84 ± 0.94	9.82 ± 0.72	5.92 ± 0.89	10.6 ± 0.56
Statistics (ANOVA)	$F_{4,45} = 1.65$	$F_{4,45} = 2.56$	$F_{4,45} = 1.24$	$F_{4,43} = 2.21$	$F_{3,36} = 2.92$
	$p = 0.18$	$p = 0.05$	$p = 0.31$	$p = 0.08$	$p = 0.05$

Abreu et al 2020

Cephalopods' ecology

- Trophic ecology
  - *M. longimana* increase >1 trophic level with grow
  - No influence of environmental conditions on the trophic position
  - *P. turqueti* feeds in higher trophic level



Matias et al 2019

Cephalopods' ecology

- Age and growth

Marine Biology (2023) 170:10
https://doi.org/10.1007/s00227-022-04156-2

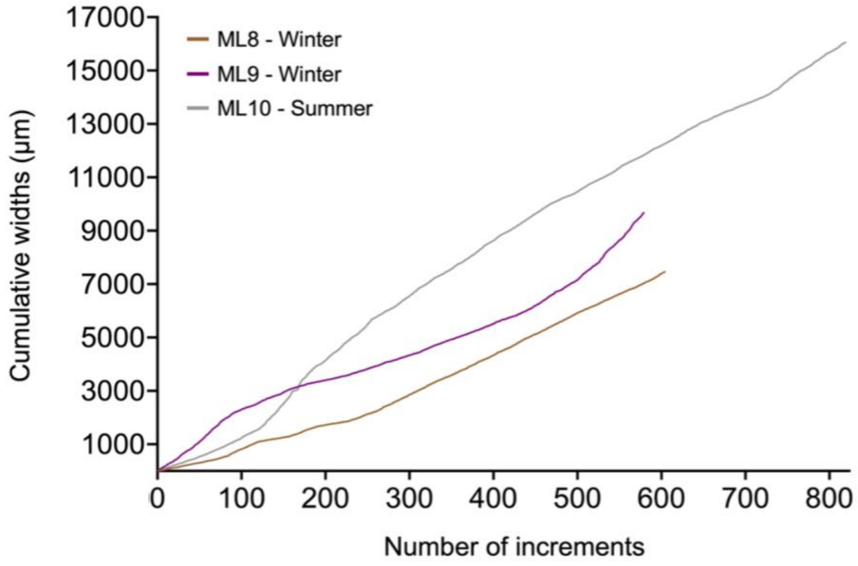
ORIGINAL PAPER

Age and growth estimation of Southern Ocean squid *Moroteuthopsis longimana*: can we use beaks collected from predators' stomachs?

José P. Queirós[1] · Aurora Bartolomé[2] · Uwe Piatkowski[3] · José C. Xavier[1,4] · Catalina Perales-Raya[2]

Cephalopods’ ecology

- Age and growth (of *M. longimana)*
  - Life-span of >2 years
  - Hatches throughout the year
  - Spring is a time of faster growth



Queirós et al 2023

Cephalopods' ecology

- Ecotoxicology (focused on Mercury)

Marine Environmental Research 161 (2020) 105049

Cephalopod beak sections used to trace mercury levels throughout the life of cephalopods: The giant warty squid *Moroteuthopsis longimana* as a case study

José P. Queirós [a,*], Paco Bustamante [b,c], Yves Cherel [d], João P. Coelho [e], José Seco [f,g], Jim Roberts [h], Eduarda Pereira [f], José C. Xavier [a,i]

Marine Pollution Bulletin 158 (2020) 111447

Antarctic octopod beaks as proxy for mercury concentrations in soft tissues

Ricardo S. Matias[a,*,1], José Seco[b,c,1], Susan Gregory[d,e], Mark Belchier[d], Maria E. Pereira[b], Paco Bustamante[f,g], José C. Xavier[a,d]

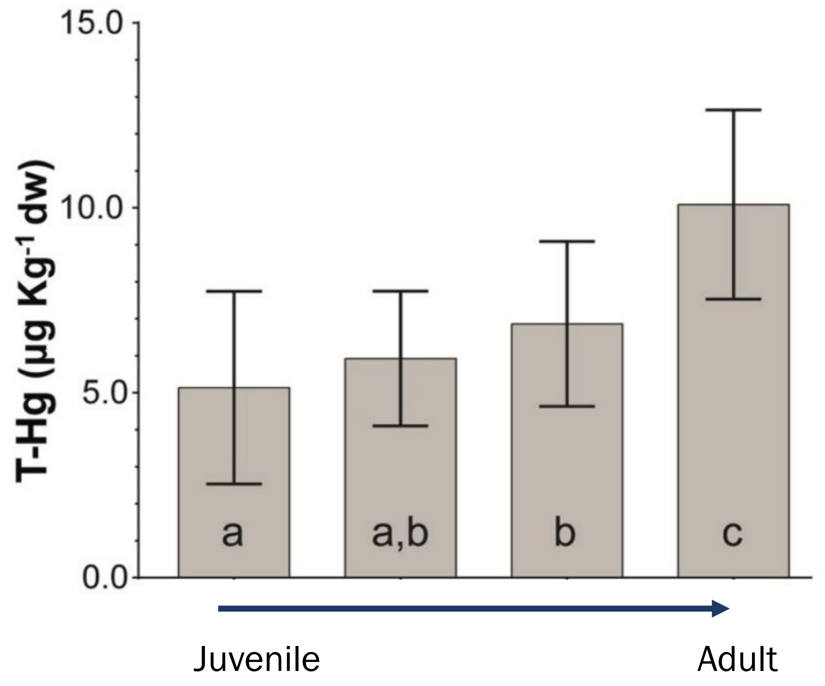
Chemosphere 239 (2020) 124785

Mercury levels in Southern Ocean squid: Variability over the last decade

José Seco [a,b,*], José C. Xavier [c,d], Andrew S. Brierley [b], Paco Bustamante [e], João P. Coelho [f], Susan Gregory [c,g], Sophie Fielding [c], Miguel A. Pardal [h], Bárbara Pereira [a], Gabriele Stowasser [c], Geraint A. Tarling [c], Eduarda Pereira [a]

Cephalopods' ecology

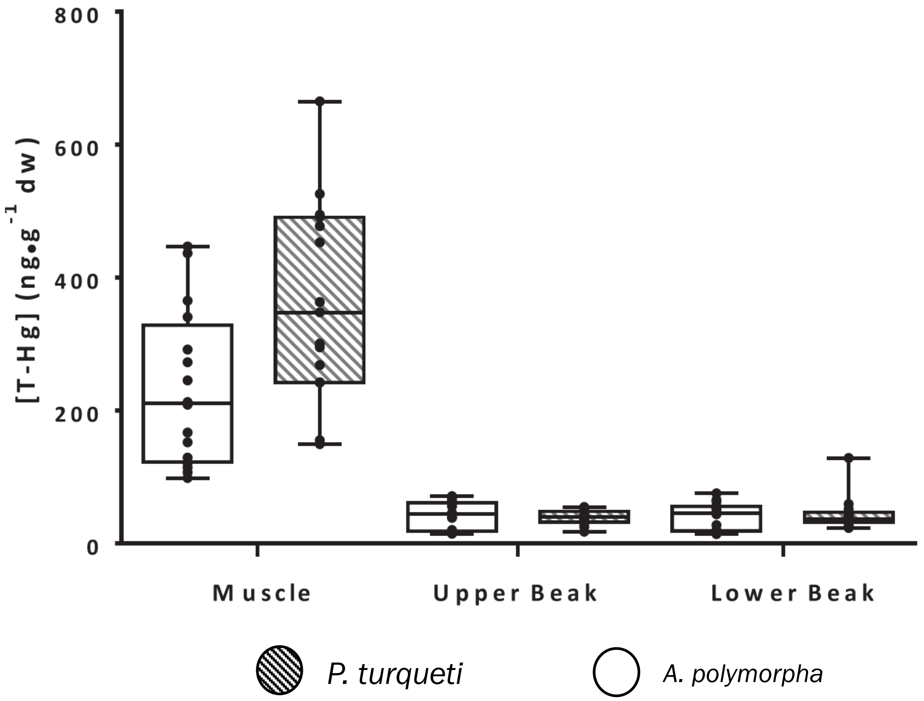
- Ecotoxicology (focused on Mercury)
  - *M. longimana*'s adults have 2x more mercury



Queirós et al 2020

Cephalopods' ecology

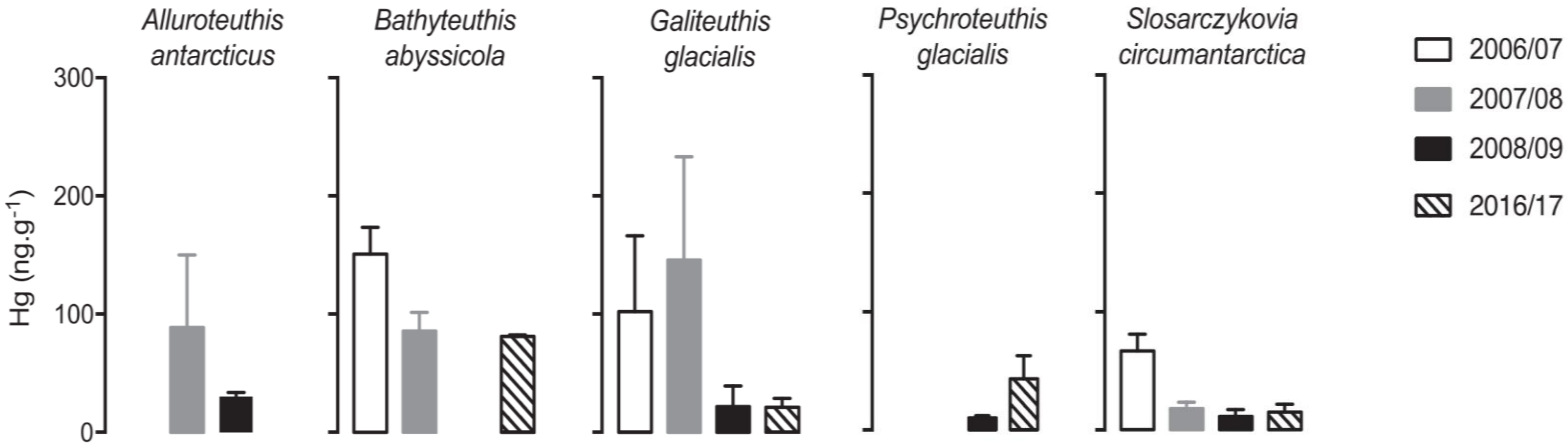
- Ecotoxicology (focused on Mercury)
  - *M. longimana*'s adults have 2x more mercury
  - *P. turqueti* has more mercury than *A. polymorpha*



Matias et al 2020

Cephalopods' ecology

- Ecotoxicology (focused on Mercury)
  - *M. longimana*'s adults have 2x more mercury
  - *P. turqueti* has more mercury than *A. polymorpha*
  - Mercury concentrations decreased



Seco et al 2020

What are we doing?

- Modelling the importance of cephalopods in terms of biomass
  - Débora Carmo with Simeon Hill
- Role of cephalopods in predators’ diet under contrasting environmental conditions
  - Mariana Quitério with Richard Philips
- Cephalopods in the diet of poorly studied predators (e.g. Macrourids)
  - José Abreu with Phil Hollyman, Martin Collins and Richard Philips

What are we doing?

- Biogeography of cephalopods at South Sandwich Islands
  - José Queirós with Phil Hollyman and Mark Belchier

- Biogeography of cephalopods in the Scotia Sea
  - Lucas Bastos with Martin Collins and Gabi Stowasser

- Baseline studies for new emergent pollutants and microplastics
  - Joana Fragão, José Seco, Sara Santos and Filipa Bessa with Clara Manno, Geraint Tarling and Ryan Saunders

What are we doing - ATCM

IP 2

XLIV ANTARCTIC TREATY CONSULTATIVE MEETING

ENG

Agenda Item:	CEP 11
Presented by:	Portugal, United Kingdom
Original:	English
Submitted:	1/4/2022

Effects of climate change on Antarctic marine food webs: new evidence from squid

1

IP 32

29.5.–8.6.2023
Helsinki – Finland
XLV ANTARCTIC TREATY CONSULTATIVE MEETING

ENG

Agenda Item:	CEP 11
Presented by:	Portugal, Bulgaria, France, Germany, Japan, United Kingdom
Original:	English
Submitted:	20 Apr 2023

Mercury in Antarctic marine ecosystems

1

To conclude!

- Cephalopods are important to predators in all life-stages
- Cephalopods are available to predators all year-round
- Cephalopods can be an important source of contaminants to predators
- Climate change can induce changes in the habitat of cephalopods

Thank you

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

- Mark Belchier
- Ashley Bennison
- Linda Capper
- Rachel Cavanagh
- Martin Collins
- Pete Convey
- John Croxall
- Mike Dunn
- Sophie Fielding
- Elaine Fitzcharles
- Jane Francis
- Peter Fretwell
- Paul Geissler
- Sue Gregory
- Simeon Hill
- Guy Hillyard
- Phil Hollyman
- Kevin Hughes
- Louise Ireland
- Nadine Johnston
- Clara Manno
- Eugene Murphy
- Lloyd Peck
- Richard Phillips
- Norman Ratcliffe
- Paul Rodhouse
- Ryan Saunders
- Iain Staniland
- Gabi Stowasser
- Geraint Tarling
- Phil Trathan
- David Vaughan
- David Walton
- Claire Waluda
- Andy Wood
- And many other BAS colleagues!

Juliet Brodie

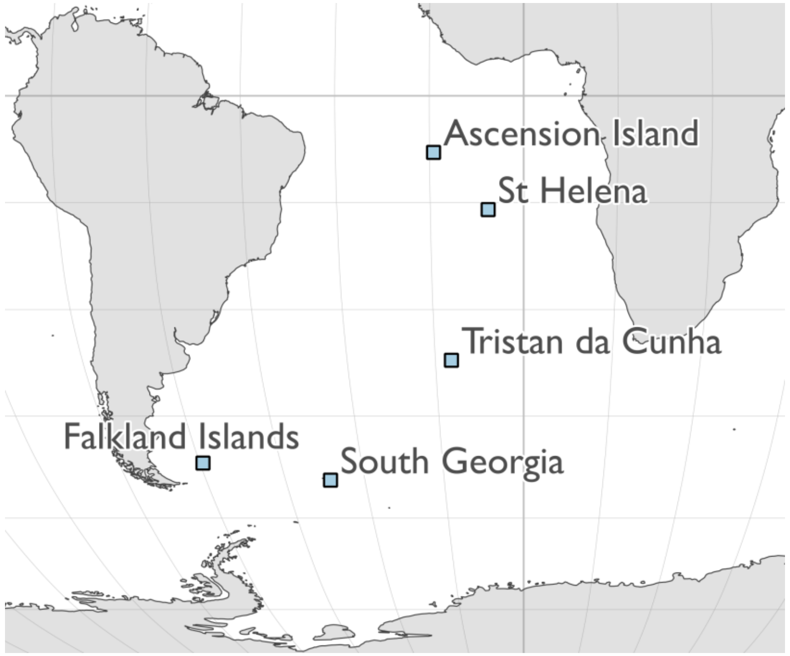
Natural History Museum

Biodiversity of South Georgia's seaweeds: unique, charismatic and essential

Juliet Brodie & Rob Mrowicki

Natural History Museum, London, UK

Seaweed collectors in South Georgia



1867: R.O. Cunningham (‘Nassau’, Extra-tropical South America)

1882-3: German International Polar Year Expedition

1907, 1921 & 1923: C. Skottsberg

1913: P. Stammwitz

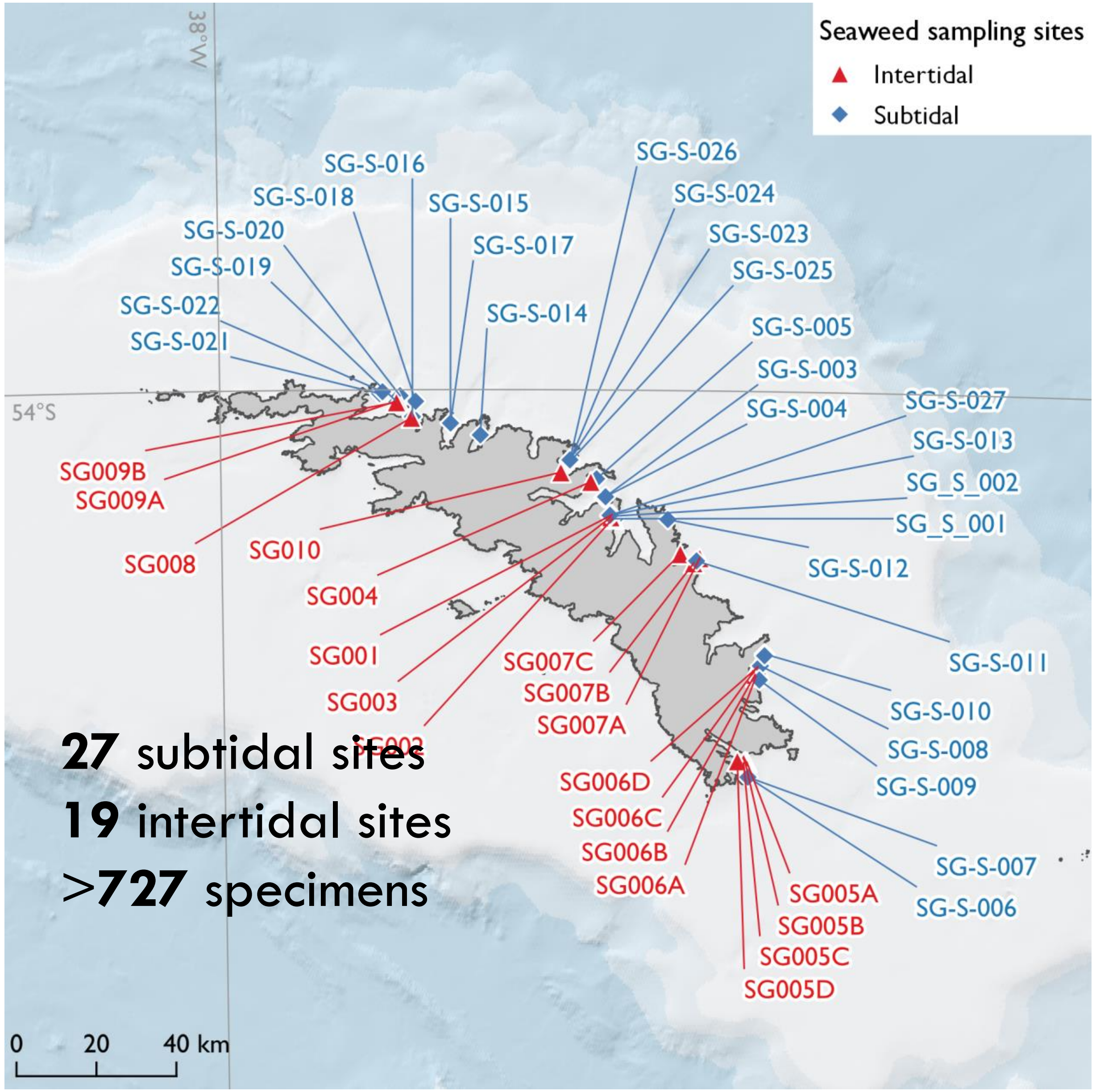
1936: ‘Discovery’ Expedition

1950s: J. Fay, W.N. Bonner

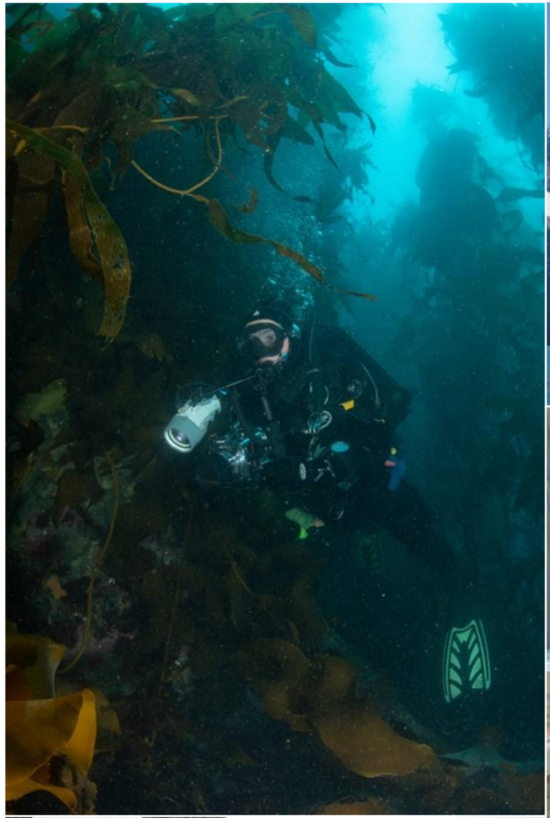
2010: E. Wells (SMSG Expedition)

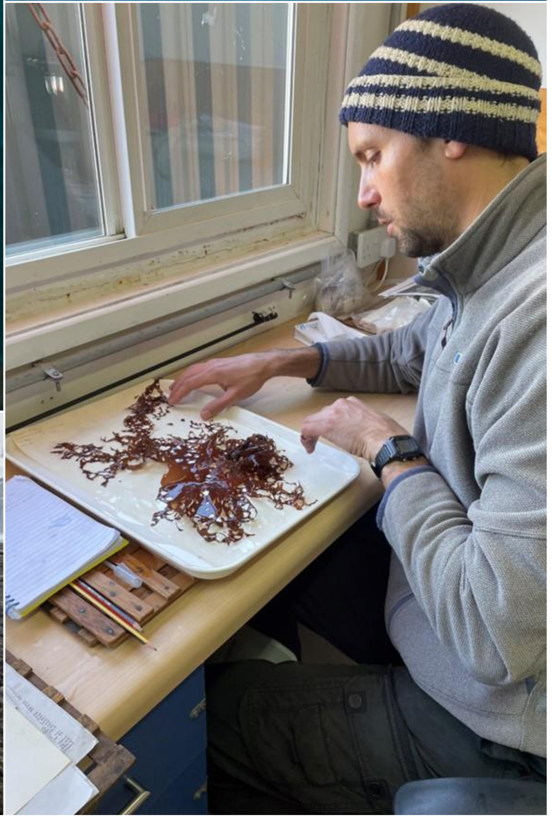
2021: ‘Operation *Himantothallus*’

South Georgia ‘Operation *Himantothallus*’ collecting sites 2021



27 subtidal sites
19 intertidal sites
>727 specimens

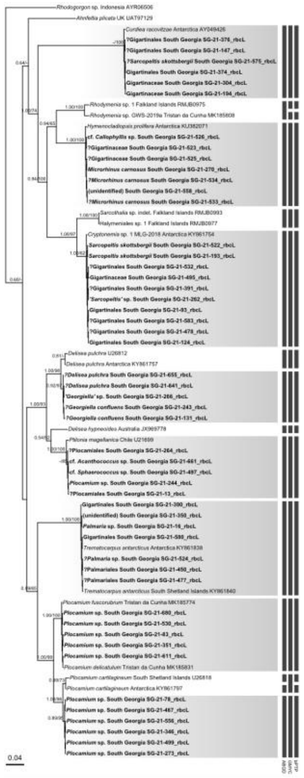




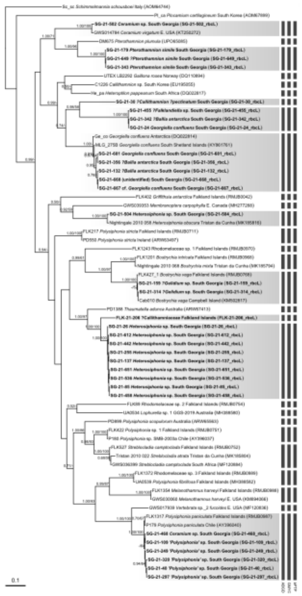
Creating a reference collection

Molecular phylogenies

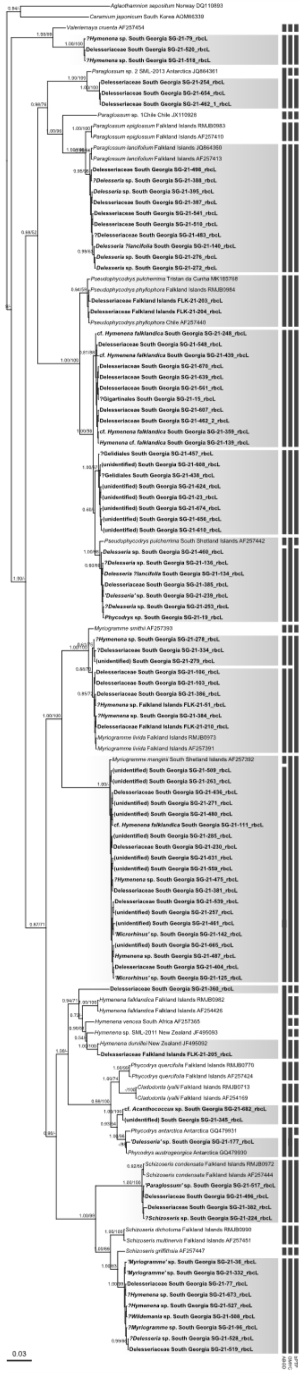
Rhodymeniophycidae (exc. Ceramiales + Gigartinales)



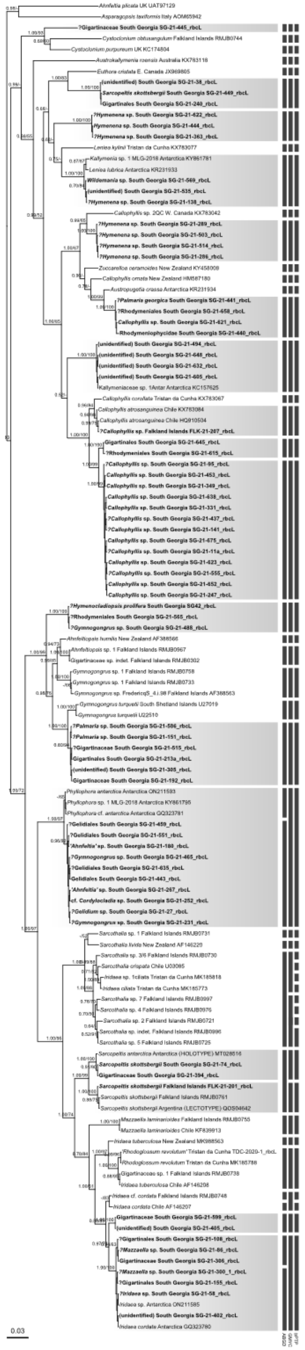
Ceramiales (exc. Delesseriaceae)



Delesseriaceae

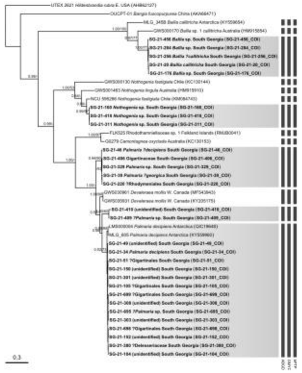


Gigartinales

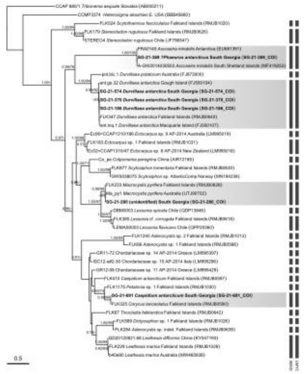


Bangiales

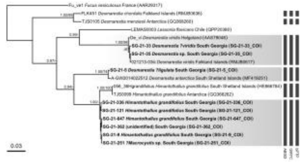
Nemaliophycidae



Phaeophyceae (exc. Desmarestiales)

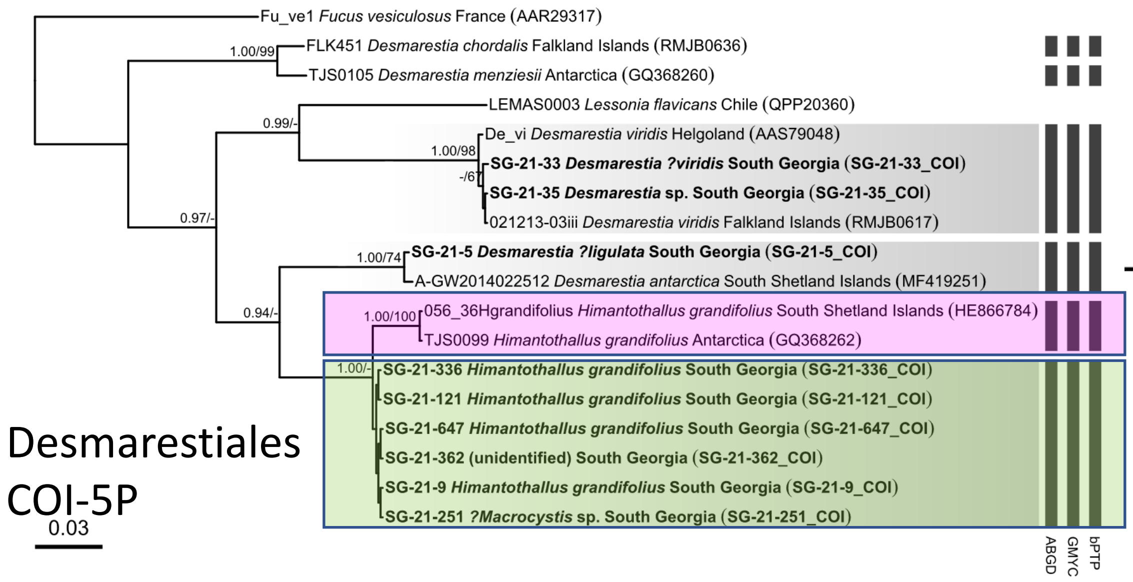


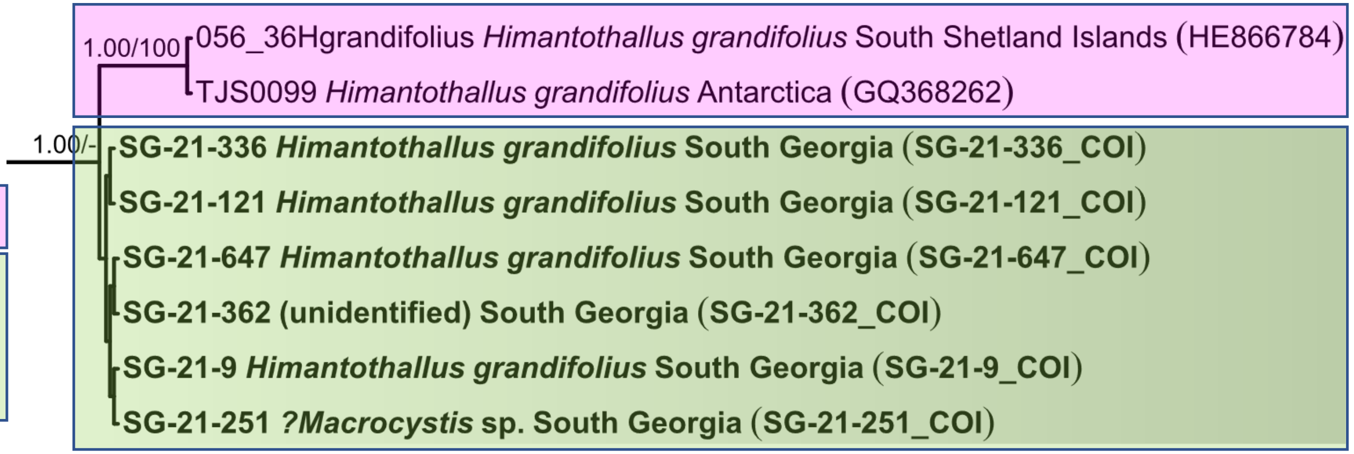
Desmarestiales

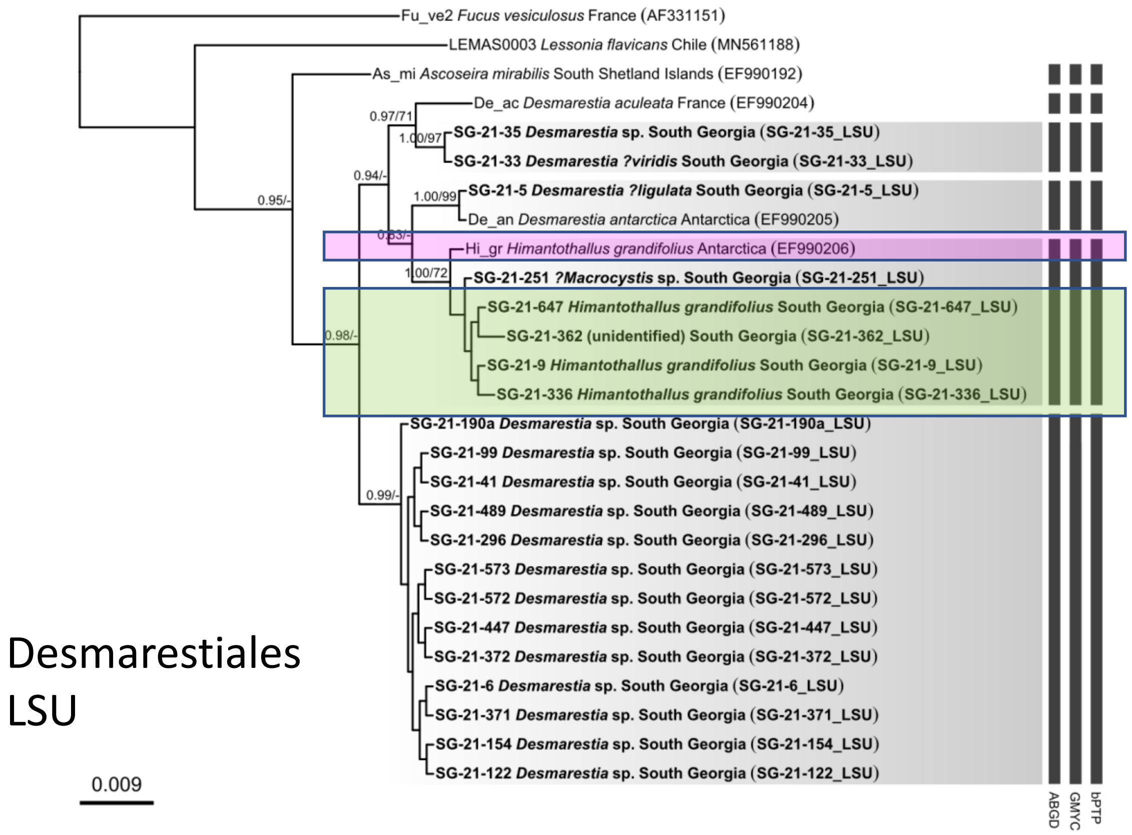


Chlorophyta

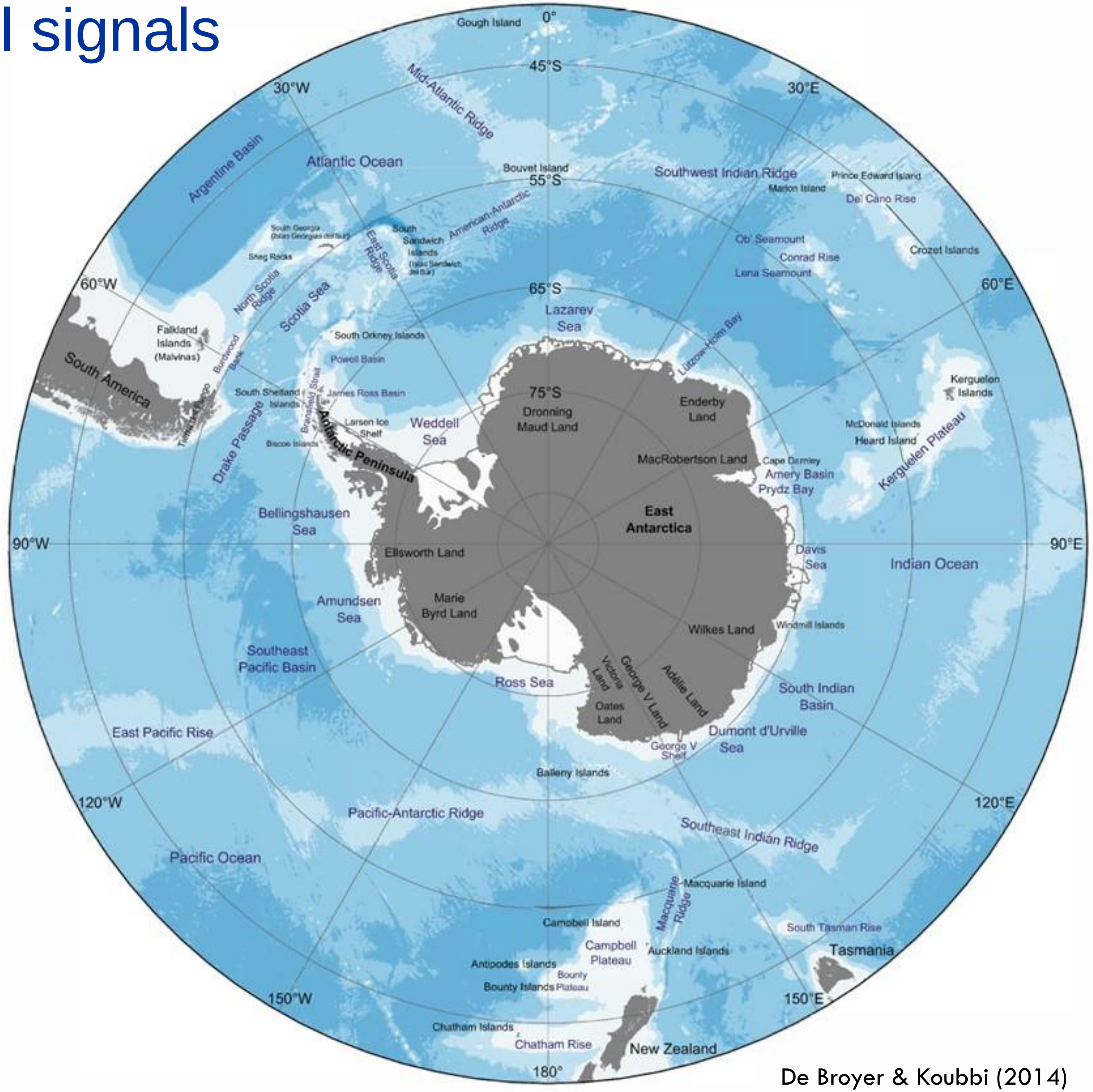
Himatothallus grandifolius: a possible endemic







Biogeographical signals



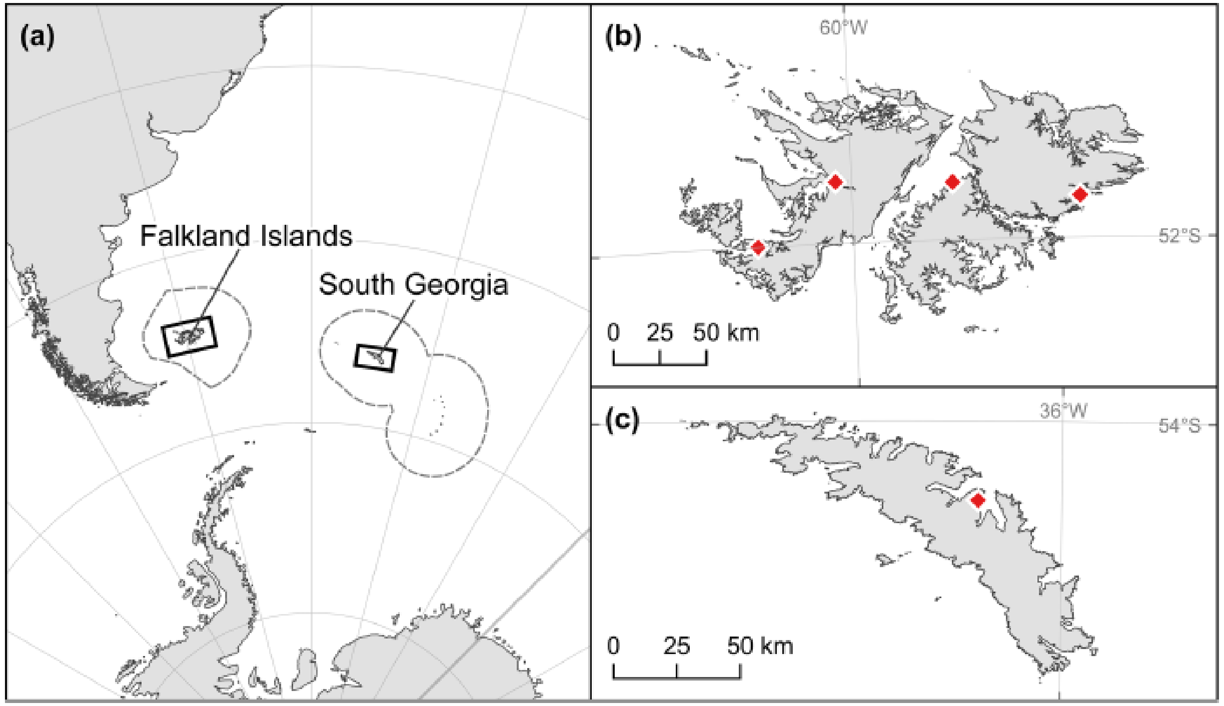
De Broyer & Koubbi (2014)
https://www.biodiversity.aq/atlas/contents/biogeography-southern-ocean/

Polar Biology
https://doi.org/10.1007/s00300-023-03136-6

BRIEF REPORT

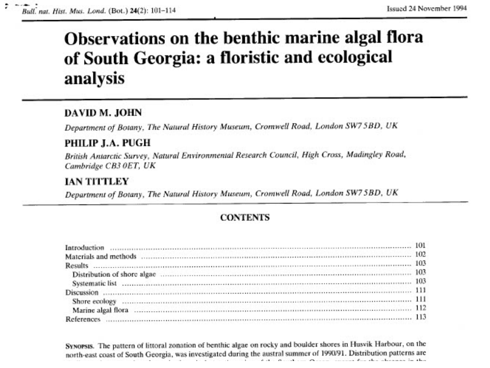
The first record of a non-native seaweed from South Georgia and confirmation of its establishment in the Falkland Islands: *Ulva fenestrata* Postels & Ruprecht

Robert J. Mrowicki[1] · Juliet Brodie[1]



Capturing historical data

83 specimens (1867–1966)
27 species


Bull. nat. Hist. Mus. Lond. (Bot.) **24**(2): 101–114 Issued 24 November 1994

Observations on the benthic marine algal flora of South Georgia: a floristic and ecological analysis

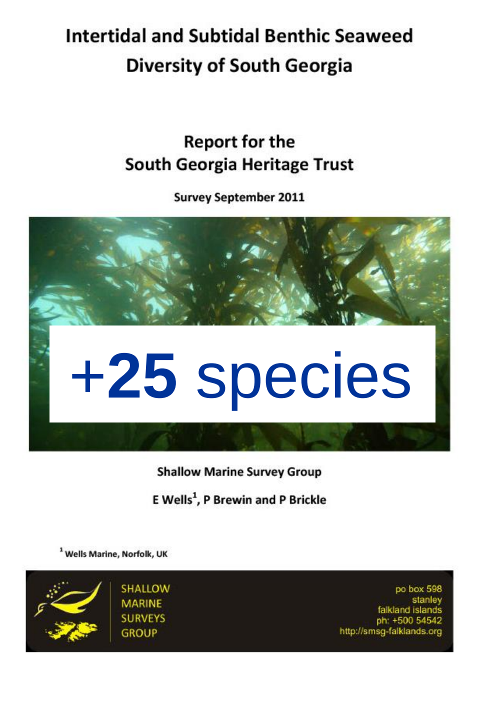
DAVID M. JOHN
Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, UK
PHILIP J.A. PUGH
British Antarctic Survey, Natural Environmental Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK
IAN TITTLEY
Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, UK

CONTENTS

Introduction 101
Materials and methods 102
Results 103
Distribution of shore algae 103
Systematic list 103
Discussion 111
Shore ecology 111
Marine algal flora 112
References 113

SYNOPSIS. The pattern of littoral zonation of benthic algae on rocky and boulder shores in Husvik Harbour, on the north-east coast of South Georgia, was investigated during the austral summer of 1990/91. Distribution patterns are

+85 species


Intertidal and Subtidal Benthic Seaweed Diversity of South Georgia

Report for the South Georgia Heritage Trust

Survey September 2011

+25 species

Shallow Marine Survey Group

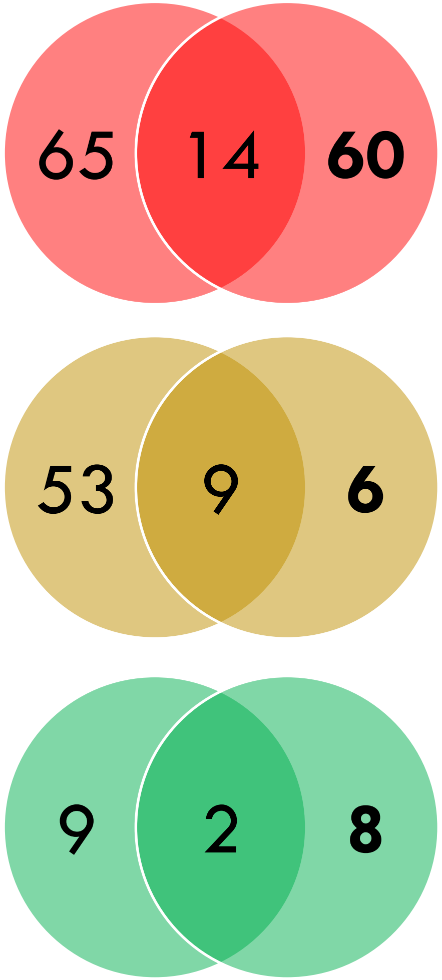
E Wells[1], P Brewin and P Brickle

[1] Wells Marine, Norfolk, UK

SHALLOW MARINE SURVEYS GROUP
po box 598
stanley
falkland islands
ph: +500 54542
http://smsg-falklands.org

= **137** species

Baseline | **Current project**

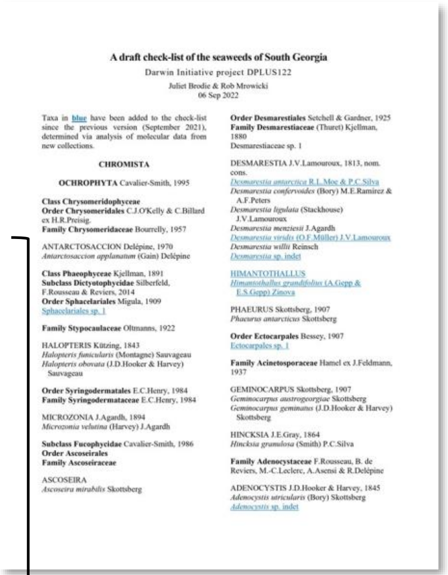


= 139

= 78

= 19

236


A draft check-list of the seaweeds of South Georgia

Darwin Initiative project DPLUS122

Juliet Brodie & Rob Mrowicki
06 Sep 2022

Taxa in blue have been added to the check-list since the previous version (September 2021), determined via analysis of molecular data from new collections.

CHROMISTA

OCHROPHYTA Cavalier-Smith, 1995

Class Chrysomeridophyceae
Order Chrysomeridales C.J.O'Kelly & C.Billard ex H.R.Preisig.
Family Chrysomeridaceae Bourrelly, 1957

ANTARCTOSACCION Delépine, 1970
Antarctosaccion applanatum (Gain) Delépine

Class Phaeophyceae Kjellman, 1891
Subclass Dictyotophycidae Silberfeld, F.Rousseau & Reviers, 2014
Order Sphacelariales Migula, 1909
Sphacelariales sp. 1

Family Stypocaulaceae Oltmanns, 1922

HALOPTERIS Kützing, 1843
Halopteris funicularis (Montagne) Sauvageau
Halopteris obovata (J.D.Hooker & Harvey) Sauvageau

Order Syringodermatales E.C.Henry, 1984
Family Syringodermataceae E.C.Henry, 1984

MICROZONIA J.Agardh, 1894
Microzonia velutina (Harvey) J.Agardh

Subclass Fucophycidae Cavalier-Smith, 1986
Order Ascoseirales
Family Ascoseiraceae

ASCOSEIRA
Ascoseira mirabilis Skottsberg

Order Desmarestiales Setchell & Gardner, 1925
Family Desmarestiaceae (Thuret) Kjellman, 1880
Desmarestiaceae sp. 1

DESMARESTIA J.V.Lamouroux, 1813, nom. cons.
Desmarestia antarctica R.L.Moe & P.C.Silva
Desmarestia confervoides (Bory) M.E.Ramirez & A.F.Peters
Desmarestia ligulata (Stackhouse) J.V.Lamouroux
Desmarestia menziesii J.Agardh
Desmarestia viridis (O.F.Müller) J.V.Lamouroux
Desmarestia willii Reinsch
Desmarestia sp. indet

HIMANTOTHALLUS
Himantothallus grandifolius (A.Gepp & E.S.Gepp) Zinova

PHAEURUS Skottsberg, 1907
Phaeurus antarcticus Skottsberg

Order Ectocarpales Bessey, 1907
Ectocarpales sp. 1

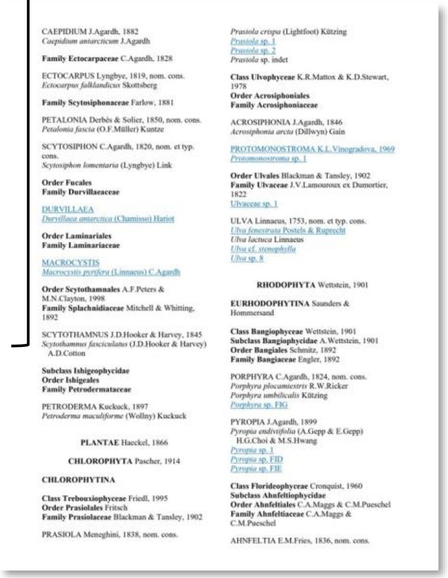
Family Acinetosporaceae Hamel ex J.Feldmann, 1937

GEMINOCARPUS Skottsberg, 1907
Geminocarpus austrogeorgiae Skottsberg
Geminocarpus geminatus (J.D.Hooker & Harvey) Skottsberg

HINCKSIA J.E.Gray, 1864
Hincksia granulosa (Smith) P.C.Silva

Family Adenocystaceae F.Rousseau, B. de Reviers, M.-C.Leclerc, A.Asensi & R.Delépine

ADENOCYSTIS J.D.Hooker & Harvey, 1845
Adenocystis utricularis (Bory) Skottsberg
Adenocystis sp. indet


CAEPIDIUM J.Agardh, 1882
Caepidium antarcticum J.Agardh

Family Ectocarpaceae C.Agardh, 1828

ECTOCARPUS Lyngbye, 1819, nom. cons.
Ectocarpus falklandicus Skottsberg

Family Scytosiphonaceae Farlow, 1881

PETALONIA Derbès & Solier, 1850, nom. cons.
Petalonia fascia (O.F.Müller) Kuntze

SCYTOSIPHON C.Agardh, 1820, nom. et typ. cons.
Scytosiphon lomentaria (Lyngbye) Link

Order Fucales
Family Durvillaeaceae

DURVILLAEA
Durvillaea antarctica (Chamisso) Hariot

Order Laminariales
Family Laminariaceae

MACROCYSTIS
Macrocystis pyrifera (Linnaeus) C.Agardh

Order Scytothamnales A.F.Peters & M.N.Clayton, 1998
Family Splachnidiaceae Mitchell & Whitting, 1892

SCYTOTHAMNUS J.D.Hooker & Harvey, 1845
Scytothamnus fasciculatus (J.D.Hooker & Harvey) A.D.Cotton

Subclass Ishigeophycidae
Order Ishigeales
Family Petrodermataceae

PETRODERMA Kuckuck, 1897
Petroderma maculiforme (Wollny) Kuckuck

PLANTAE Haeckel, 1866

CHLOROPHYTA Pascher, 1914

CHLOROPHYTINA

Class Trebouxiophyceae Friedl, 1995
Order Prasiolales Fritsch
Family Prasiolaceae Blackman & Tansley, 1902

PRASIOLA Meneghini, 1838, nom. cons.
Prasiola crispa (Lightfoot) Kützing
Prasiola sp. 1
Prasiola sp. 2
Prasiola sp. indet

Class Ulvophyceae K.R.Mattox & K.D.Stewart, 1978
Order Acrosiphoniales
Family Acrosiphoniaceae

ACROSIPHONIA J.Agardh, 1846
Acrosiphonia arcta (Dillwyn) Gain

PROTOMONOSTROMA K.L.Vinogradova, 1969
Protomonostroma sp. 1

Order Ulvales Blackman & Tansley, 1902
Family Ulvaceae J.V.Lamouroux ex Dumortier, 1822
Ulvaceae sp. 1

ULVA Linnaeus, 1753, nom. et typ. cons.
Ulva fenestrata Postels & Ruprecht
Ulva lactuca Linnaeus
Ulva cf. *stenophylla*
Ulva sp. 8

RHODOPHYTA Wettstein, 1901

EURHODOPHYTINA Saunders & Hommersand

Class Bangiophyceae Wettstein, 1901
Subclass Bangiophycidae A.Wettstein, 1901
Order Bangiales Schmitz, 1892
Family Bangiaceae Engler, 1892

PORPHYRA C.Agardh, 1824, nom. cons.
Porphyra plocamiestris R.W.Ricker
Porphyra umbilicalis Kützing
Porphyra sp. FIG

PYROPIA J.Agardh, 1899
Pyropia endiviifolia (A.Gepp & E.Gepp) H.G.Choi & M.S.Hwang
Pyropia sp. 1
Pyropia sp. FID
Pyropia sp. FIE

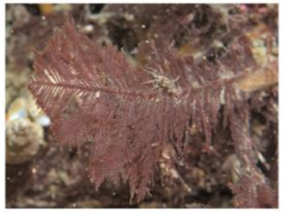
Class Florideophyceae Cronquist, 1960
Subclass Ahnfeltiophycidae
Order Ahnfeltiales C.A.Maggs & C.M.Pueschel
Family Ahnfeltiaceae C.A.Maggs & C.M.Pueschel

AHNFELTIA E.M.Fries, 1836, nom. cons.

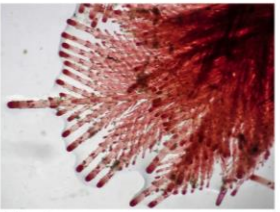
An identification guide to the seaweeds of South Georgia

Ballia sp.1

Ballia sp. 1.



Ballia sp. 1.



Ballia sp. 1.

Ballia sp. 1.

DESCRIPTION Erect axes, up to 29 cm in height, densely branched in one plane to give a feathery appearance. Main axes with opposite to irregular branching, more densely packed towards the tips to give a bushy wedge-shaped appearance. Attached by a robust holdfast up to 1 cm in diameter.

TEXTURE AND COLOUR Slightly rough texture, and spongy in very densely branched specimens. Bright to dark red.

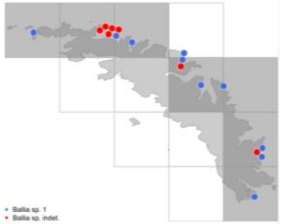
HABITAT Frequent in the subtidal on rock and crustose coralline algae up to 18.5 m depth; occasional in rockpools in the intertidal.

DISTRIBUTION Widespread along the whole extent of the north coast of South Georgia in the subtidal; widespread in the intertidal.

SIMILAR SPECIES

NOTES ON SPECIES IDENTITY Based on molecular data, this species is a fairly close match to Ballia callitricha but may represent an undescribed species.

COMMENTS Epiphytic red seaweeds, including crustose corallines, Delesseriaceae and a tough, Ahnfeltia-like species are common. Some specimens very compact which in addition to the seaweeds, support a wide range of worms, isopods, bryozoans and bivalves. There is uncertainty about the identif cation of Ballia specimens from South Georgia and they may represent more than one species.



Ballia sp. 1 distribution map.

Himantothallus cf. grandifolius

Himantothallus cf. grandifolius.

Himantothallus cf. grandifolius.

Himantothallus cf. grandifolius.

Himantothallus cf. grandifolius.

DESCRIPTION A massive thallus, up to (at least) 17 m long and 1 m wide. Holdfast is a network of tangled f laments, sometimes tens of centimetres in diameter. Small fronds are round or oar-shaped, developing from a narrow, branched stipe. Even in larger plants, stipes tend to be <3 cm wide, and have a f attened cross-section. Stipes (and fronds) may become twisted into a spiral.

TEXTURE AND COLOUR Tough, thick and leathery, with very smooth fronds. Golden to dark brown in colour.

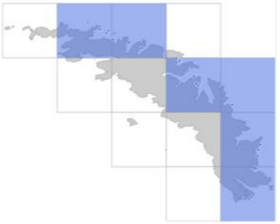
HABITAT Low intertidal and sublittoral fringe, and subtidal to at least 18 m depth. Grows on rocky substrata.

DISTRIBUTION Common and widely distributed along the north coast of South Georgia, from Esbensen Bay in the southeast to the Bay of Isles in the northwest.

SIMILAR SPECIES Young individuals may resemble small Ascoseira mirabilis and Macrocystis pyrifera plants, but Himantothallus cf. grandifolious tends to have rounded or oar-shaped fronds, rather than elongated and tapered; also the stipe has a distinctive, irregular branching pattern.

NOTES ON SPECIES IDENTITY It was thought that this species was the same as Himantothallus grandifolius found in Antarctica; however, molecular analyses indicate that specimens from South Georgia belong to a separate, possibly endemic, species.

COMMENTS This habitat-forming seaweed can be found at high densities, carpeting the seabed with its expansive fronds. The complex holdfast supports a high biodiversity of seaweeds and invertebrates.



Himantothallus cf. grandifolius distribution map.

Protomonostroma sp.1

Protomonostroma sp. 1.

Protomonostroma sp. 1.

Protomonostroma sp. 1.

Protomonostroma sp. 1.

DESCRIPTION Extremely thin green blades with very irregular margins, one cell layer thick. Cells are very small compared to other green seaweeds. Variable in size and shape, from small, compact rosettes a few centimetres across, to broad, lobed or divided sheets (up to c. 14 cm long and 5 cm wide) arising from a central point. Attached to the substratum via a central discoid holdfast. Exhibits a characteristic growth phase, consisting of inf ated hollow sacs, sometimes >10 cm across, which presumably develop into f attened blades.

TEXTURE AND COLOUR Soft, delicate and fragile. Bright lime green to olive green in colour, appearing translucent.

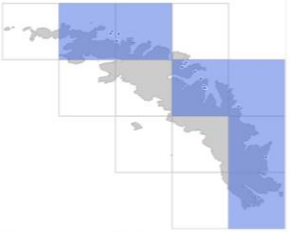
HABITAT In the intertidal zone, from the upper to lower shore. Commonly grows in rock pools on hard substrata, but can also be epiphytic on other seaweeds (such as Porphyra or Pyropia species).

DISTRIBUTION Common and widespread along the north coast of South Georgia, from Drygalski Fjord in the southeast to the Bay of Isles in the northwest.

SIMILAR SPECIES Similar to bladed Ulva species, but consists of a single cell layer, as opposed to two. The 'inf ated sacs' growth phase has only been observed in this species.

NOTES ON SPECIES IDENTITY Probably an undescribed species in the genus Protomonostroma. Matches other specimens from the Falkland Islands and Antarctica.

COMMENTS It is unclear whether the 'inf ated sacs' growth phase is just a seasonal phenomenon (observed during spring/ summer).



Protomonostroma sp. 1 distribution map.

Citizen Science: Monitoring seaweed biodiversity in South Georgia

Activity 1: Shifting Seaweeds

Join the survey

When? During any shore excursion, either aboard the Zodiac (or other small boat) between ship and landing area, or by foot on the shore itself. Try to do the survey within one hour of low tide.

Where? Anywhere on the coast of South Georgia.

Who can take part? Everyone.

How long does it take? 10 minutes.

You will need:

- The *Shifting Seaweeds* activity guide
- A *Shifting Seaweeds* recording form
- A clipboard and pencil
- A camera or smartphone
- A watch or other timekeeping device
- A handheld GPS device

What to do:

1. Choose a shore. If you are on a small boat, look for seaweed-covered rocky outcrops that you can get close to (without compromising safety). If you are on foot, find a rocky area of the shore with seaweeds growing on it, out of the way of territorial or sensitive wildlife (such as fur seals or breeding birds).

1. Bladder weed, *Adenocystis utricularis*
Bladders can be almost spherical to narrow and cylindrical. Soft and gelatinous when fresh, tough and leathery when dry. Found in mid to low shore pools and on emergent rock.

2. Bull kelp, *Durvillaea antarctica*
Texture smooth, tough and leathery, but sometimes feels spongy. Commonly at the water's edge and in shallow water on rocky coastlines, although sometimes occurs in low shore pools.

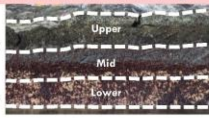
3. Antarctic turf foot, *Caepidium antarcticum*
This species has both a basal crust and an upright phase. Found on emergent rock from mid to low shore, around rock pools and at the water's edge. Often seen just as a crust, without uprights.

4. Red palm weeds, Palmariaceae spp.
This group includes various species. Can be thin and slippery, or cartilaginous. Flat blades with rounded edges. Emergent rock on mid to low shore and at the water's edge.

5. Calcified crusts
There are various unidentified species of calcified crust (examples here are from the Falklands). Mauve or brownish pink to white or grey. Water's edge, low and mid shore rock pools and wet rocks.

Estimating the severity of seaweed bleaching

1. Divide your survey area into three approximately equal horizontal bands, between the water's edge and the high water mark:



2. For each band, estimate the total amount of seaweed tissue that appears bleached (i.e. with partial or total loss of colour):

Low (<35%) | Moderate (35–65%) | High (>65%)

Activity 2: Alien Invaders

Join the survey

When? While ashore, during any shore excursion, and at any time except high Spring tides.

Where? Anywhere on the coast of South Georgia, but especially around Grytviken and King Edward Point.

Who can take part? Everyone.

How long does it take? 10 minutes.

You will need:

- The *Alien Invaders* activity guide
- An *Alien Invaders* recording form
- A clipboard and pencil
- A camera or smartphone
- A watch or other timekeeping device
- A handheld GPS device

What to do:

1. Choose your survey area. Aim for a relatively flat section of shore (sandy or pebbly shores work best, but flat rocky areas might also be suitable), out of the way of territorial or sensitive wildlife (such as fur seals or breeding birds). Find the strandline – the uppermost line or band of debris, including seaweeds, that has been washed up at the top of the shore. This will form the upper limit of your search area.

2. Take a picture. Standing on the shore between the strandline and the water's edge, take a photograph in the direction of your survey, including as much of the strandline as possible. This will provide an important record of the environmental conditions on the shore.

Probable non-native seaweeds already present in South Georgia

1. Sea lettuce, *Ulva fenestrata*
Thin but tough blades, slightly translucent in appearance, with irregular edges and sometimes covered in holes. May grow up to tens of centimetres across. Inhabits a wide range of intertidal and subtidal environments. Found as free-floating drift at Grytviken.

2. Oyster thief/Sea potato, Ectocarpales sp(p).
This unidentified seaweed may include more than one species. Hollow sacs with paper-thin or leathery walls. Often grows epiphytically on other seaweeds. Found washed up on the shore near Grytviken, and inhabiting other shores to the northwest.

Non-native seaweeds that could potentially arrive from elsewhere

3. Green sponge fingers, *Codium fragile*
Unmistakeable. Firm and velvety in texture. In pools and on emergent rock on the mid to low shore and at the water's edge. Often with brown or red filamentous seaweeds growing on it.

4. Green fluffy spongy weed, *Spongomorpha aeruginosa*
Fine filamentous seaweed with a soft and spongy texture. Found in wet areas, pools, and at the water's edge. Looks like mini pom-poms when submerged. Commonly grows on other seaweeds.

Activity 3: Raft Watch

Join the survey

When? On board your ship, while cruising in a straight line between destinations.

Where? On the way to or from South Georgia, either on the open ocean or within sight of land.

Who can take part? Everyone.

How long does it take? 30 minutes.

You will need:

- The *Raft Watch* activity guide
- A *Raft Watch* recording form
- A clipboard and pencil
- A camera (with telephoto lens)
- Binoculars
- A watch or other timekeeping device
- A handheld GPS device

What to do:

1. Find an observation point. This can be on either side of the ship, or with views across both sides, and facing either forwards or backwards. Make sure you can see the surface of the sea both nearby (within one ship's width) and far away (towards the horizon, if visible).

2. Start looking for rafts. Use the *Raft Watch* recording form to write down all data (don't forget to record the time and GPS position at the beginning of the survey). As the ship moves along, scan up and down between the ship and the horizon, using binoculars to look at floating objects in more detail.

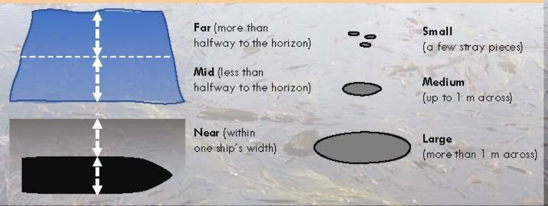
When you spot a seaweed raft:

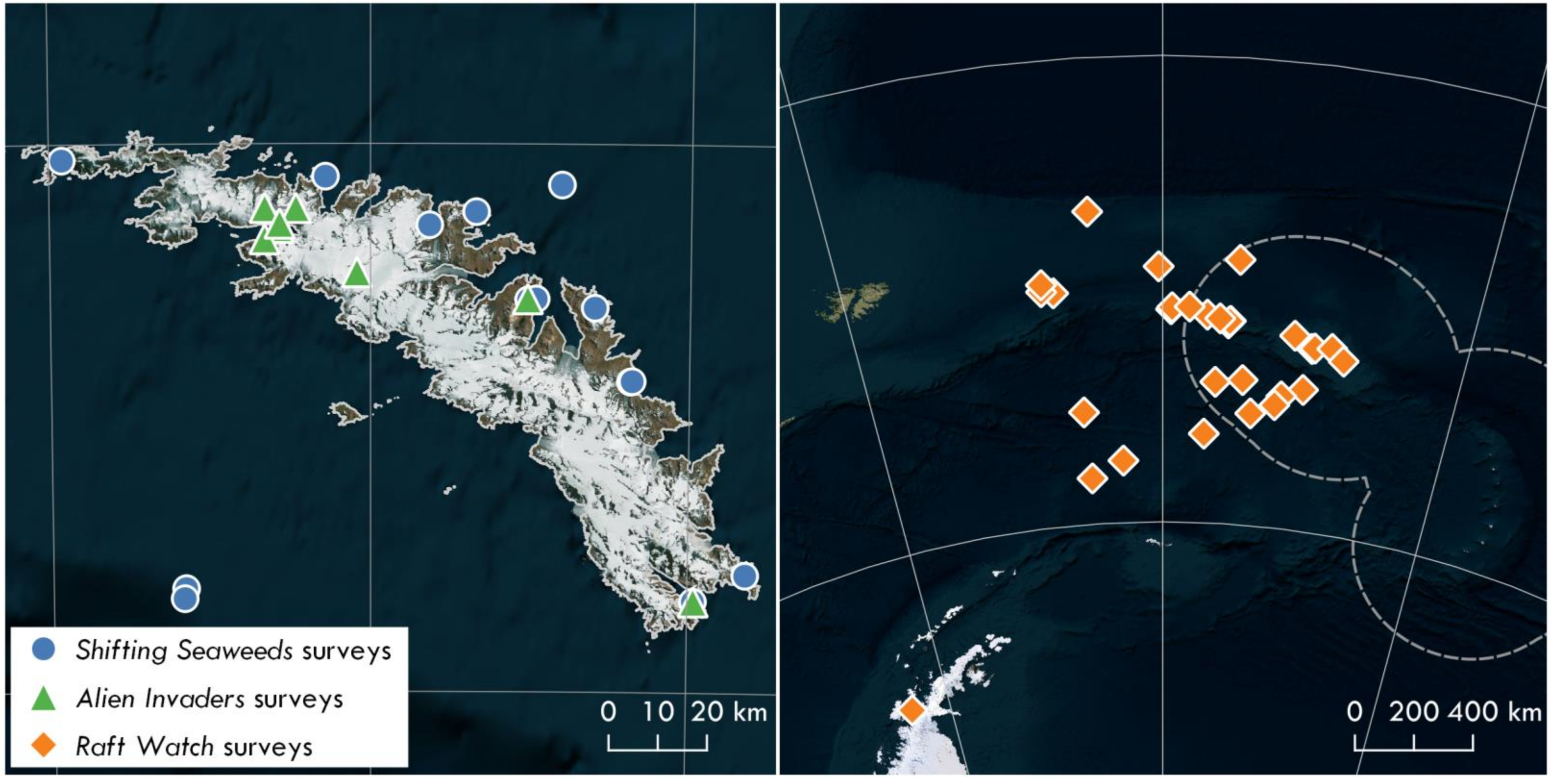
- Record its distance and size using the guide below.
- Identify which of the two main seaweed species it consists of.
- Note whether there is any non-biological debris and/or wildlife associated.
- If possible, take a photograph using a camera with telephoto lens.

3. Stop looking after 30 minutes (or less). Record the time and GPS position at the end of the survey. If you didn't see any rafts, record this on the form.

4. Submit your results. As soon as possible after the survey, give the recording form and any photos to your guide – they will then submit the results to seaweed experts at the Natural History Museum in London, who will use your data in scientific investigations and reports.

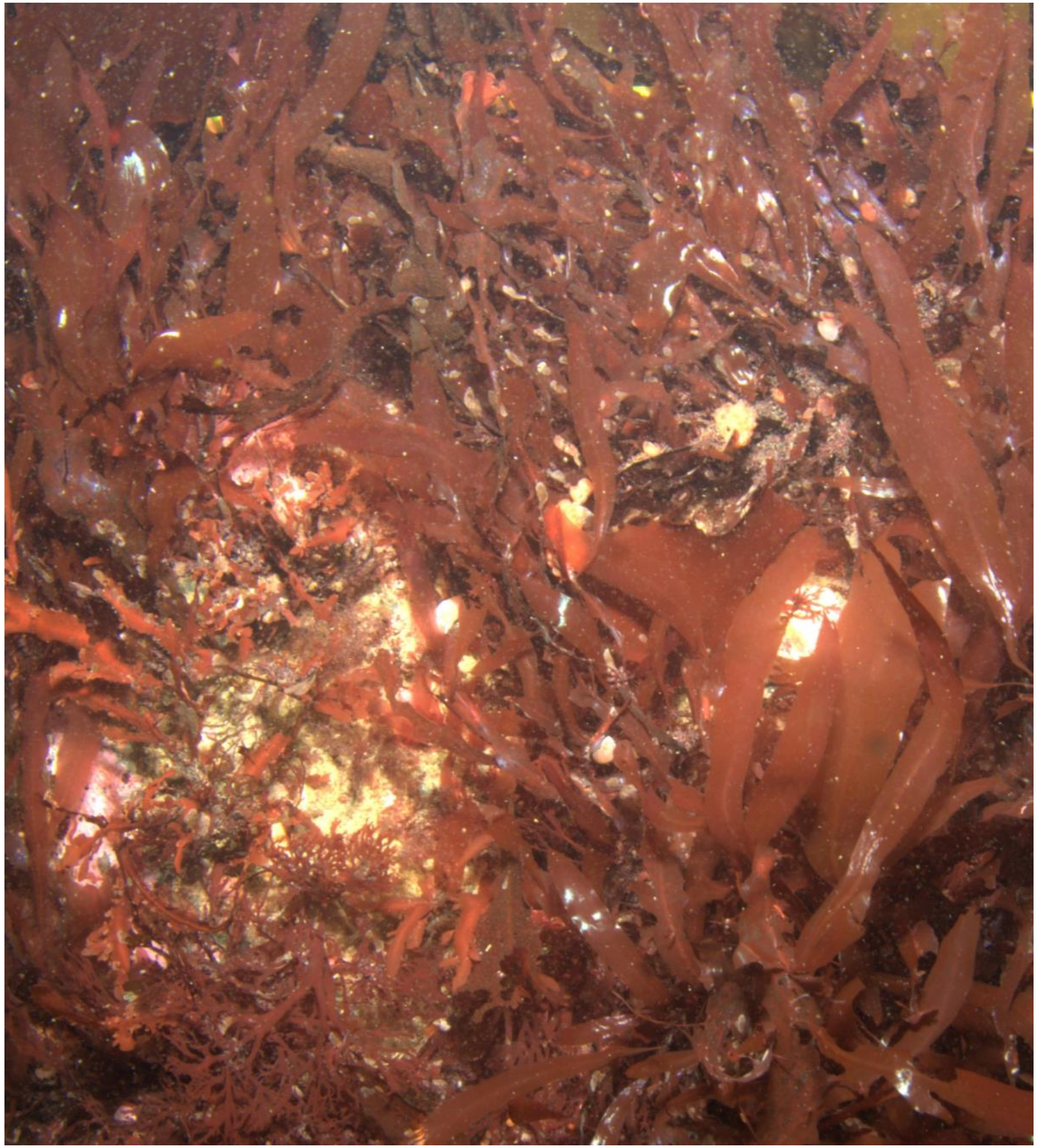
Estimating the distance and size of rafts:

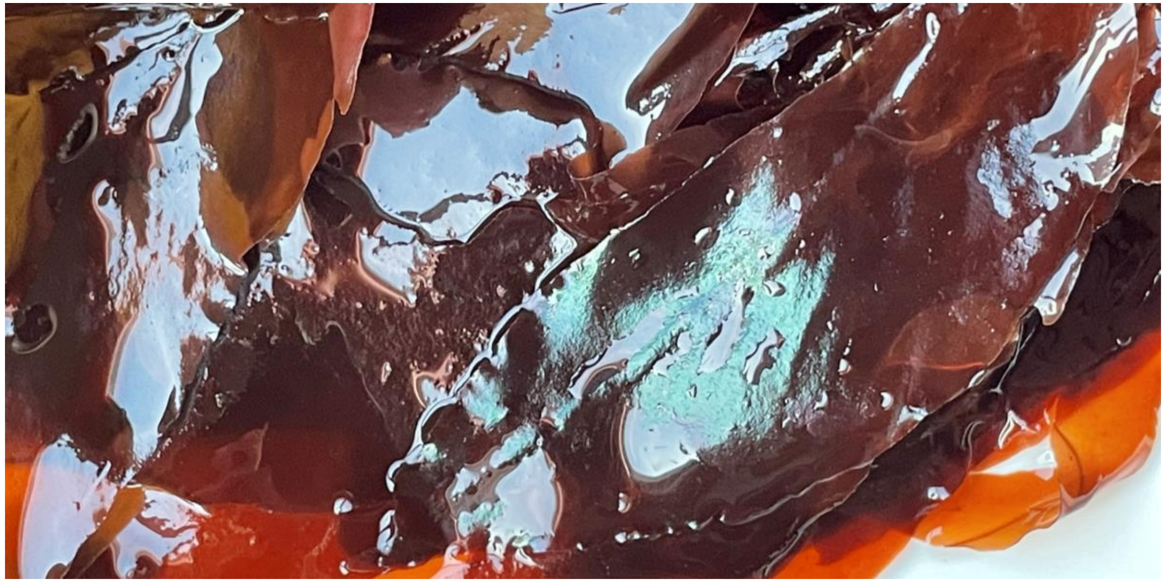


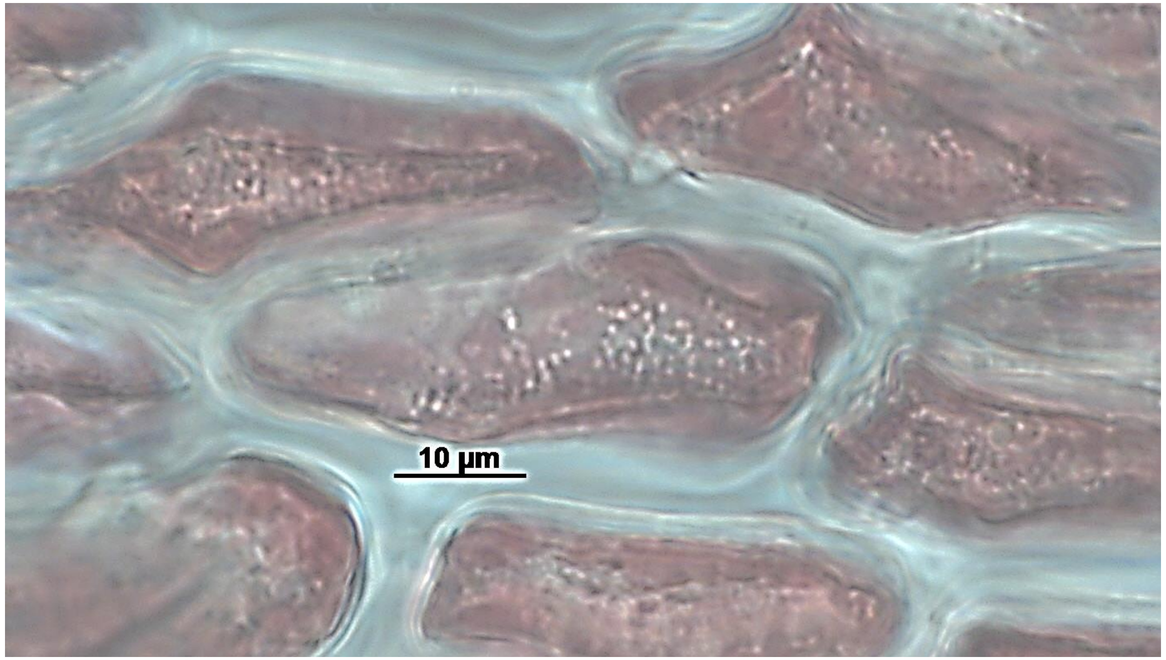


33 surveys so far

Myriogramme manginii with structural colour







Future work

Mapping spatial/temporal distributions are valuable for Red List and Important Plant Area assessments.

There is a need for more work in South Georgia, including south side of the island.

The huge taxonomic gaps need addressing and require a global approach.

There are phenomena to be explored, e.g., structural colour.





NATURAL HISTORY MUSEUM
DARWIN INITIATIVE
DESIRE THE RIGHT
SOUTH ATLANTIC ENVIRONMENTAL RESEARCH INSTITUTE
SHALLOW MARINE SURVEYS GROUP
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
Tritonia scientific
FALKLANDS CONSERVATION

Michelle Taylor

University of Essex


ESA


Sue G


Cefas

Connectivity patterns are species dependent in Southern Ocean deep-sea octocorals

María Belén Arias; Kerry-Lee Etsebeth; Rui Vieira; Andrea M. Quattrini, Jessica Gordon; ; Alice Malcolm-McKay;

Michelle Taylor – University of Essex

@Dr_MTaylor www.taylorlab.science

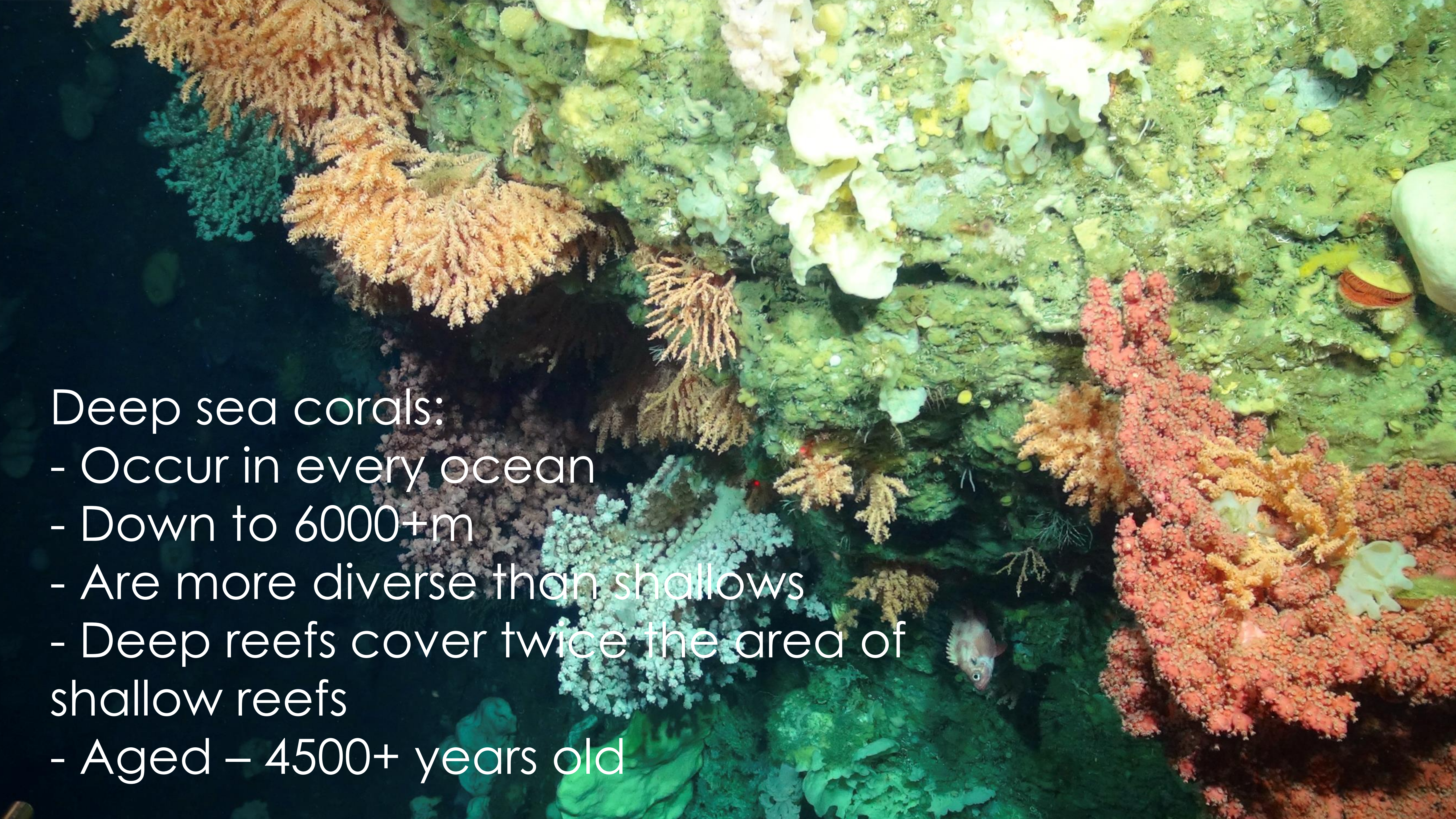
DARWIN INITIATIVE

Centre for Environment Fisheries & Aquaculture Science Cefas

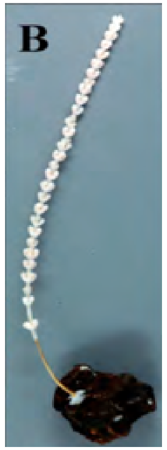
CCSUS Collaborative Centre for Sustainable Use of the Seas

UEA University of East Anglia

NATURAL HISTORY MUSEUM


Deep sea corals:
- Occur in every ocean
- Down to 6000+m
- Are more diverse than shallows
- Deep reefs cover twice the area of shallow reefs
- Aged – 4500+ years old

Study design – UCEs > SNPs



Primnoella chilensis

Sampling sites: 6

Total: 92 individuals

Reproductive strategy: brood then 'crawling' larvae

Dasystenella acanthina

Sampling sites: 11

Total: 86 individuals

Reproductive strategy: brooding (i.e., internal fertilization)

Thouarella viridis

Sampling sites: 4

Total: 63 individuals

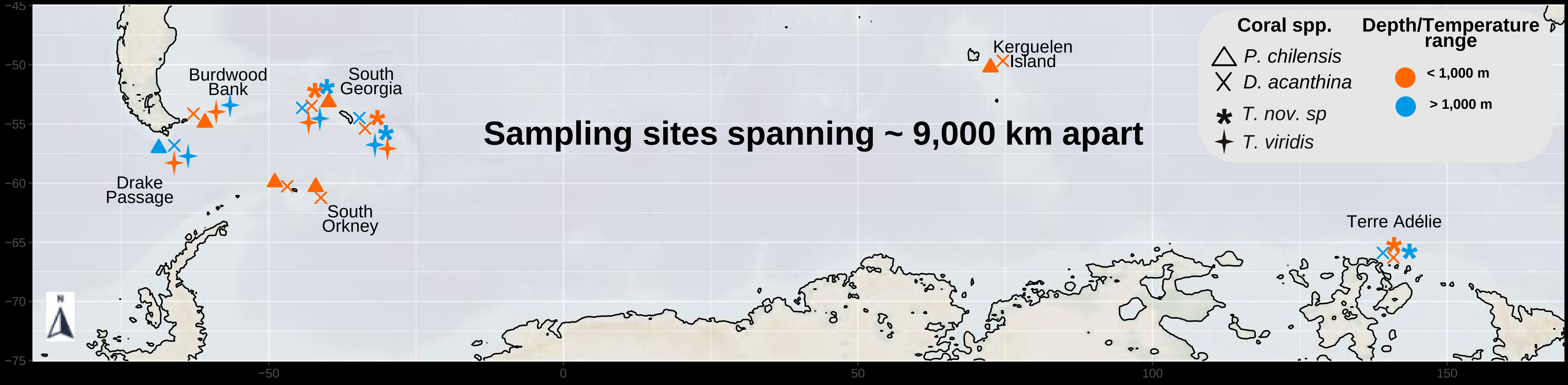
Reproductive strategy: brooding (i.e., internal fertilization)

Thouarella nov. sp

Sampling sites: 4

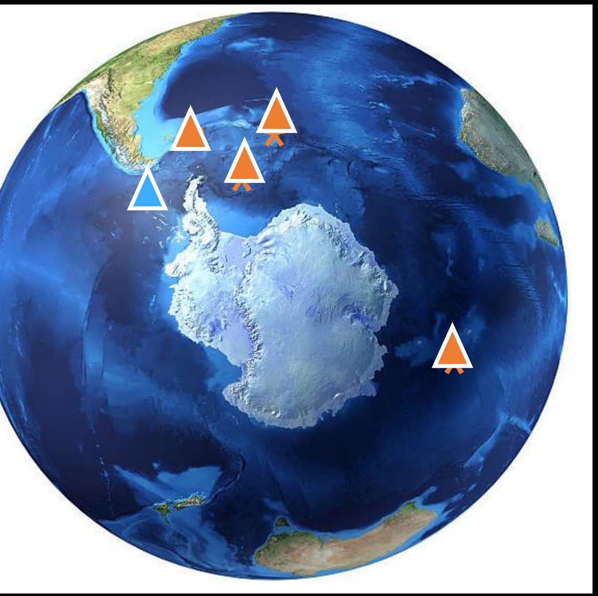
Total: 88 individuals

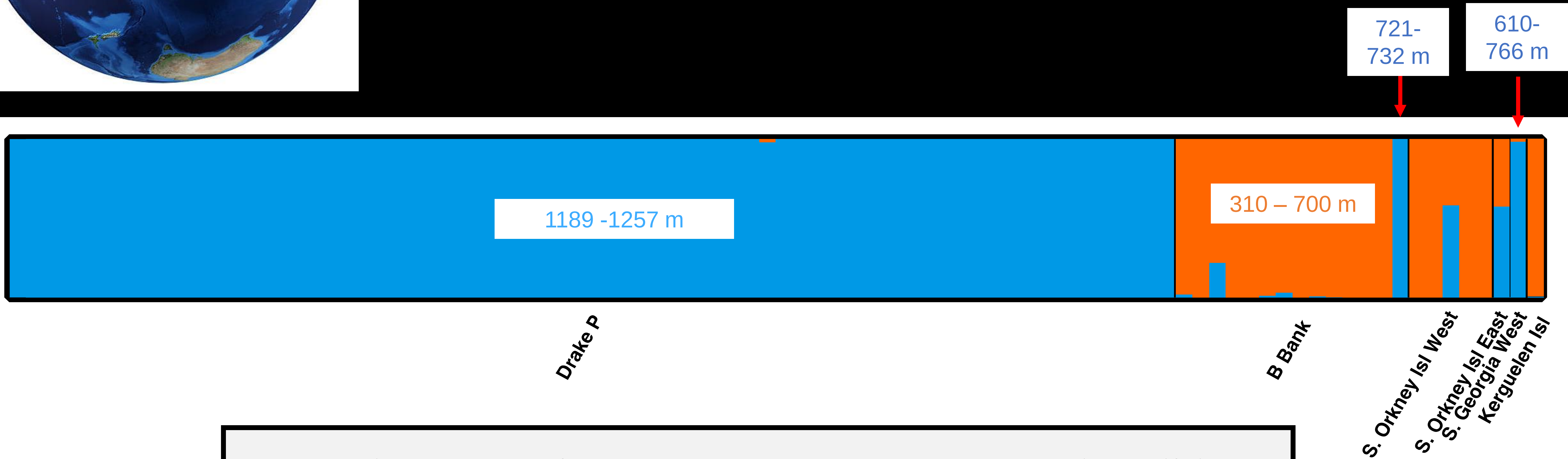
Reproductive strategy: brooding (i.e., internal fertilization)



Genetic clustering of *P. chilensis*

Two distinct genetic cluster identified by depth (2,663 SNPs)





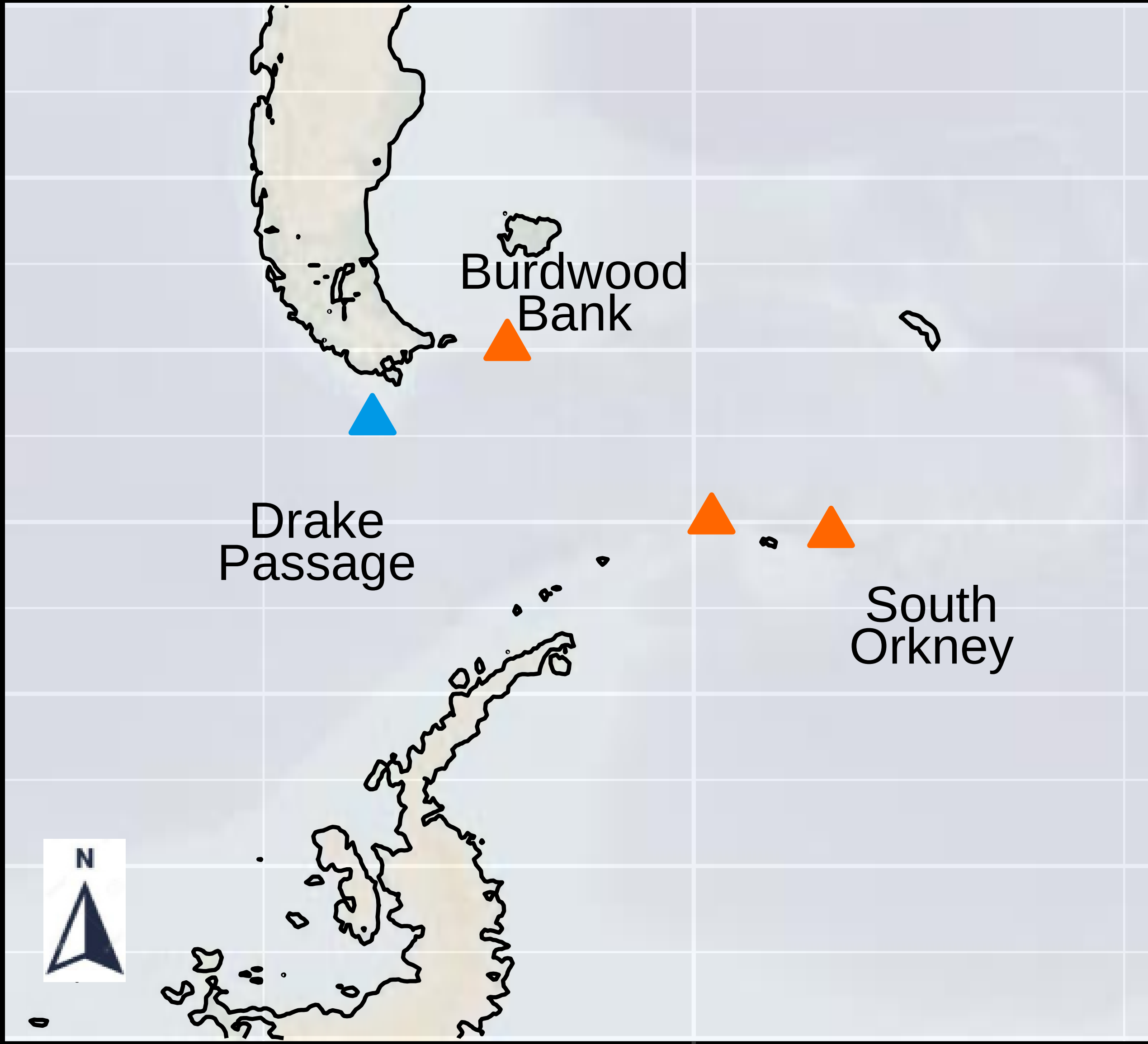
West

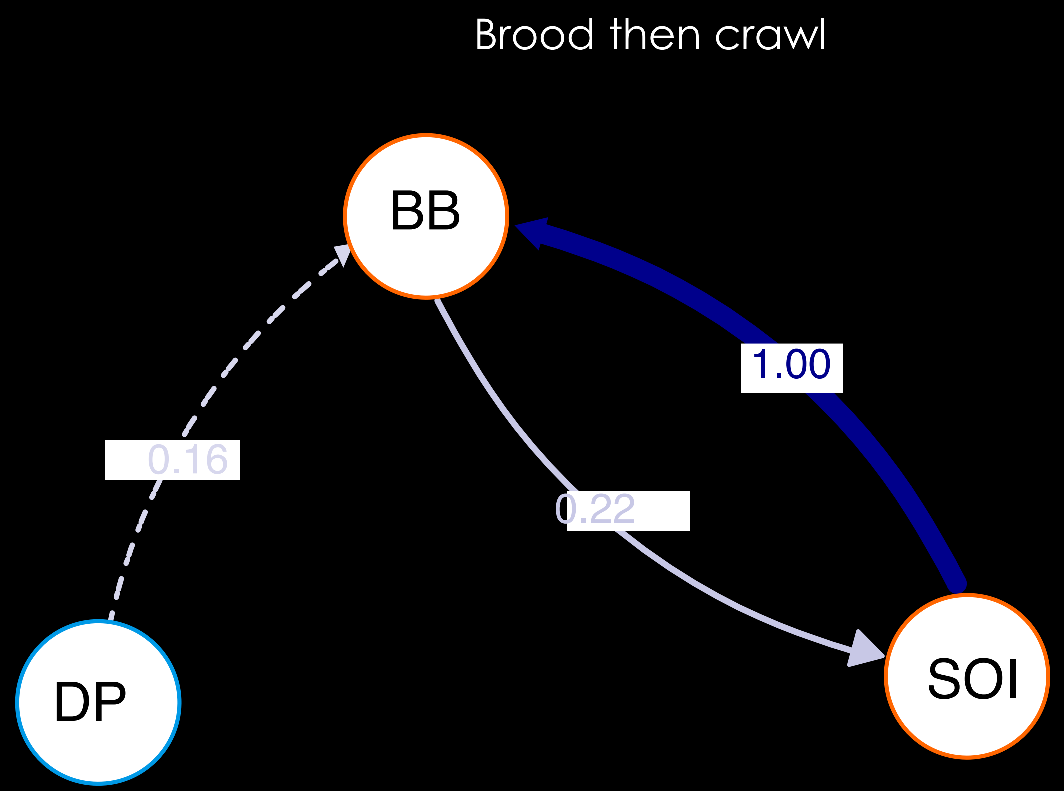
Genetic structure found between Shallow vs Deep identifying **~800 m isobath as potential dispersal barrier** across sampling sites despite samples spanning thousands of kilometers apart

East

Migration dynamics of *P. chilensis*

Strong gene flow among shallow samples sites



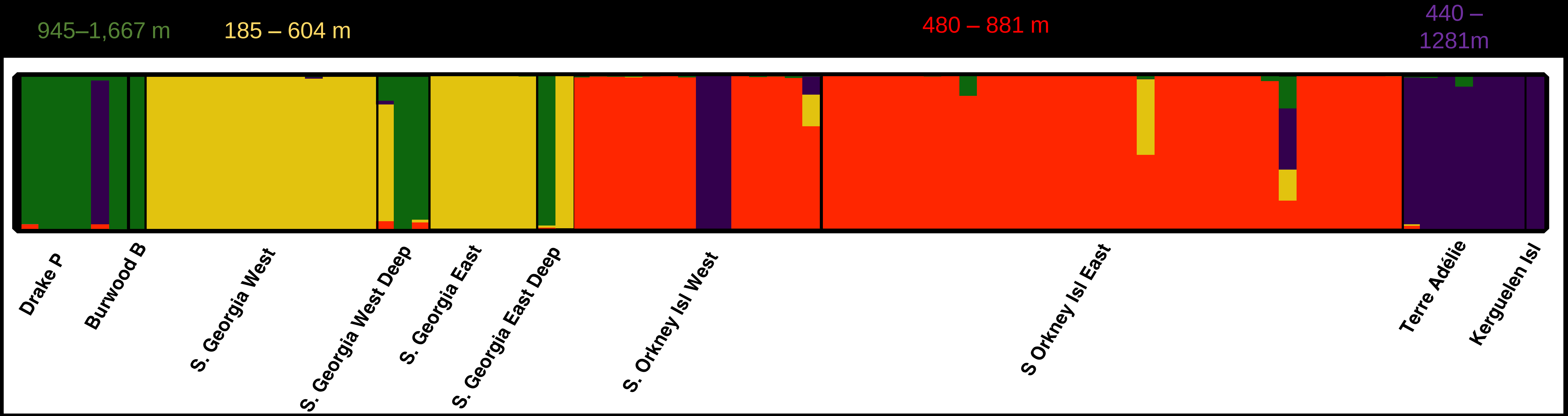


An study of *Thouarella spp*. (2 nuclear markers) populations across the ACC (South Pacific and Southern Ocean) shared haplotypes (Dueñas et al., 2016)

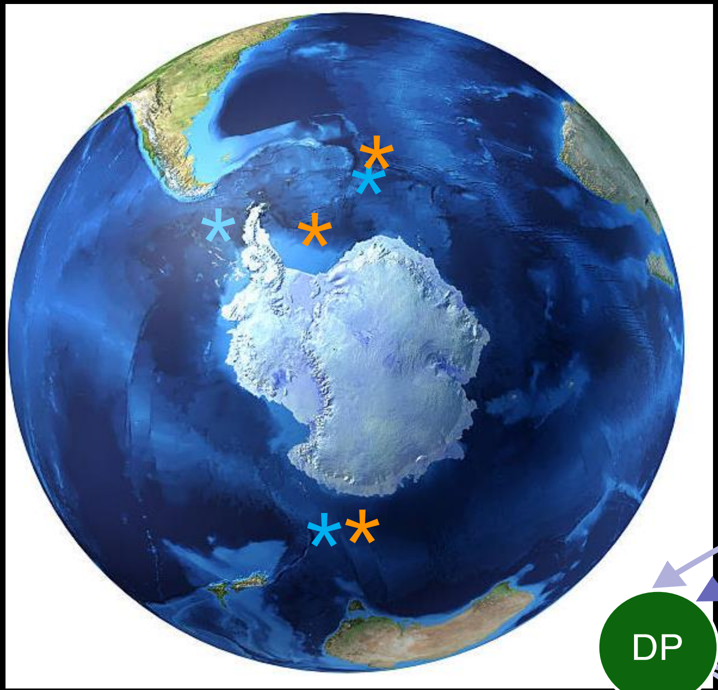
Genetic clustering of *D. acanthina*

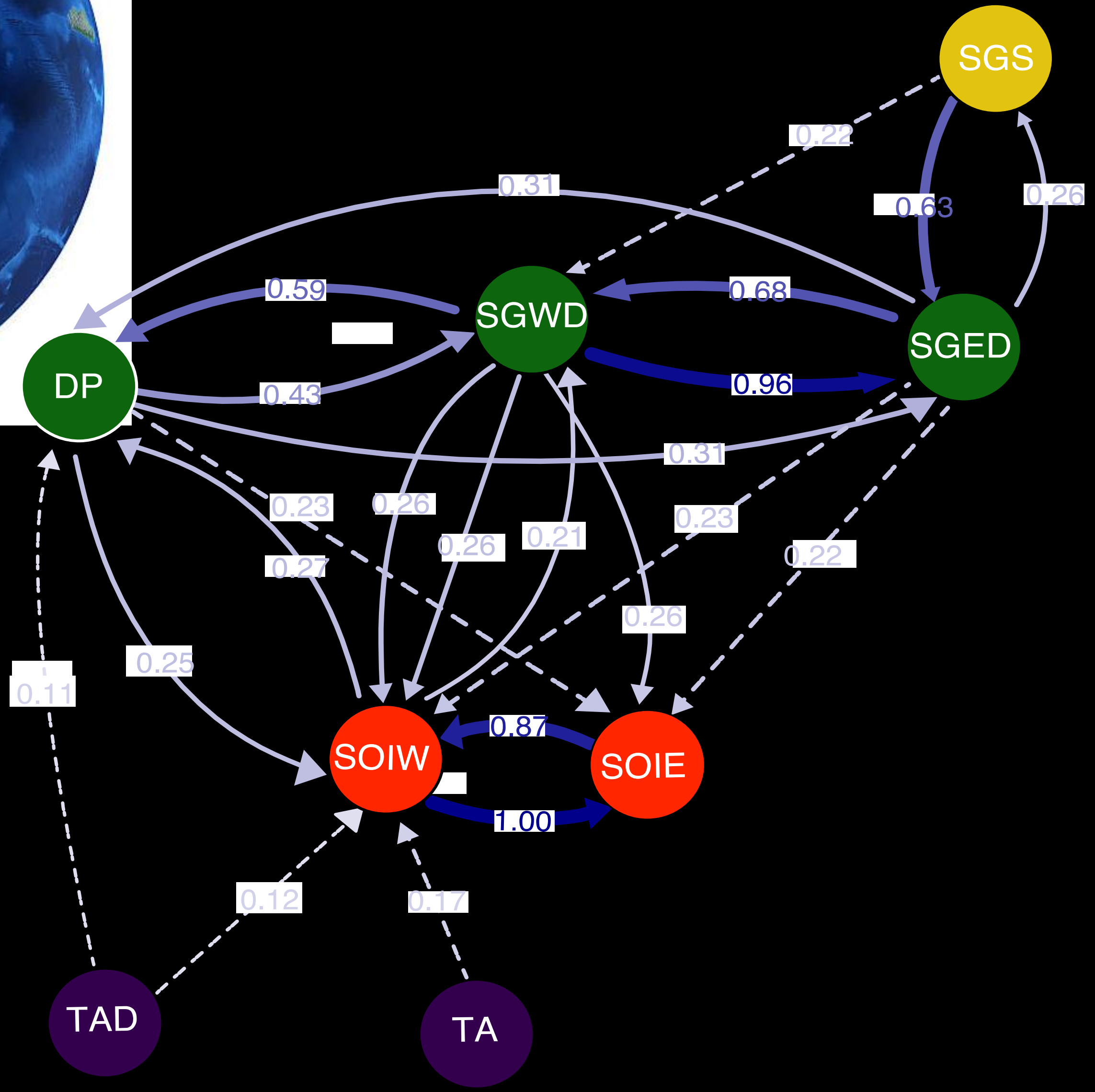
Depth and geographic location (2,400 SNPs)

4 genetic clusters
West sampling sites (dark green and yellow) are assigned to different genetic clusters despite their origin (from the same location).
Dark green cluster is predominant across **sites > 945 m indicating panmixia (depth)**
South Orkney samples **(red)** and **East sampling sites** (purple) are assigned to a **unique genetic** clusters despite their similar depths.



Connectivity of *D. acanthina*





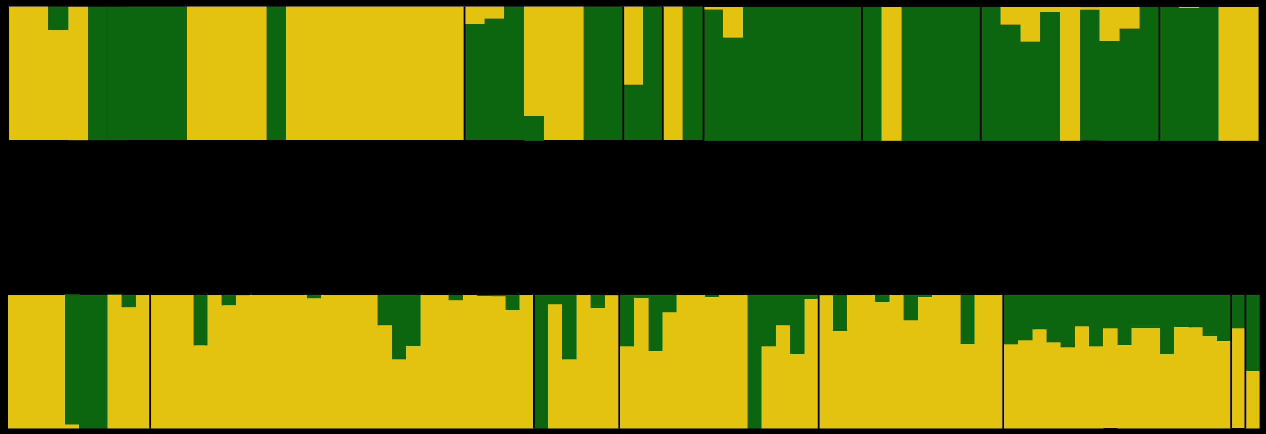
Brooder

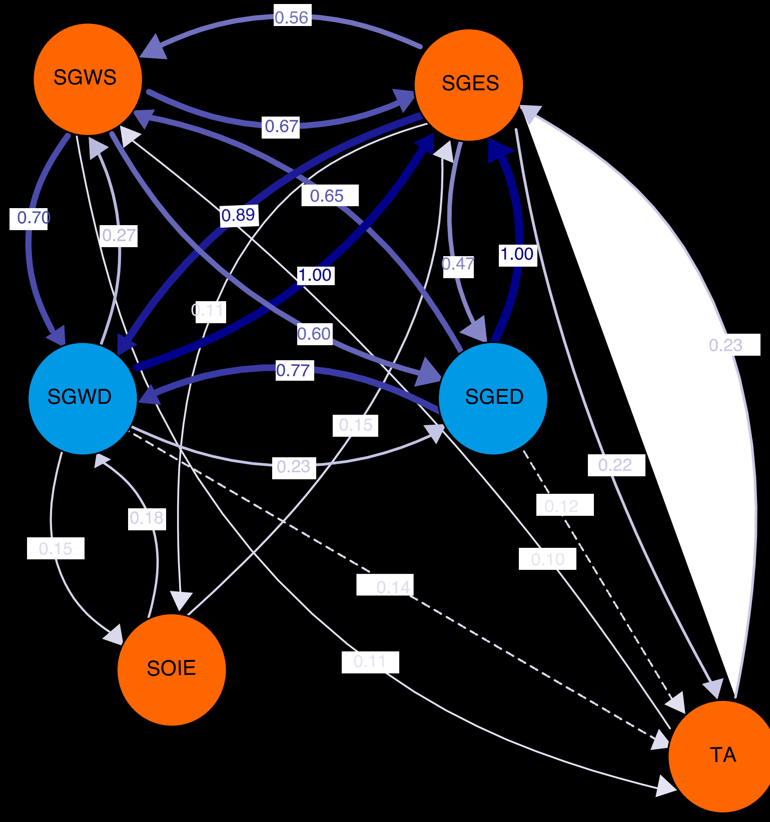
Bidirectional migration was detected among most of the sampling sites **(9000km!)**

Strong connectivity was identified **across bathymetric range** (Shallow to Deep).

Moderate vertical connectivity was identified from Shallow to Deep populations, especially S. Orkney Isl.

Genetic clustering and connectivity of *T. viridis and T. nov.sp.*

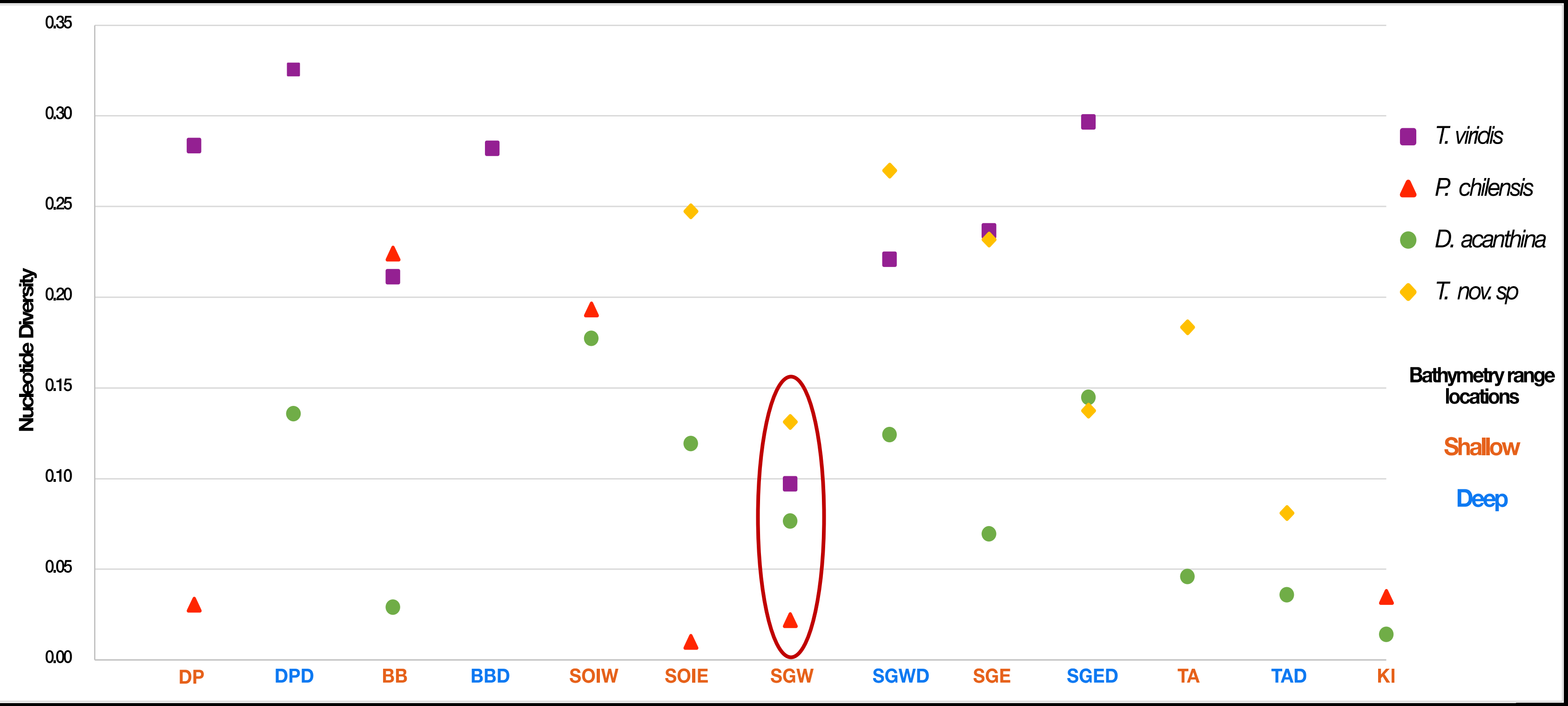




These species **showed panmixia across ~9,000 km despite multiple barriers** (i.e., oceanographic currents and oceanic features) among the sampling sites.

Bidirectional migration

Genetic diversity



T. viridis & **_T. nov sp._** presented the highest genetic diversity comparable *Acropora digitifera* (Av 0.3) (Adam et al. 2022)

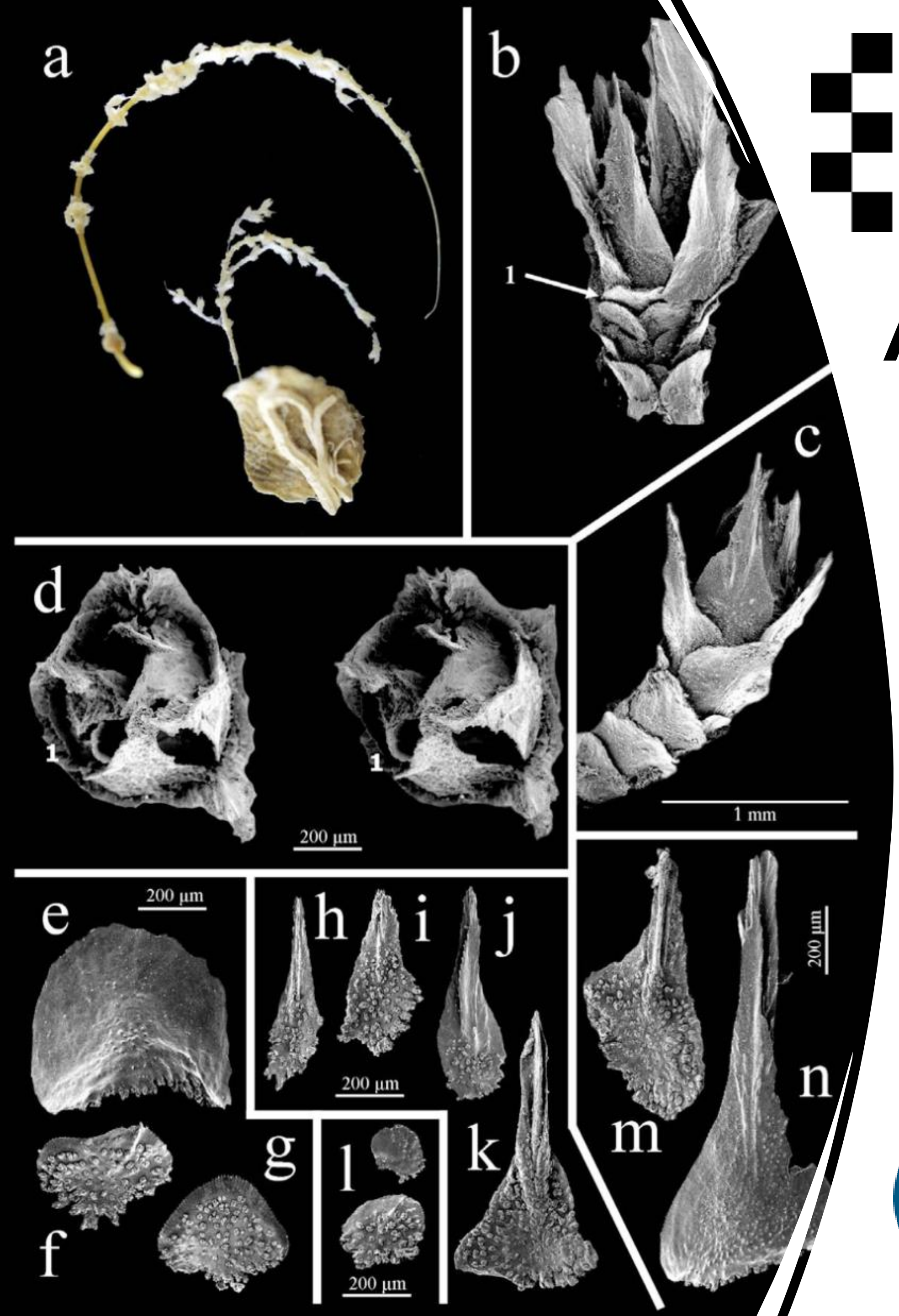
P. chilensis & **_D. acanthina_** presented similar diversity **to previous studies** in sponges **collected in Antarctic peninsula** using SNPs (Av 0.16; 0.2) (Leiva et al. 2019, 2022).

In **South Georgia Shallow** water present **low genetic** diversity that **might affect their capacity** to deal with **future environmental and human pressures**

Summary

- Targeted enrichment of **UCE successfully differentiate populations** of octocorals.
- **Depth** structuring genetic pattern in *P. chilensis* and the western sampling sites of *D. acanthina.*
- **Geography** (latitude) was the potential genetic barrier in eastern sampling sites of *D. acanthina*.
- **High genetic diversity and connectivity** of both *Thouarella* spp.
- **Lowest genetic diversity across the four spp** was identified in **South Georgia** shallow water = priority of this area for future conservation measurements?
- Reflect different life traits (larvae behaviour), complex demographic interactions (environmental/oceanographic conditions) or combination both?

Images from Blue Belt project



Acknowledgements

Darwin Plus Grant for funding DPR7P\100040

Members of the Taylor's lab

Scientist and crew involved in the data collection:

Cefas

SGSSI Government

MRAG

BAS

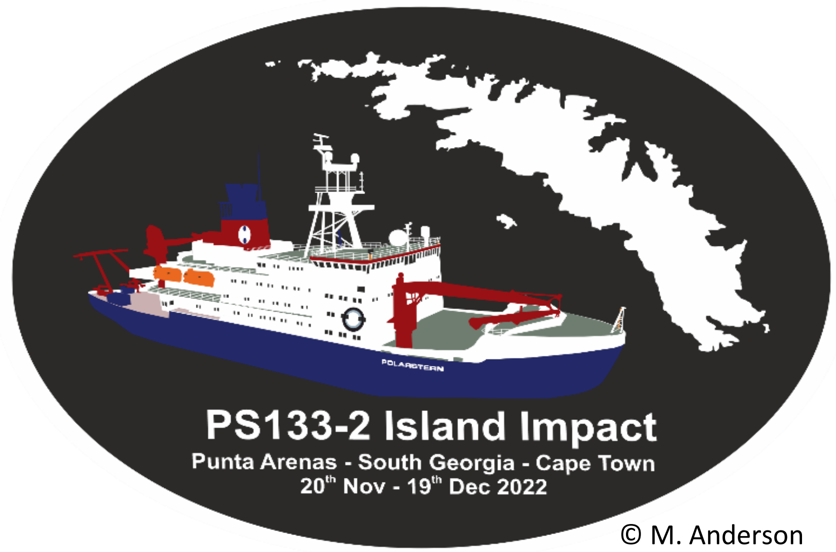
Sabine Kasten

Alfred Wegener Institute

Expedition PS133-2

Expedition PS133-2 "Island Impact"

Understanding the regional impact of islands (South Georgia) on Southern Ocean biogeochemistry and ecosystem function



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Start: 20.11.2022 in Punta Arenas (Chile)
End: 19.12.2022 in Cape Town (South Africa)

Leg PS133-2

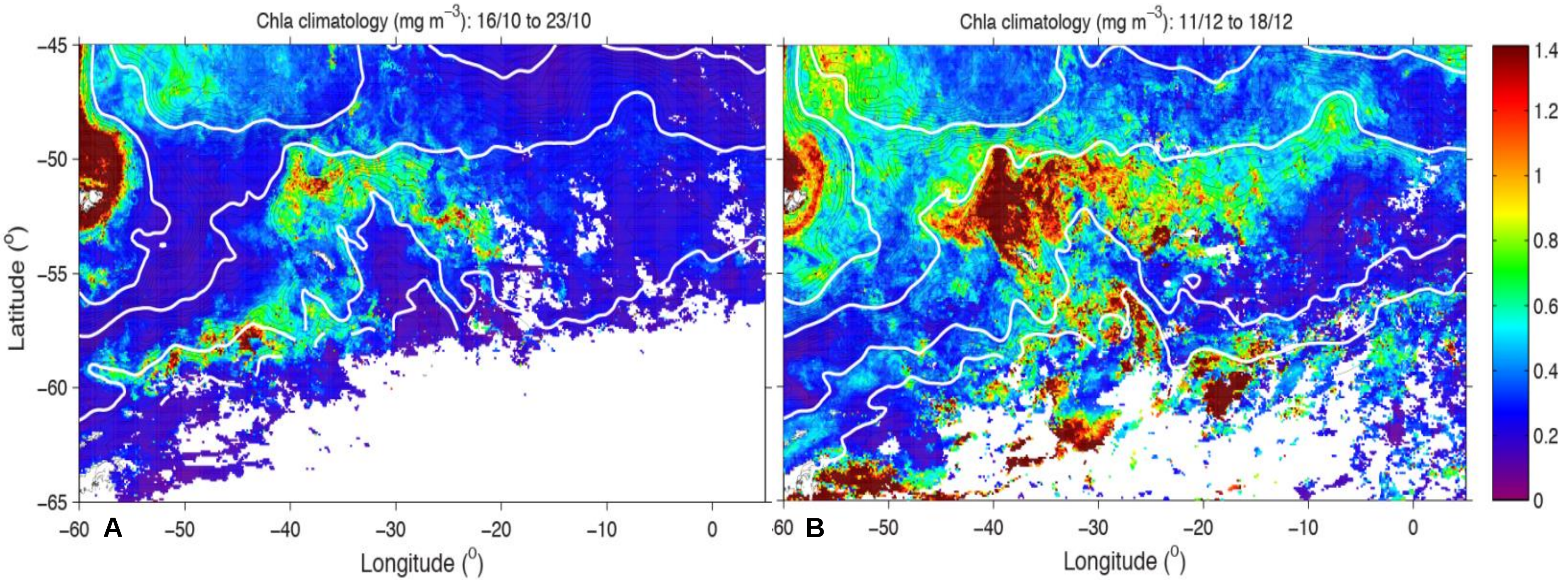
Main objective of expedition "*Island Impact*":

investigate and quantify the sources, transport pathways and fluxes of nutrients, iron, other trace elements and carbon
<u>over the whole terrestrial/coastal/open ocean continuum</u>

-> combining work on different environmental compartments, namely terrestrial coast, sediment and water column, to trace nutrients, iron and carbon from source to sink

Leg PS133-2 - Motivation

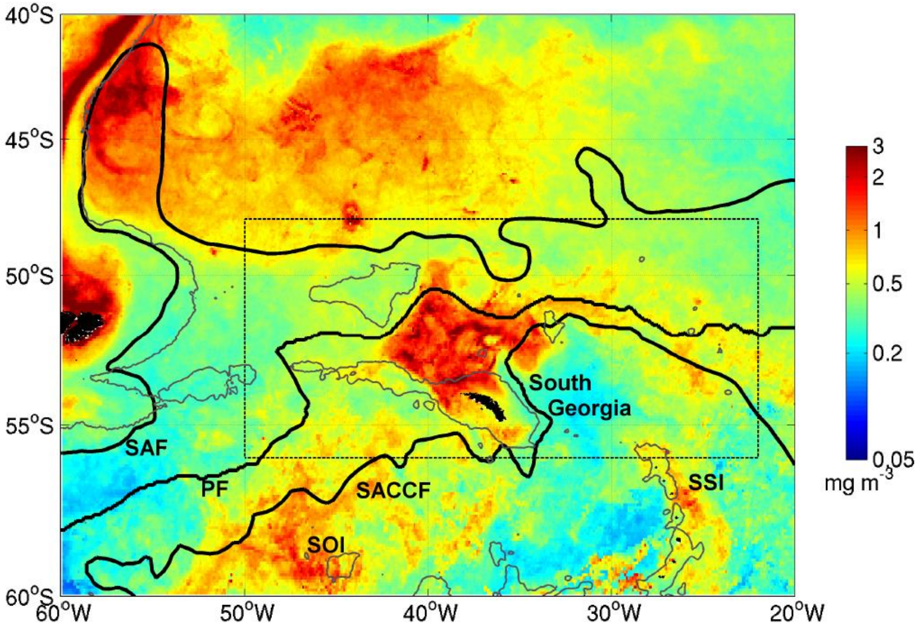
Areas of high surface water productivity along flow path of ACC and downstream of South Georgia



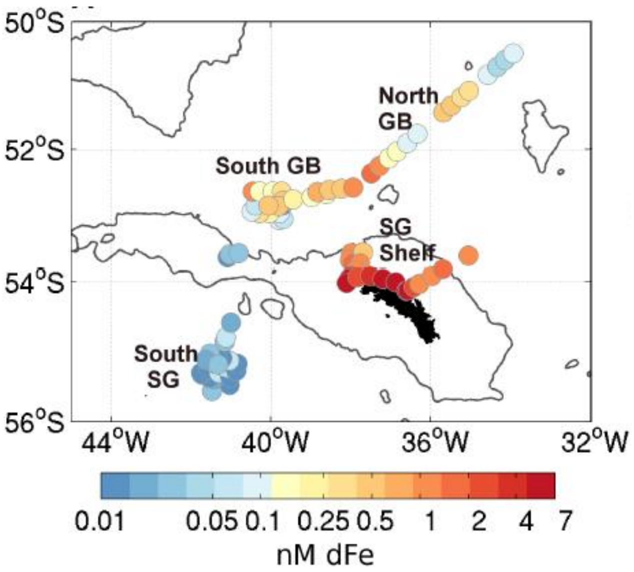
Inherent link between Leg1 PS133-1 (chief scientist: C. Klaas) and Leg2 PS133-2!

Motivation: Iron input drives plankton blooms around/downstream South Georgia

- Southern Ocean (SO) accounts for 20% of the global annual phytoplankton production (Behrenfeld and Falkowski, 1997)
- Large part of SO is a high nutrient low chlorophyll (HNLC) region
- Significant plankton blooms occur downstream (north) of South Georgia due to Fe input
- Limited knowledge about respective Fe sources hampers assessing the sensitivity of the region under changing climate conditions

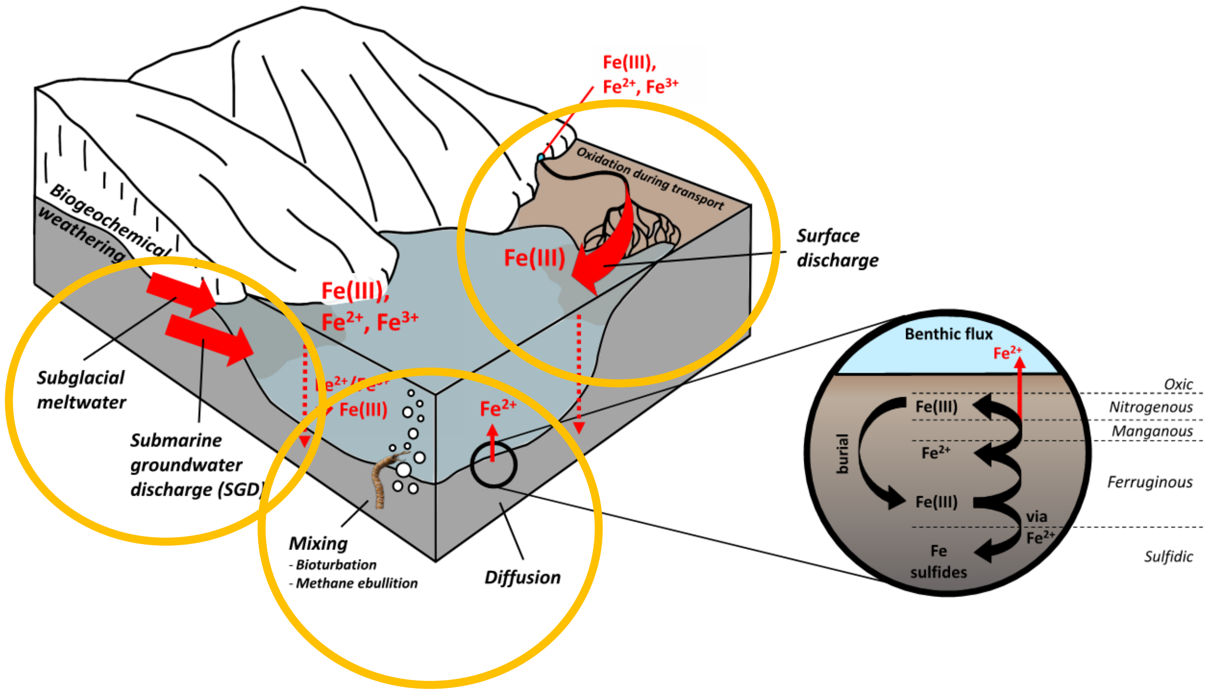


Austral summer Chl *a* distribution around South Georgia 2007-2011 (MODIS data);
Borrione et al. (2013), BGD



Underway measurements of dFe, Jan-Feb 2008
(Nielsdóttir et al., 2012), Mar. Chem.

Potential sources and transport pathways of iron (Fe)



Henkel et al. (2018)
GCA, *modified*

>130 active methane seeps
in South Georgia fjords and troughs
(Römer et al., 2014; EPSL)

(I) Input of Fe-rich freshwater:

- **glacial and subglacial meltwater**
- **(submarine) groundwater discharge**

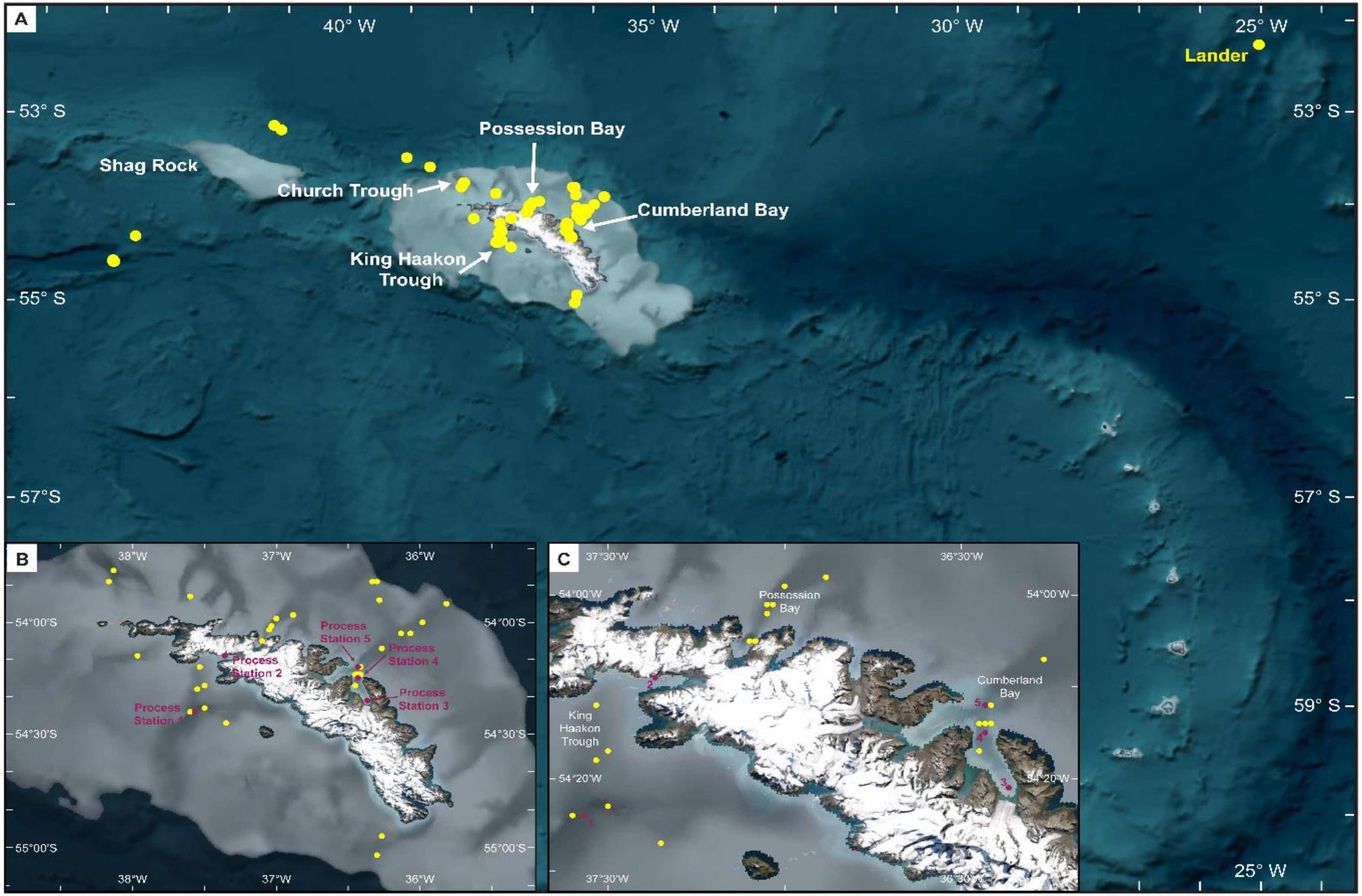
(II) Fe and nutrient release from fjord sediments :

- **diffusion and advection**
- **macrobenthic mixing/bioturbation**
- **methane bubble ebullition**

International and Multidisciplinary Team on board

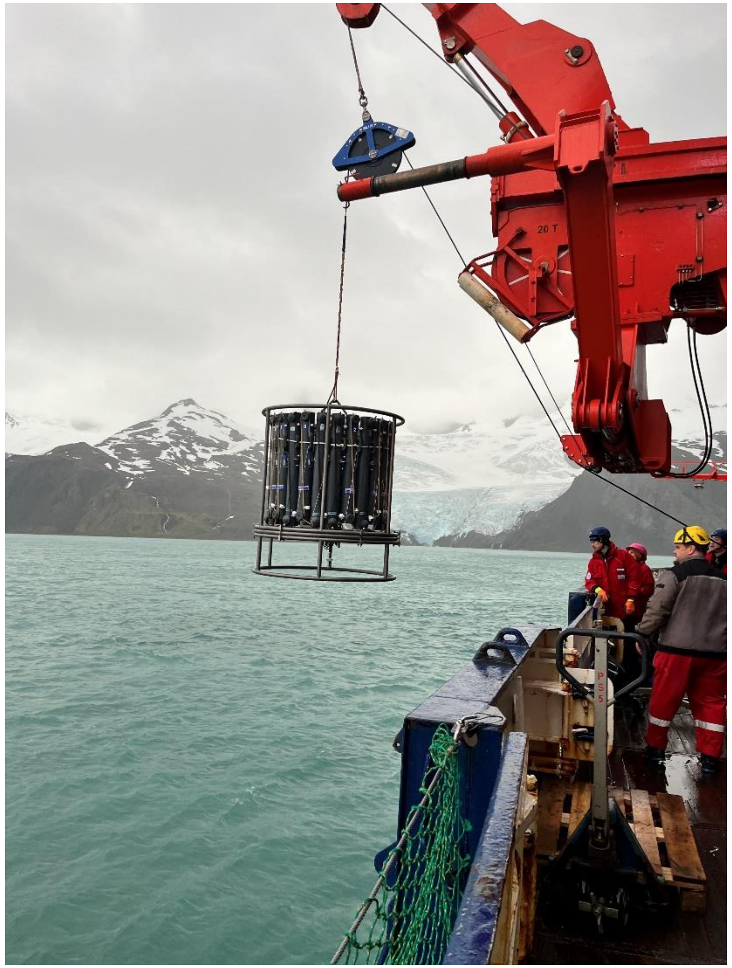
-> 13 working groups and different scientific disciplines

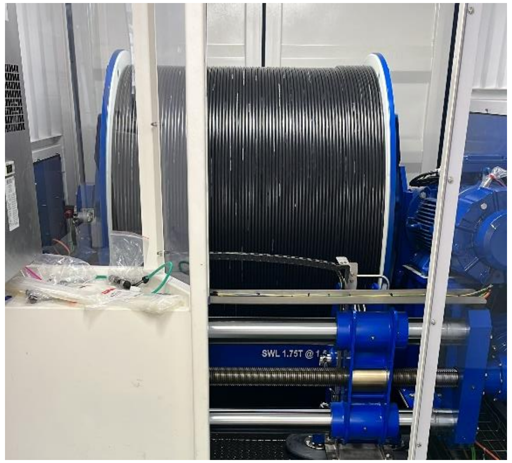
Sampling Stations



Sampling tools – Examples I

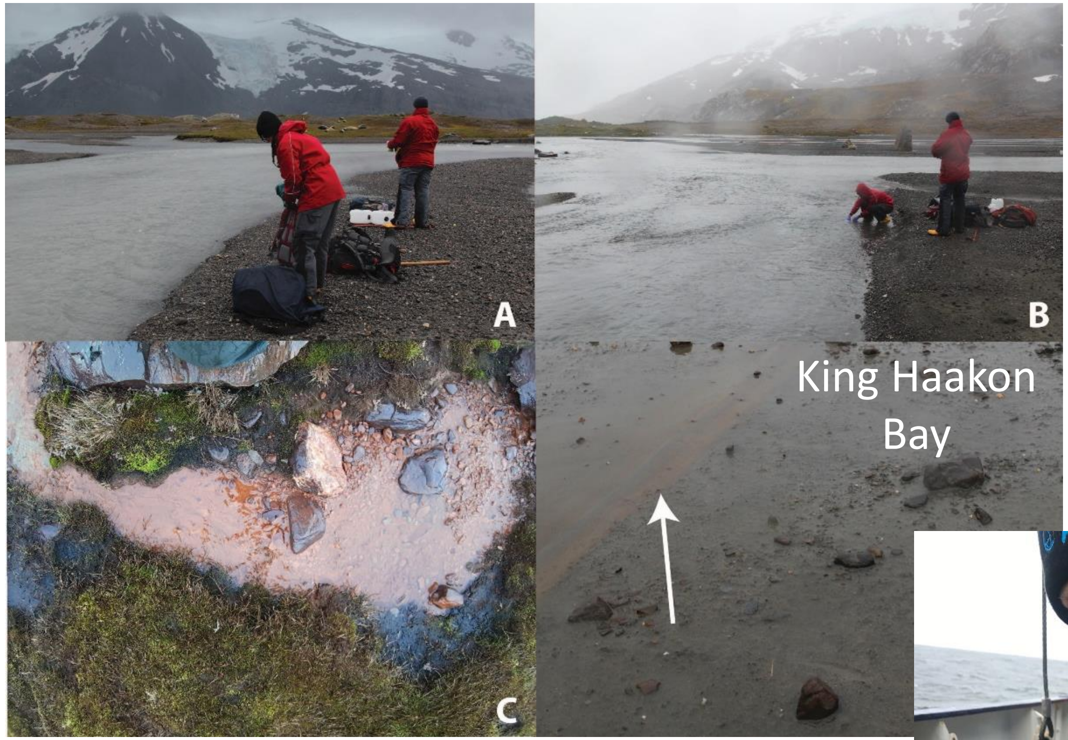
Trace-Metal Clean CTD/Rosette System with Winch and Clean-Lab Container

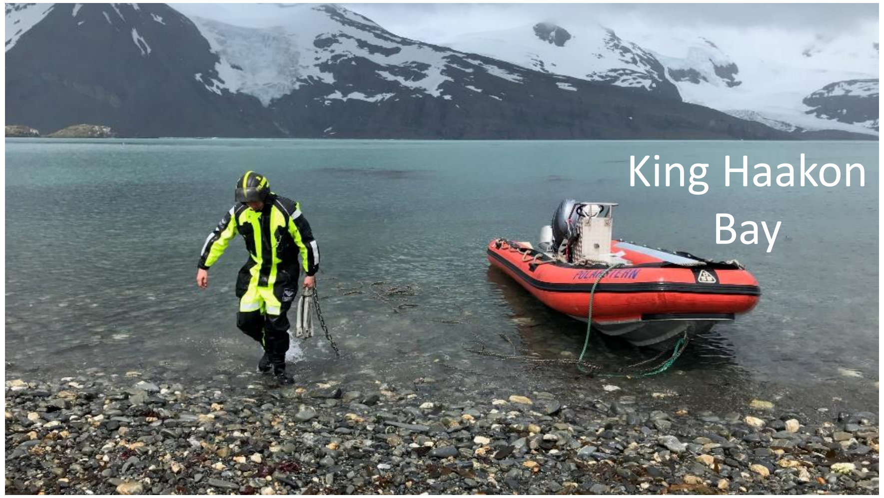


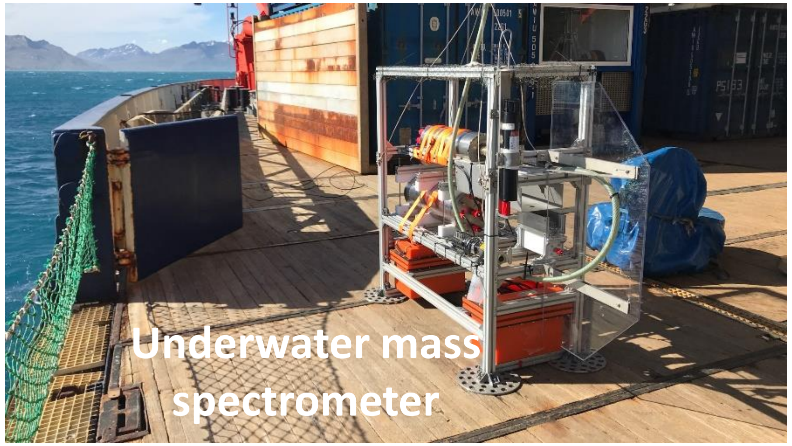


-> focus on dissolved Fe concentrations and stable iron isotopes in the water column

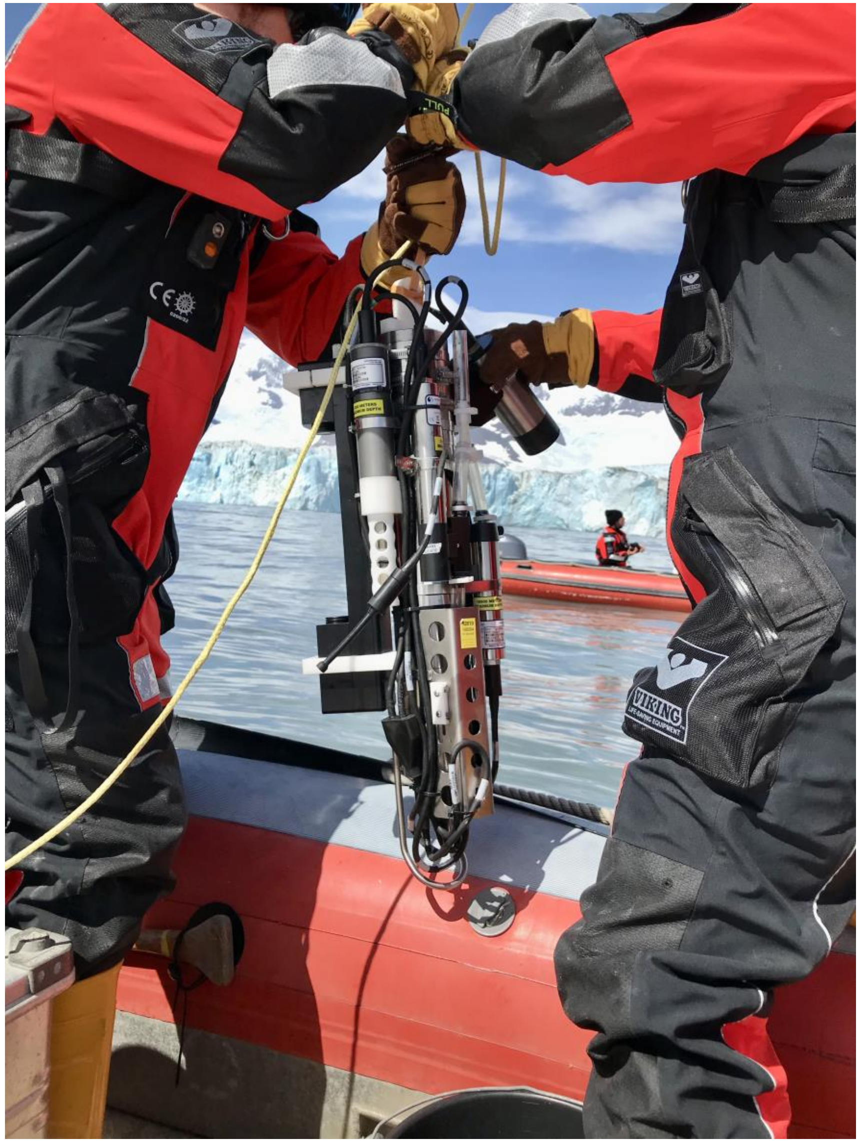
Sampling tools – Examples II







Sampling tools – Examples III



Visit at Grytviken and King Edward Point Research Station

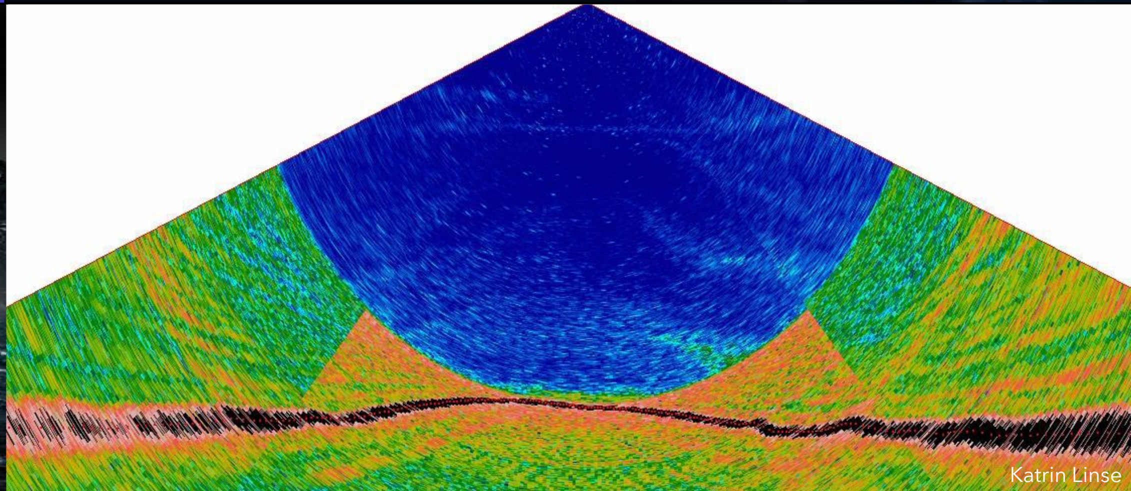
December 5th

-> Visit of Grytviken and KEP research station including **short presentation** of expedition PS133-2

Leg PS133-2 „Island Impact“

Madeline Anderson

British Antarctic Survey

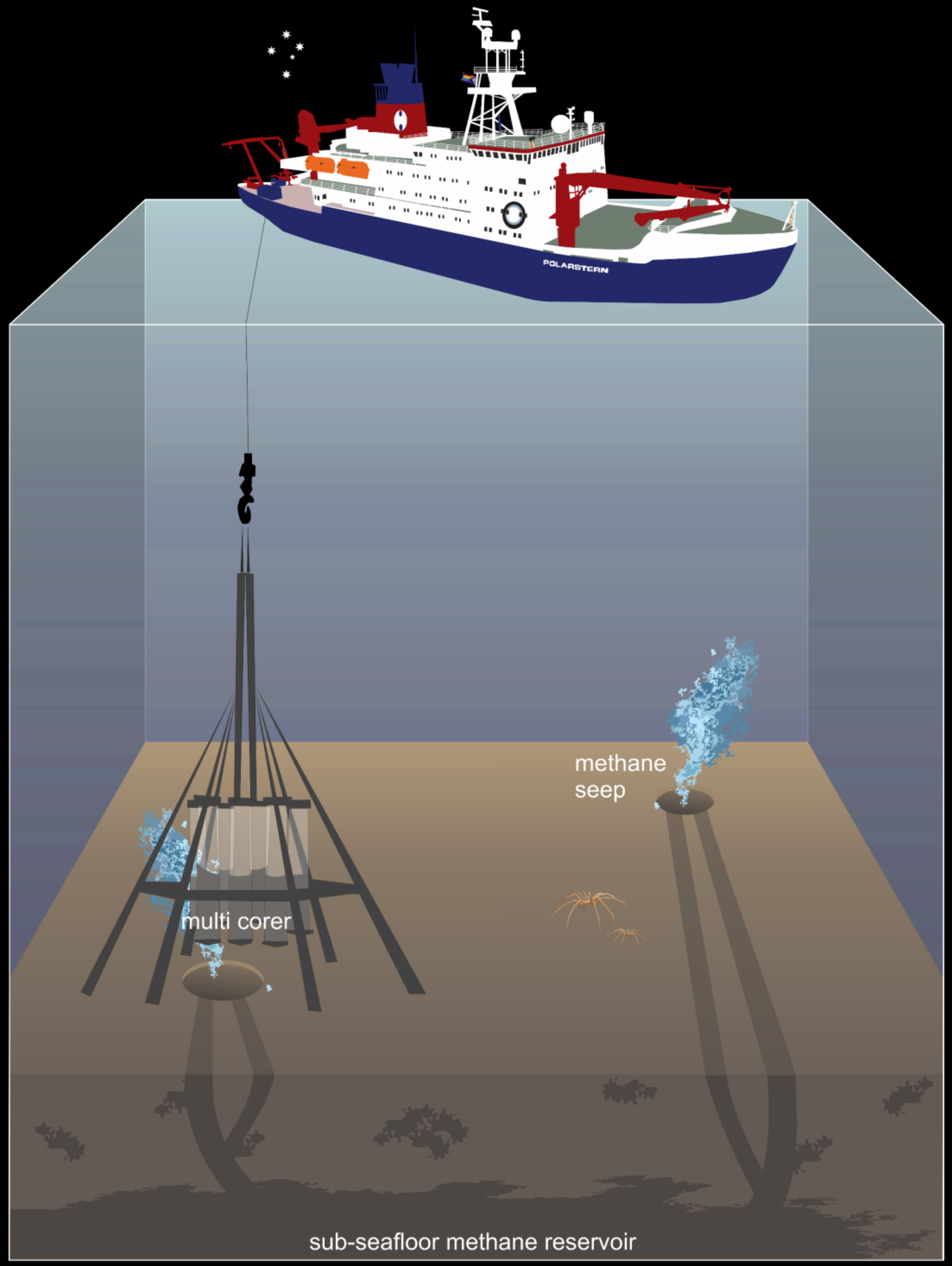


FROM BUBBLES TO BIOLOGY

The impact of methane gas on South Georgia's seafloor animals

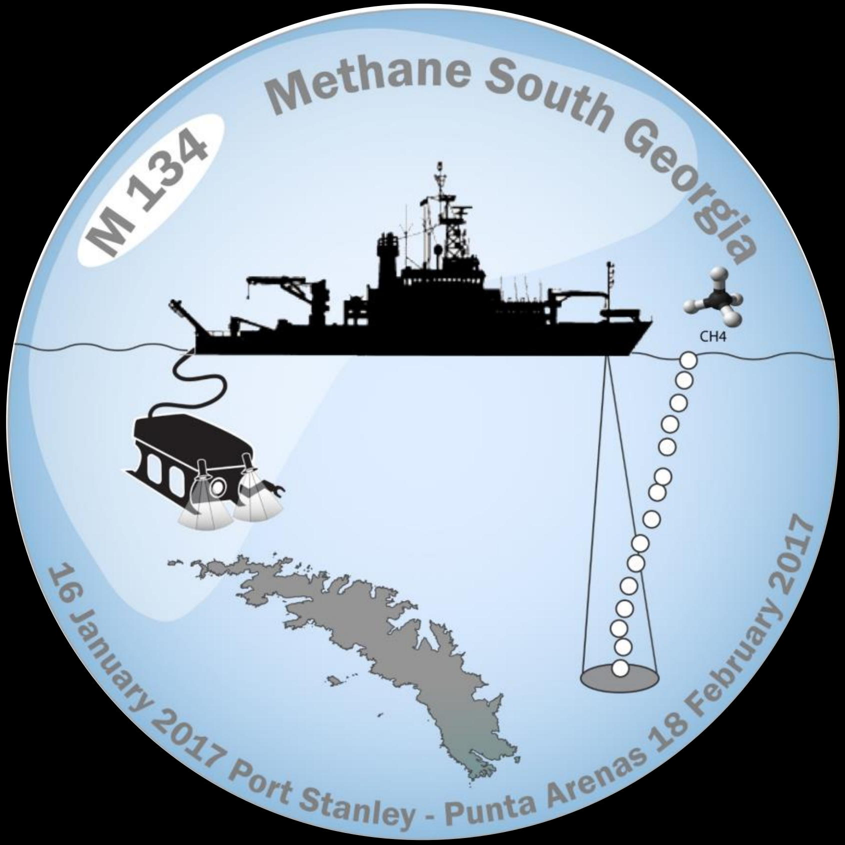
Mads Anderson

✉mason@bas.ac.uk @MarineMads

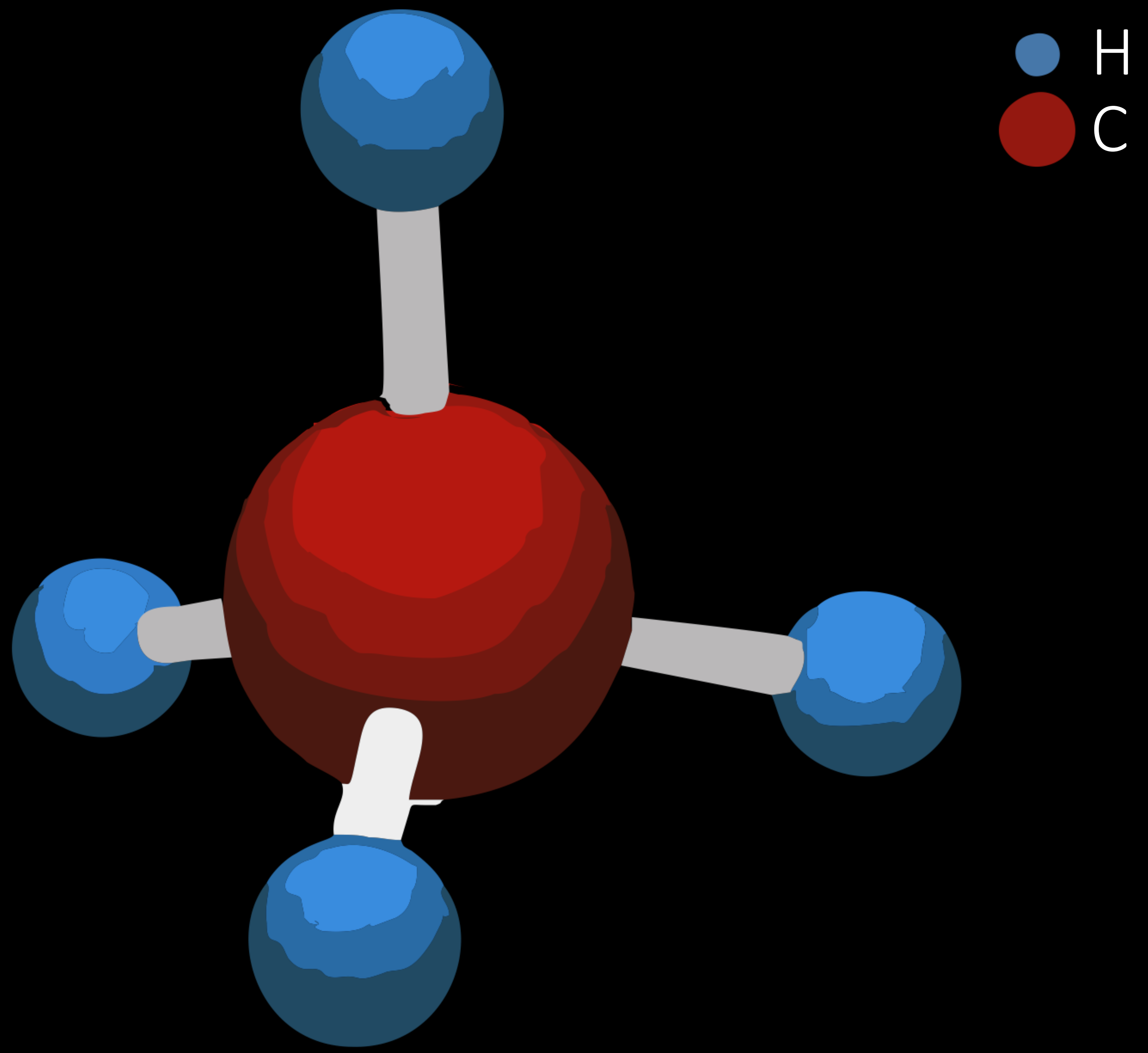


2017

2022


Methane South Georgia
M 134
CH4
16 January 2017 Port Stanley - Punta Arenas 18 February 2017


POLARSTERN
PS133-2 Island Impact
Punta Arenas - South Georgia - Cape Town
19th Nov - 19th Dec 2022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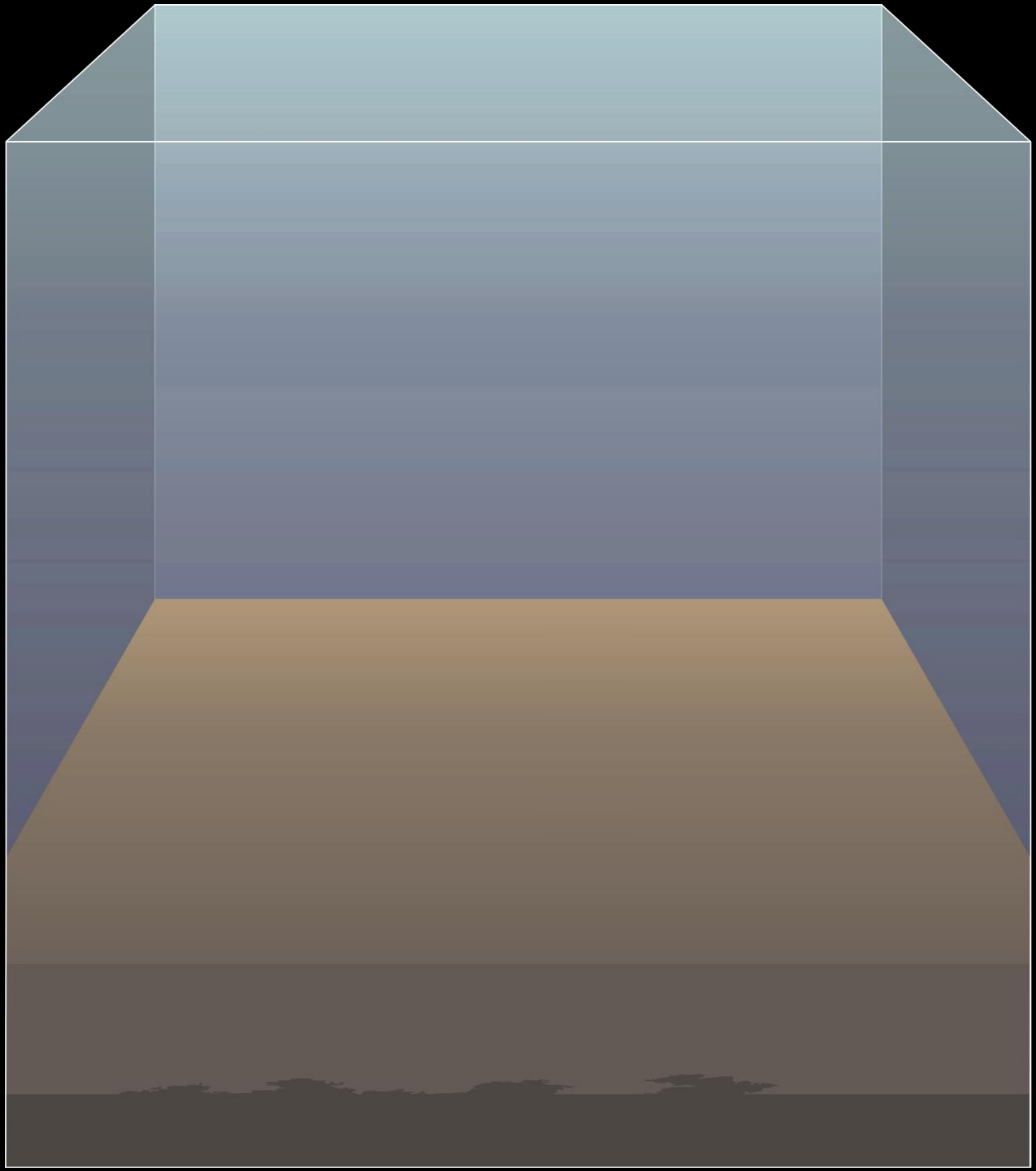
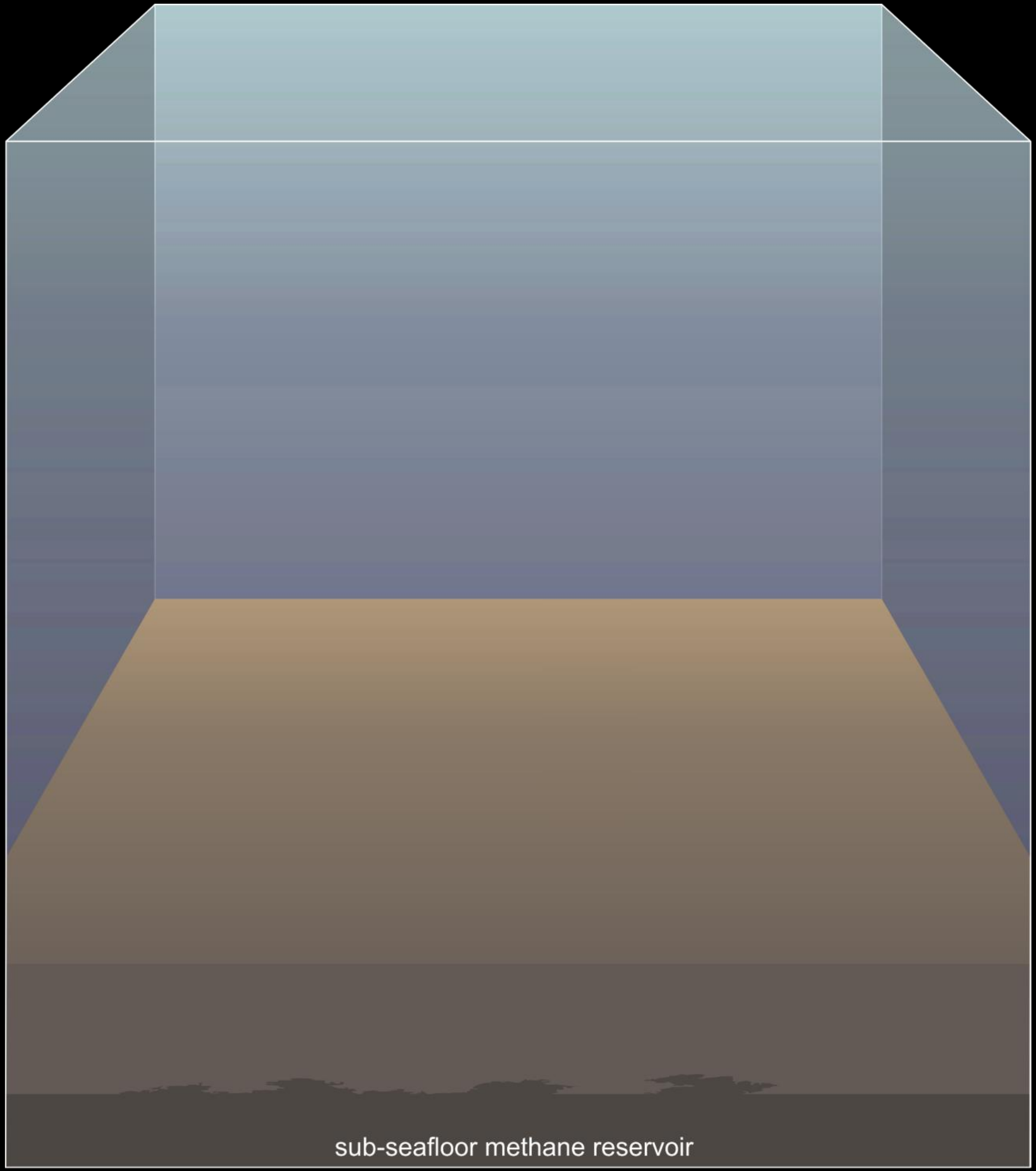
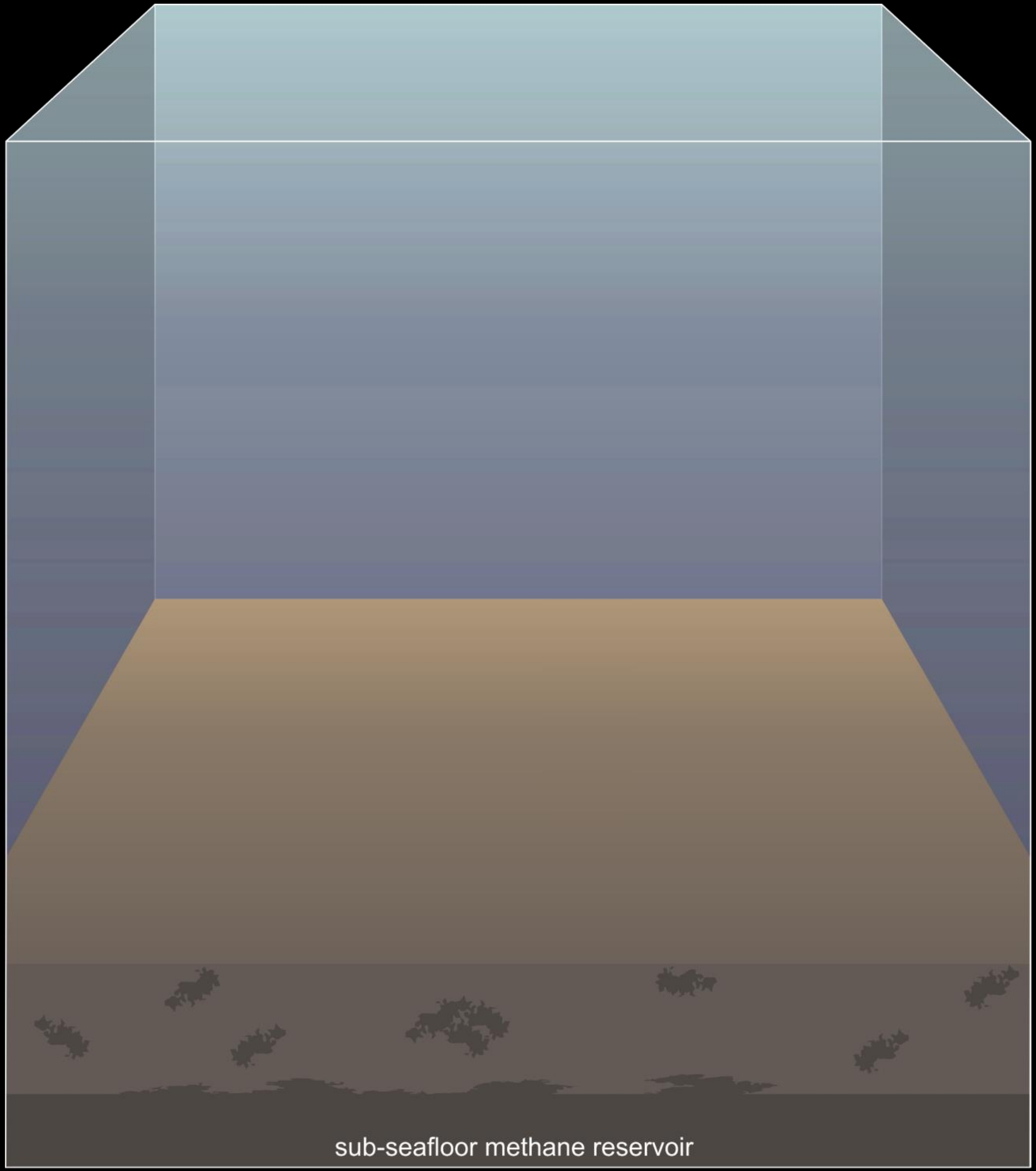
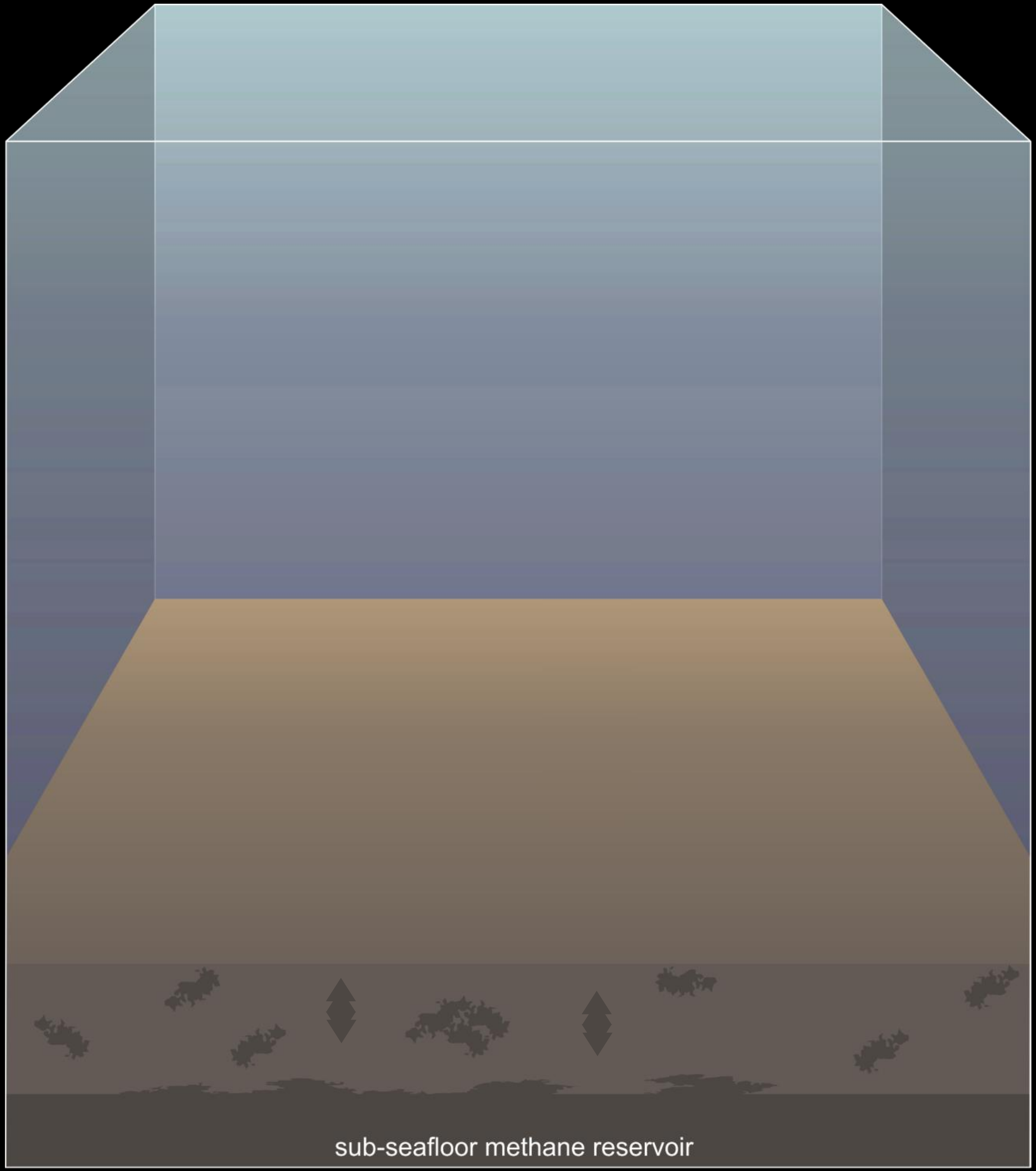
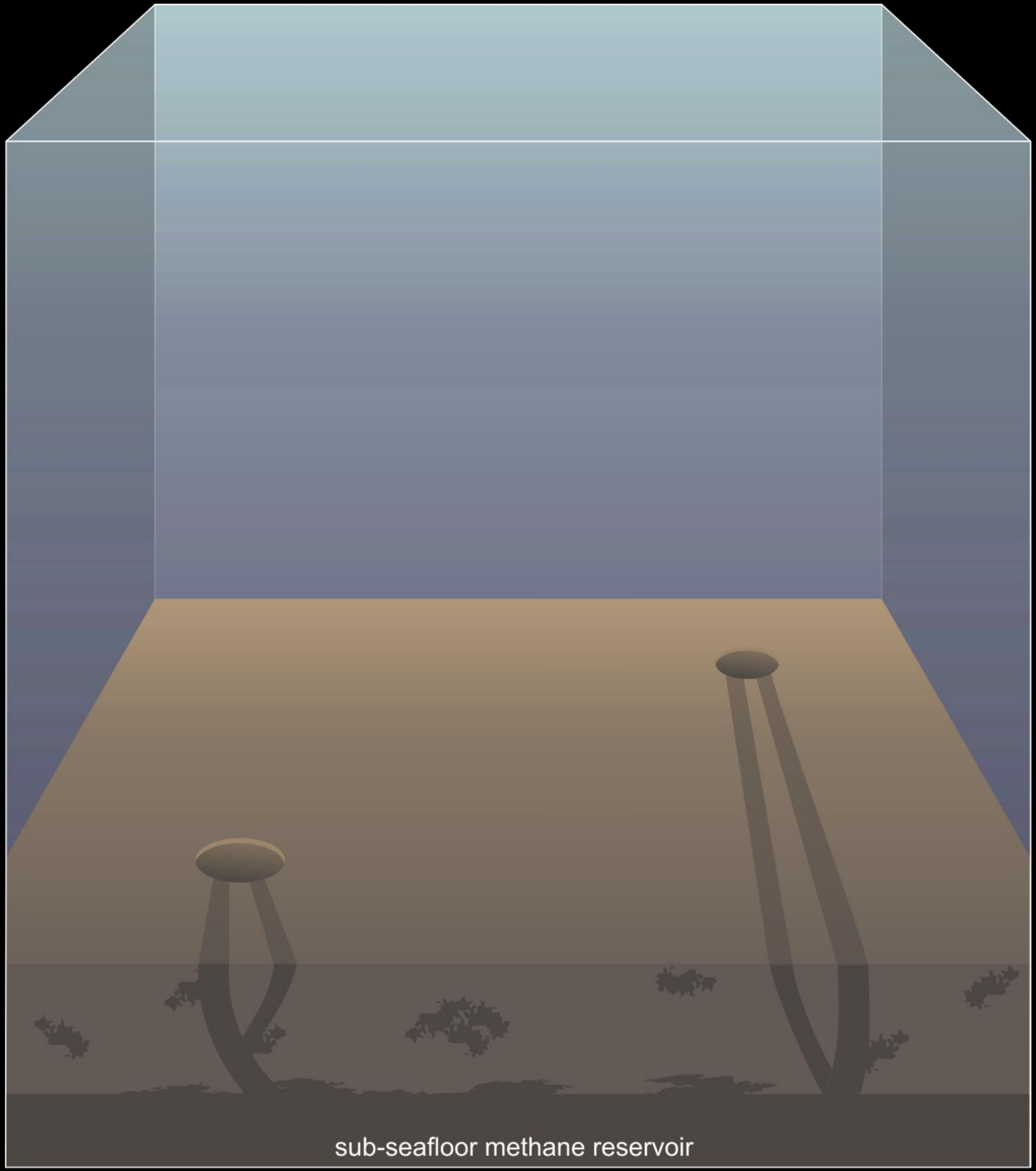
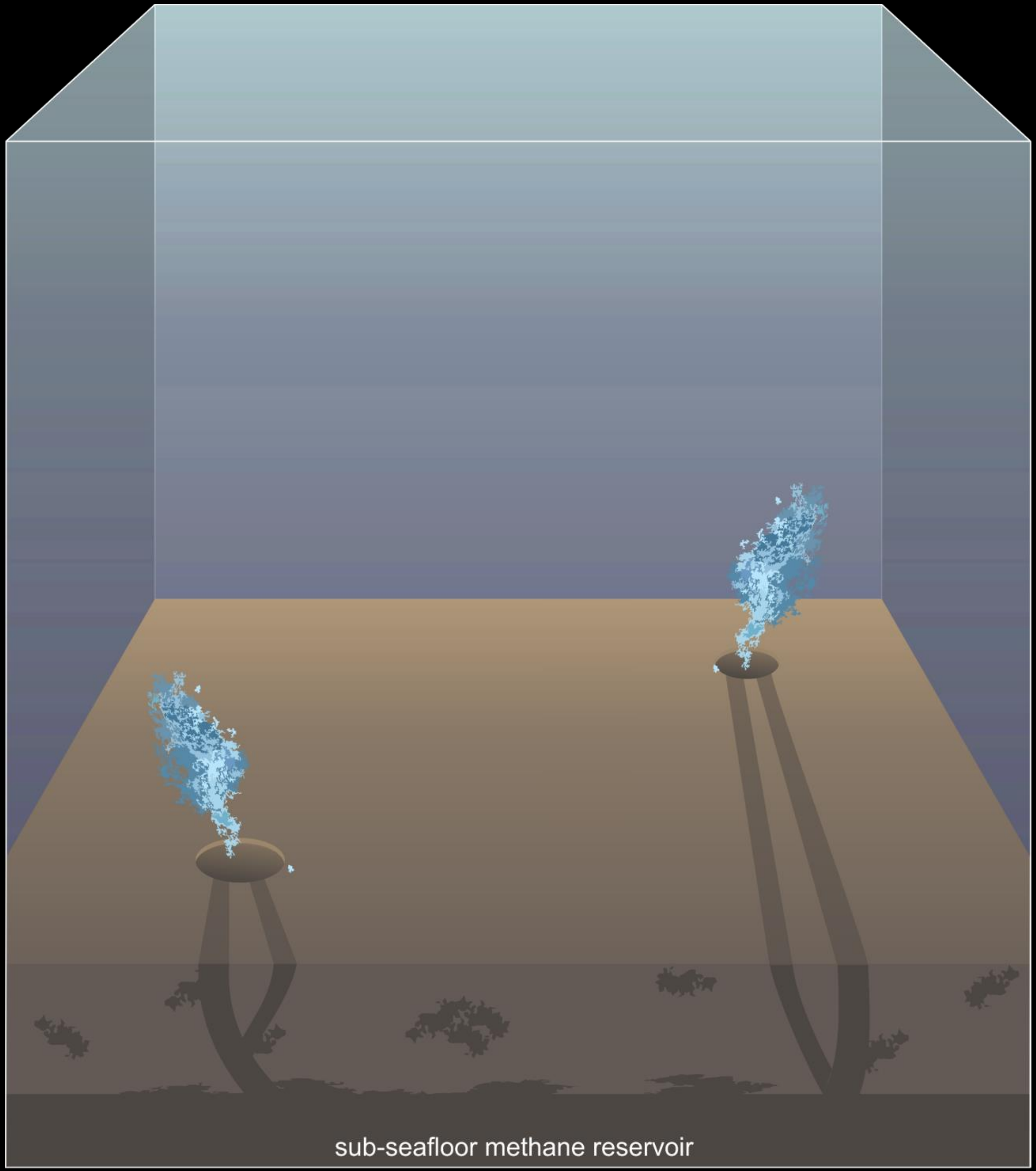


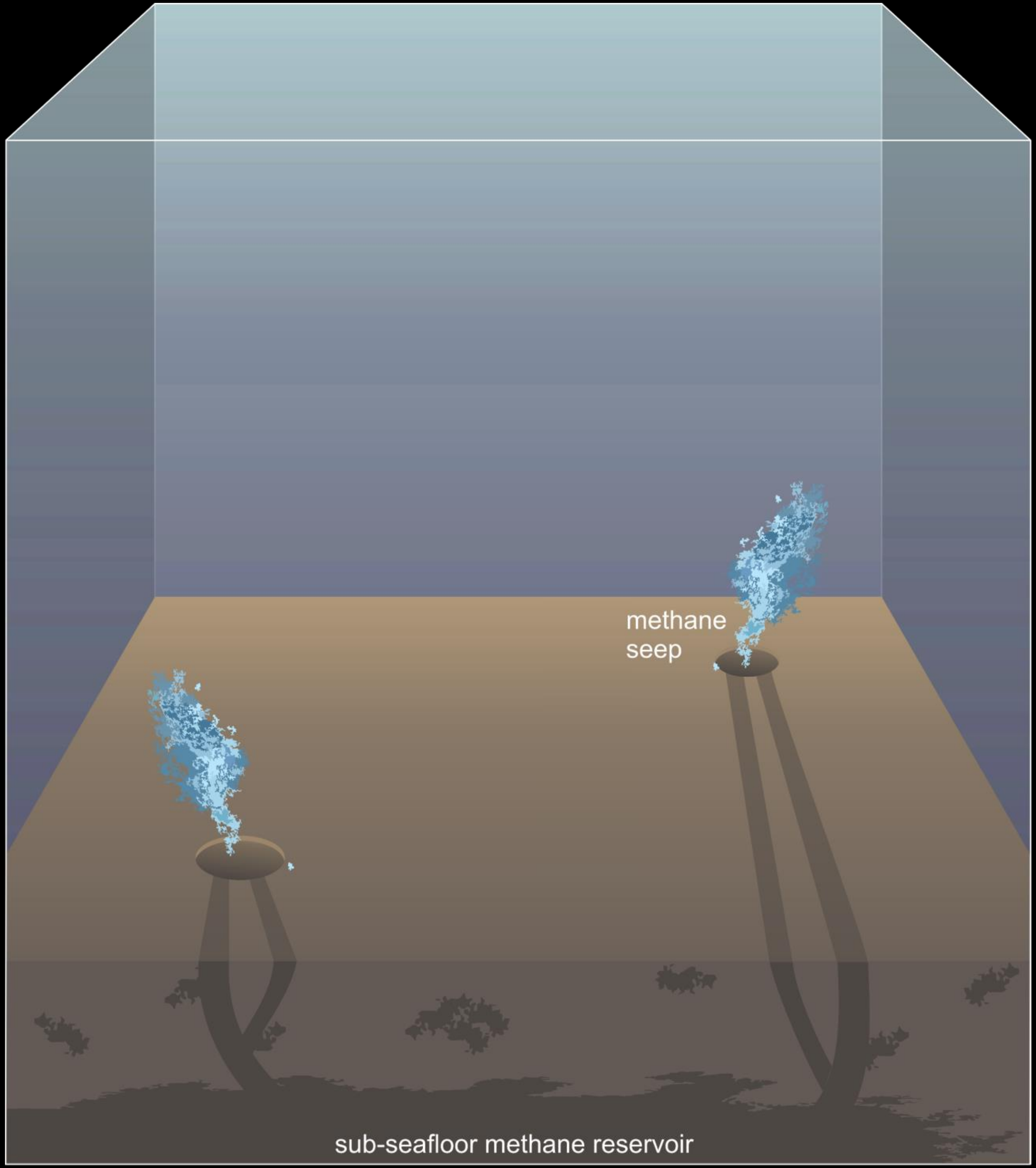

sub-seafloor methane reservoir

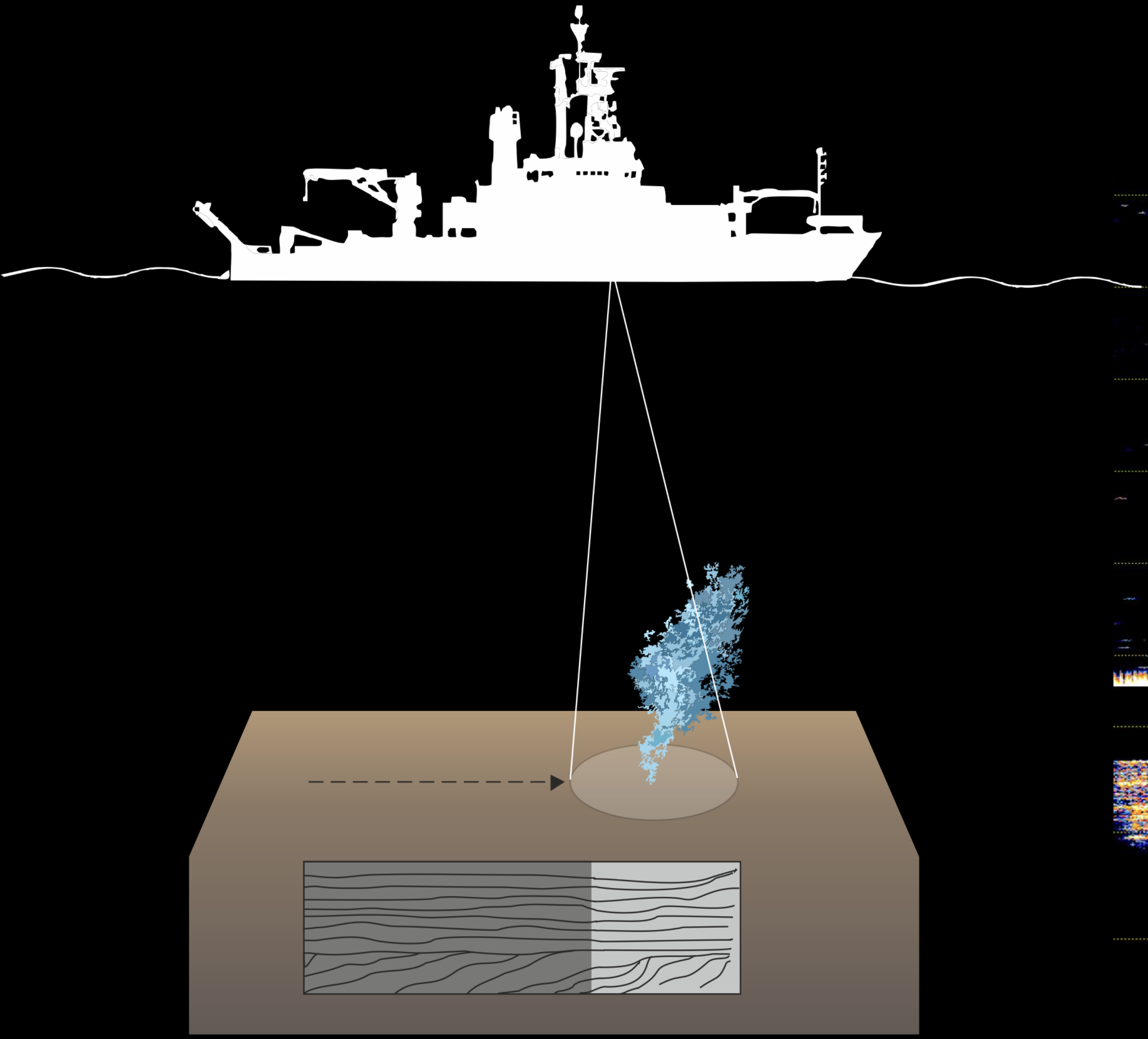

sub-seafloor methane reservoir

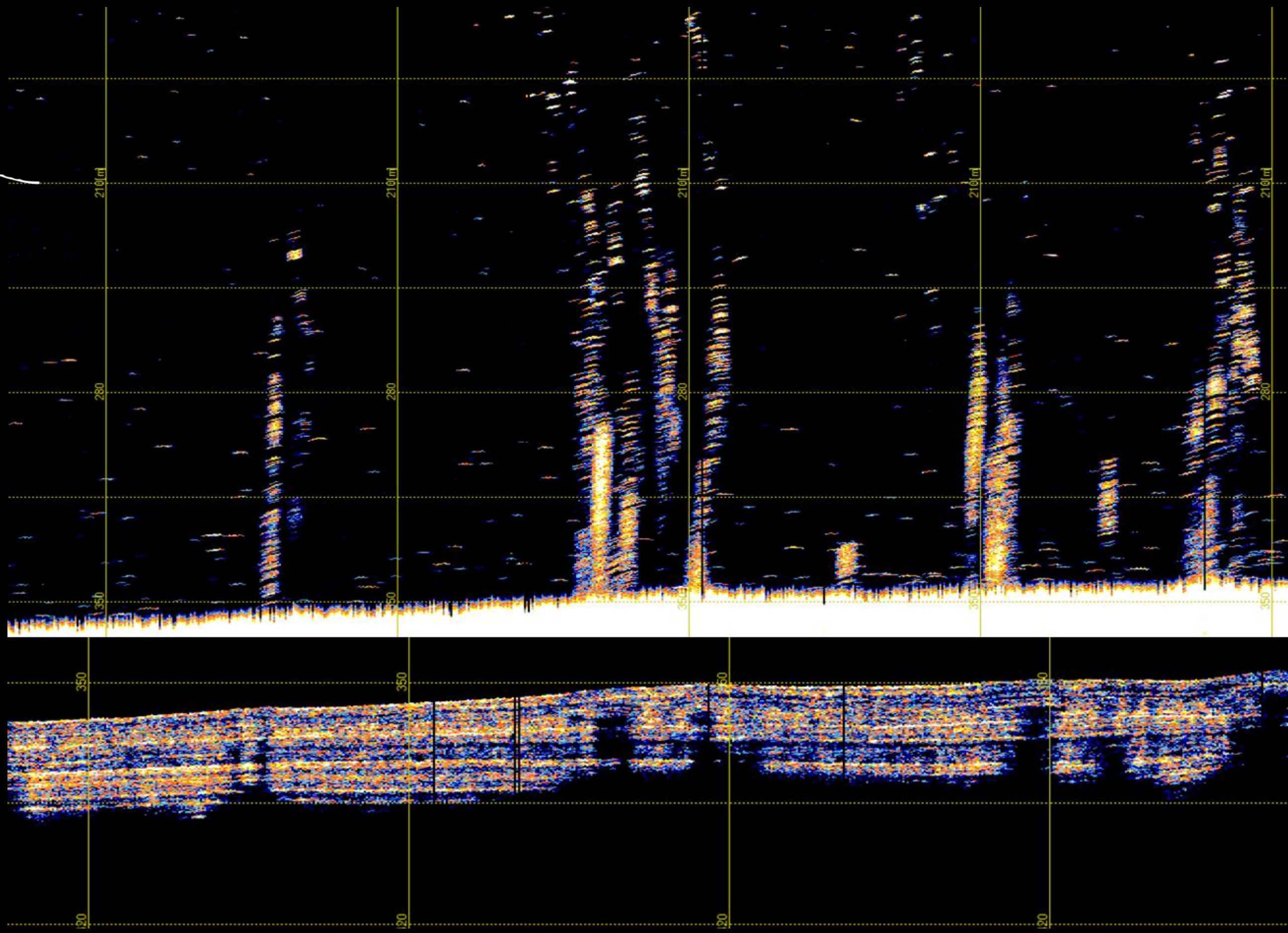

sub-seafloor methane reservoir

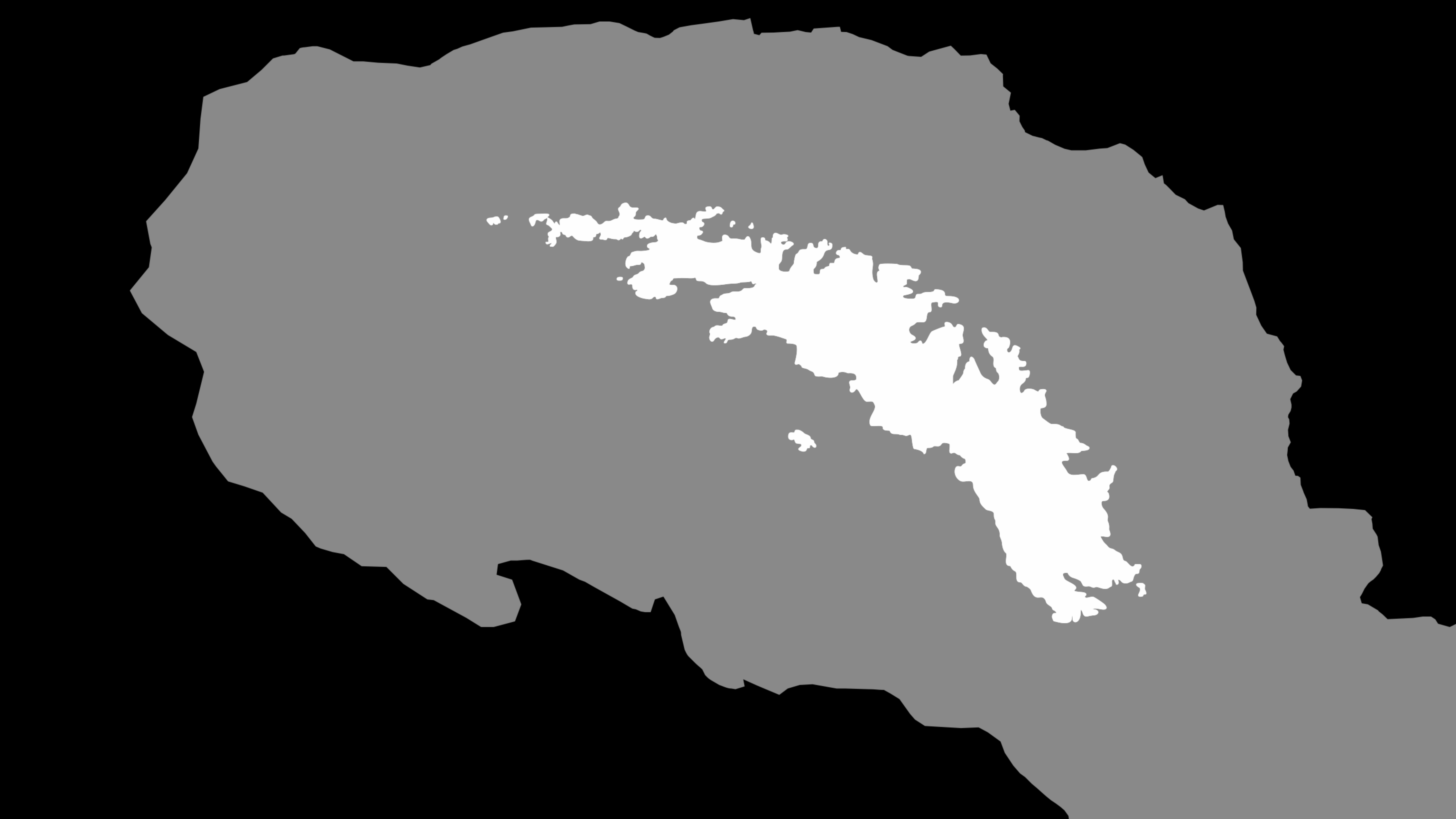

sub-seafloor methane reservoir

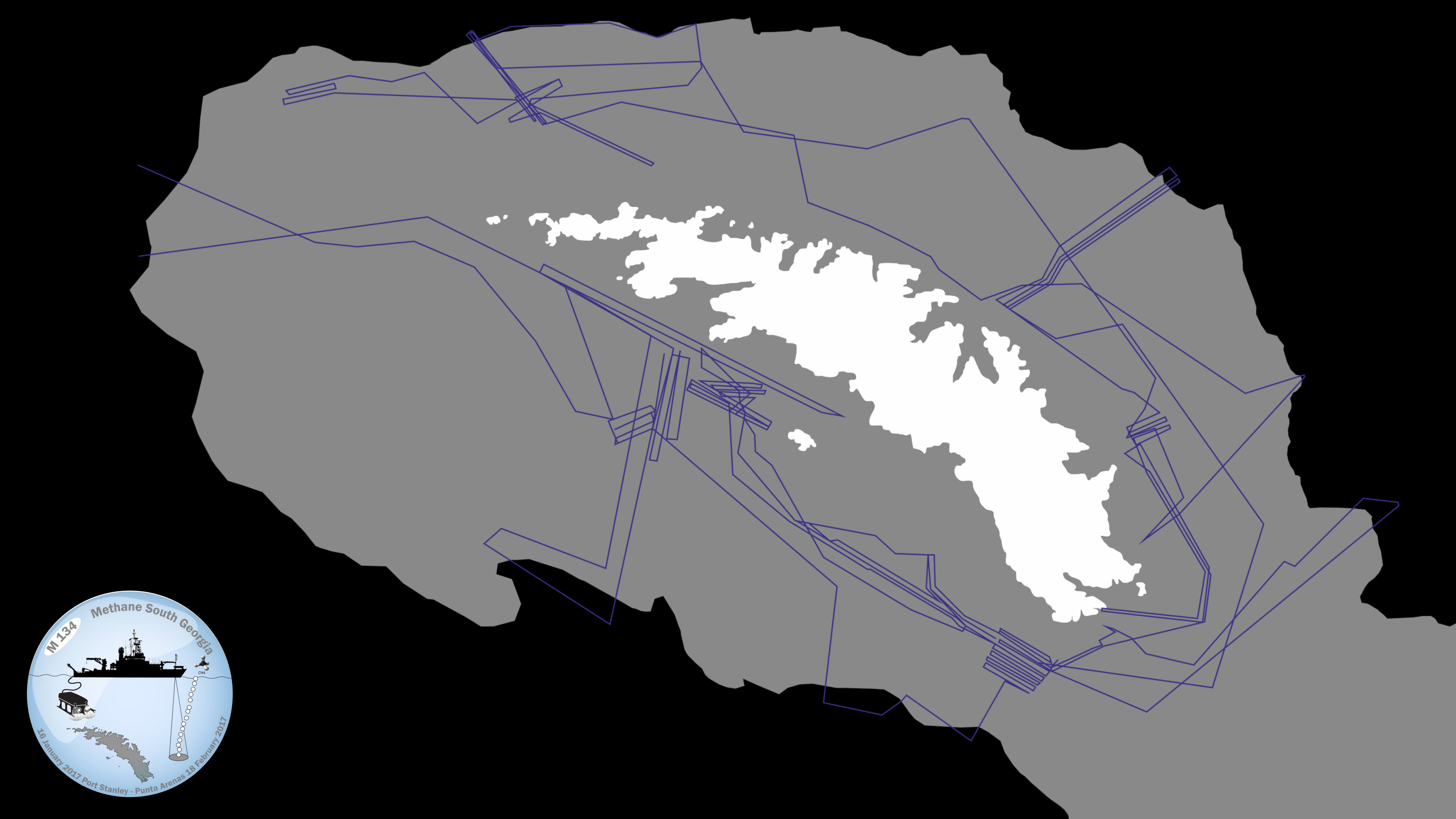

sub-seafloor methane reservoir

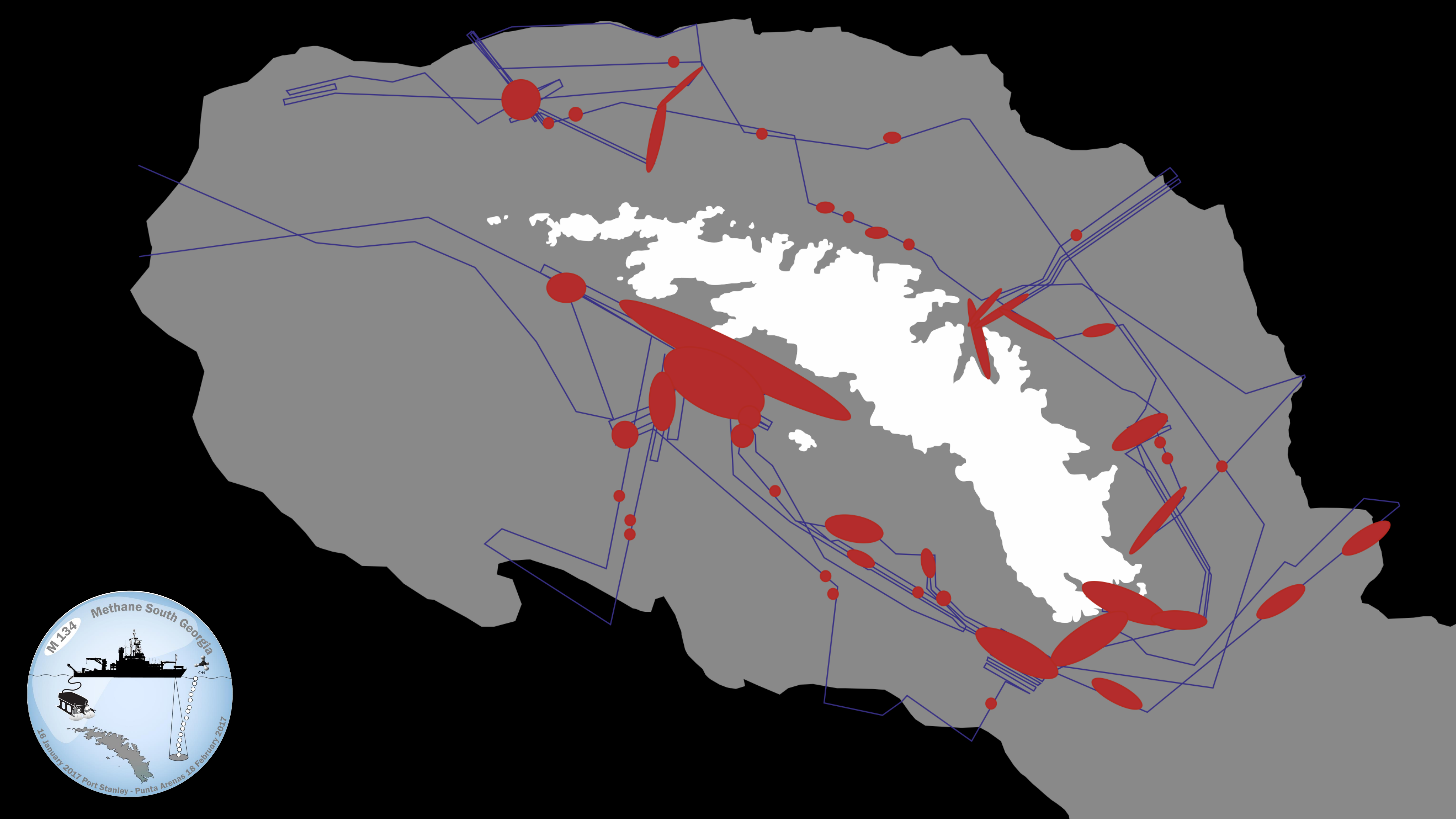

methane
seep
sub-seafloor methane reservoir

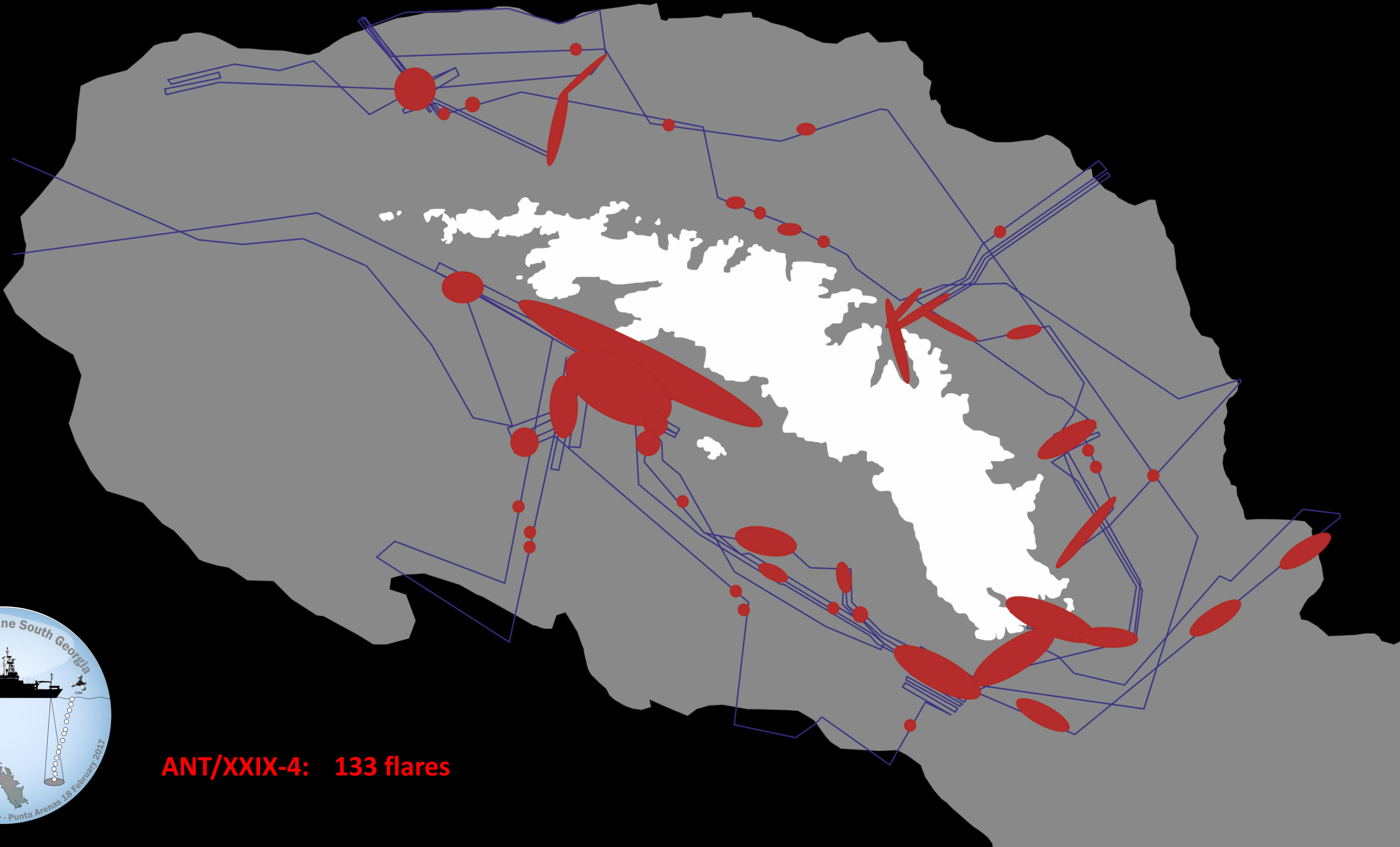




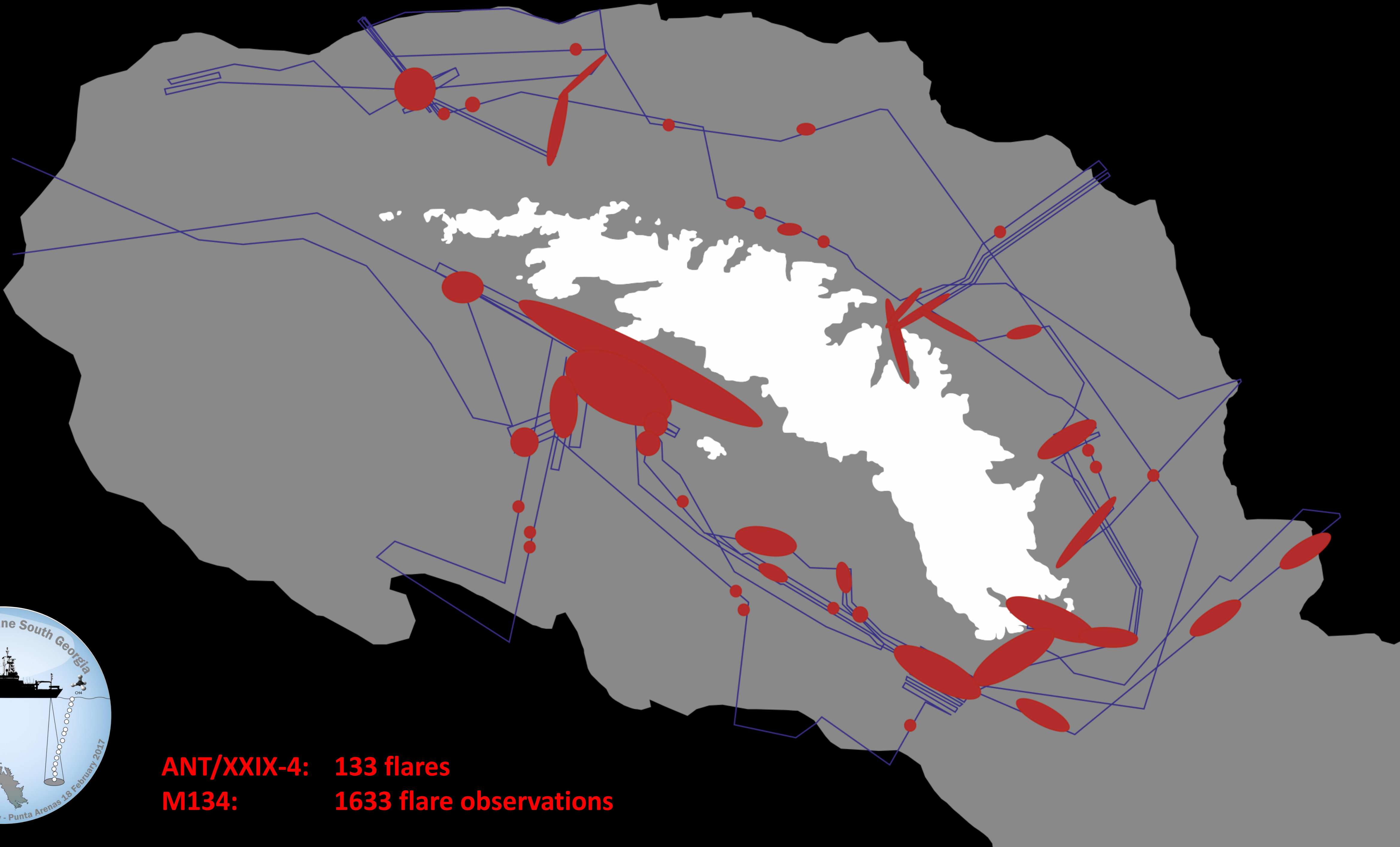



M 134
Methane South Georgia
CH4
16 January 2017 Port Stanley - Punta Arenas 18 February 2017


Methane South Georgia
M 134
CH4
16 January 2017 Port Stanley - Punta Arenas 18 February 2017

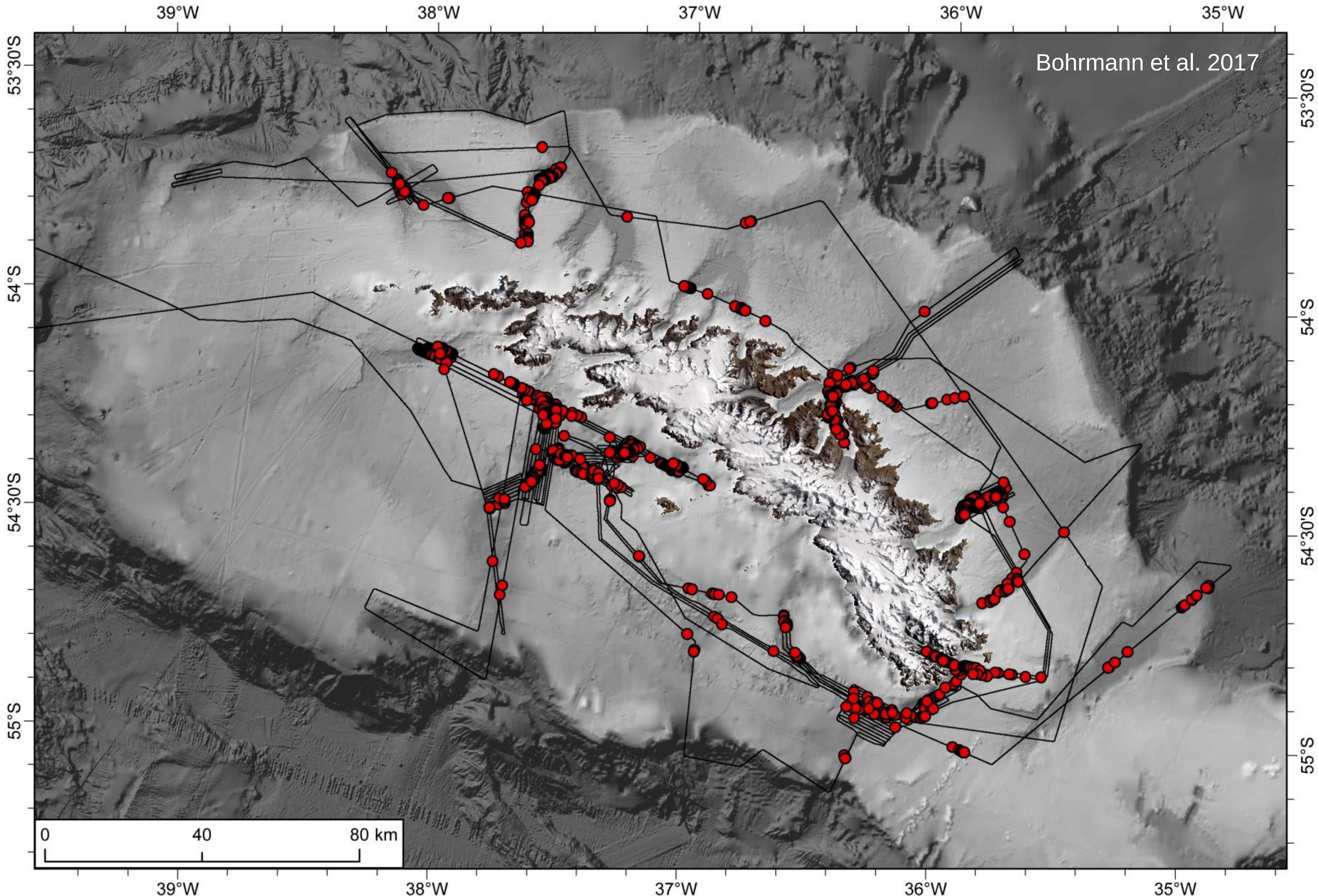


ANT/XXIX-4: 133 flares



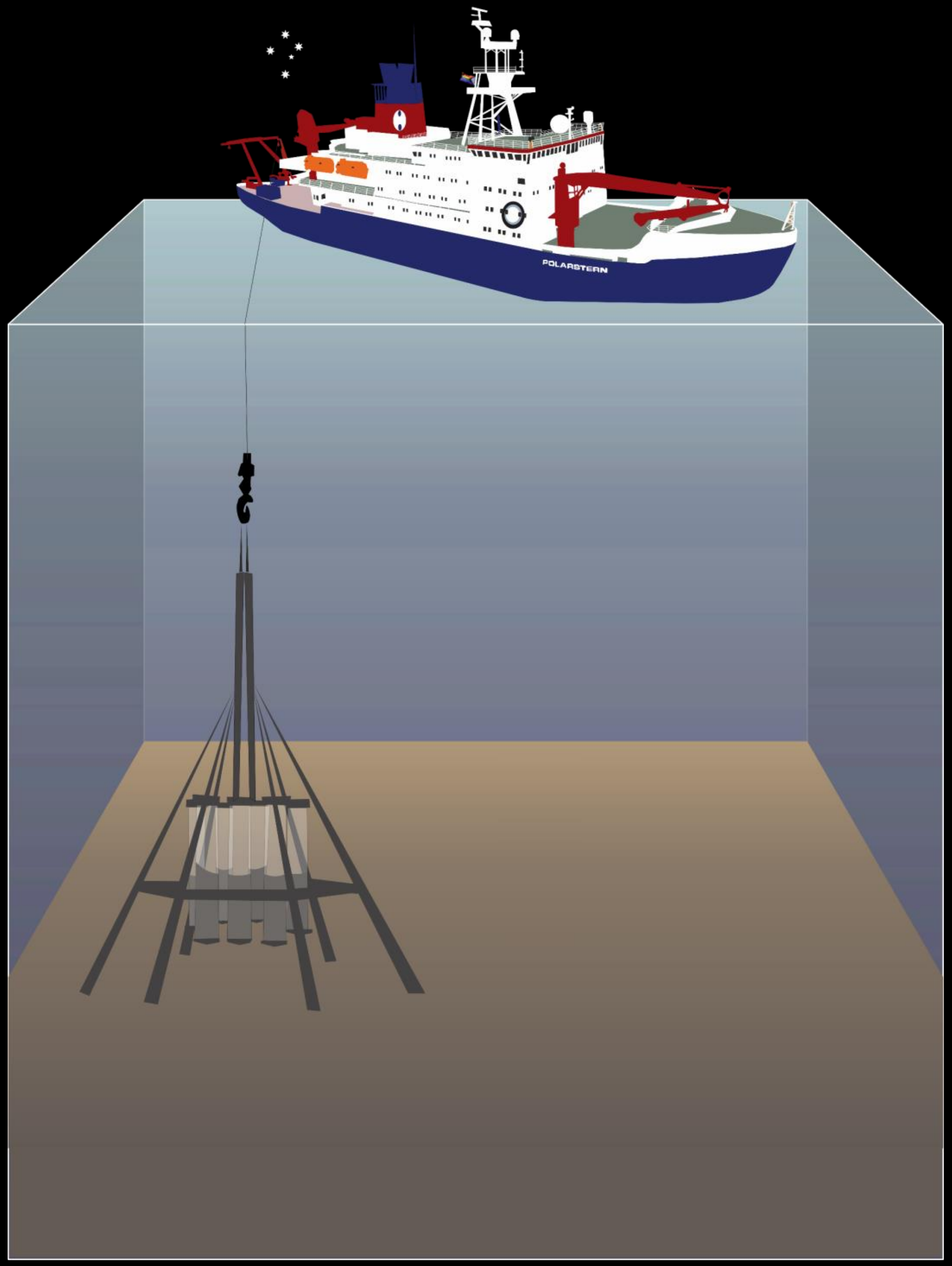
ANT/XXIX-4: **133 flares**

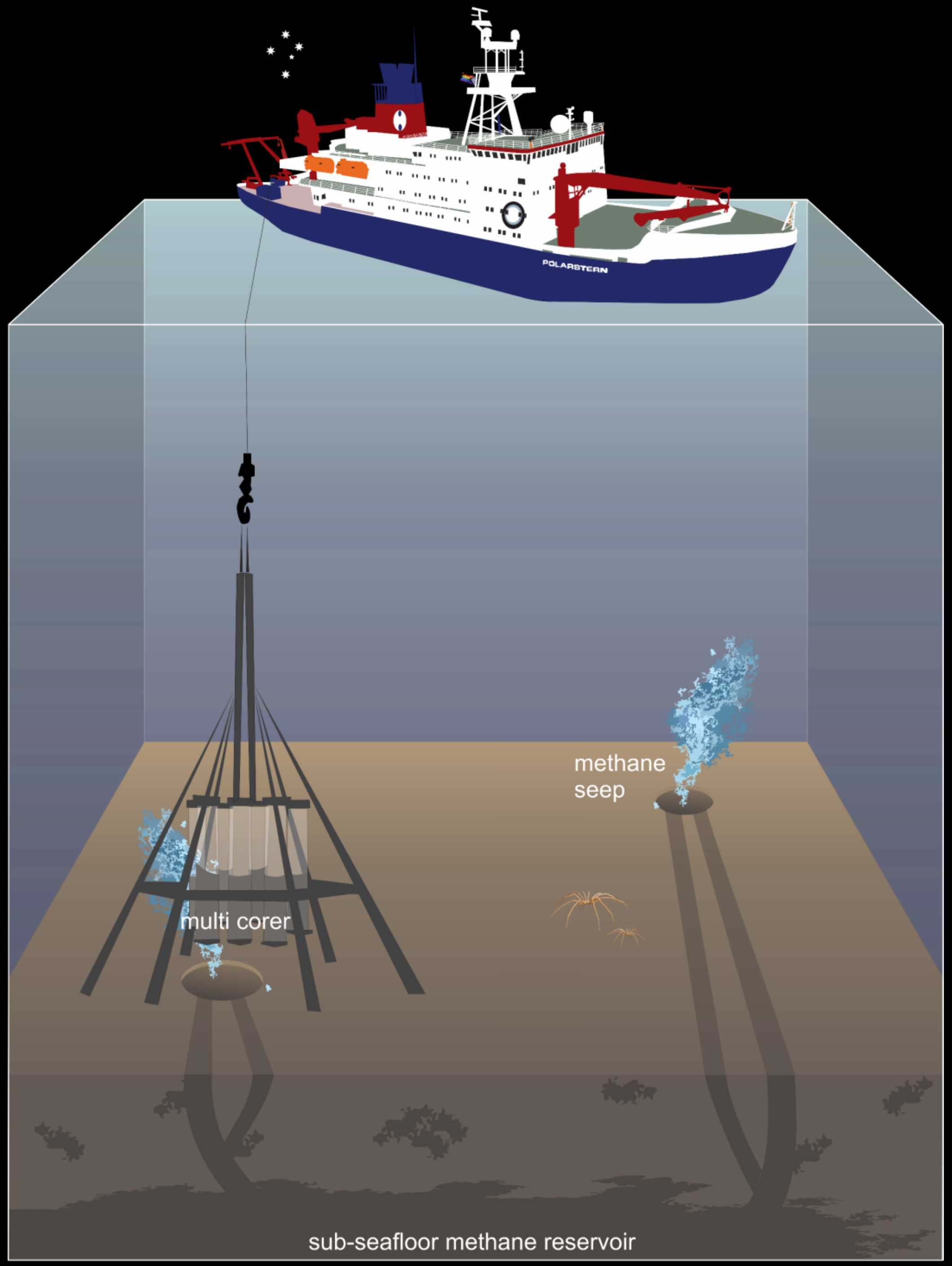
M134: **1633 flare observations**


39°W
38°W
37°W
36°W
35°W
53°30'S
54°S
54°30'S
55°S
Bohrmann et al. 2017
0
40
80 km

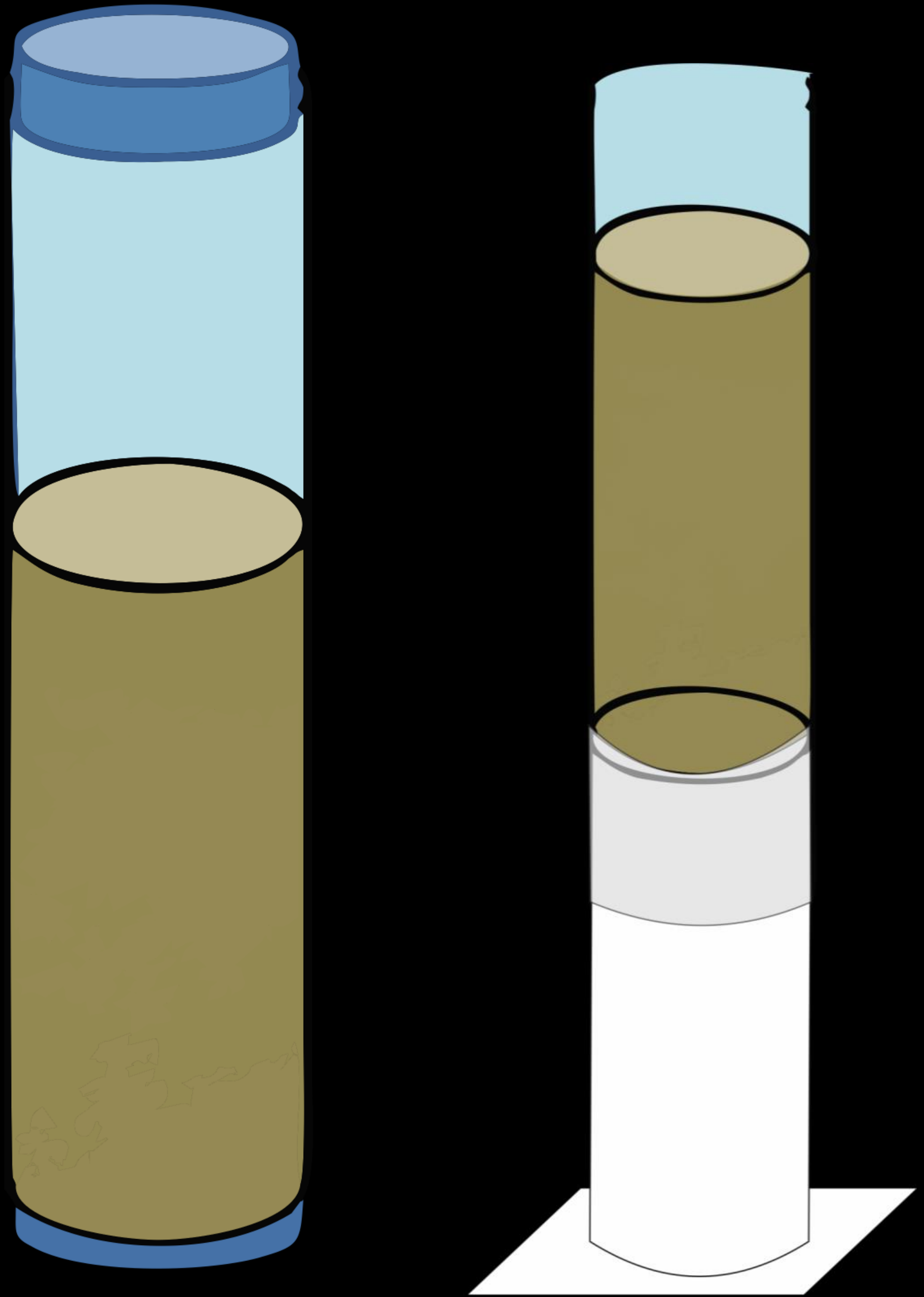

DANGER

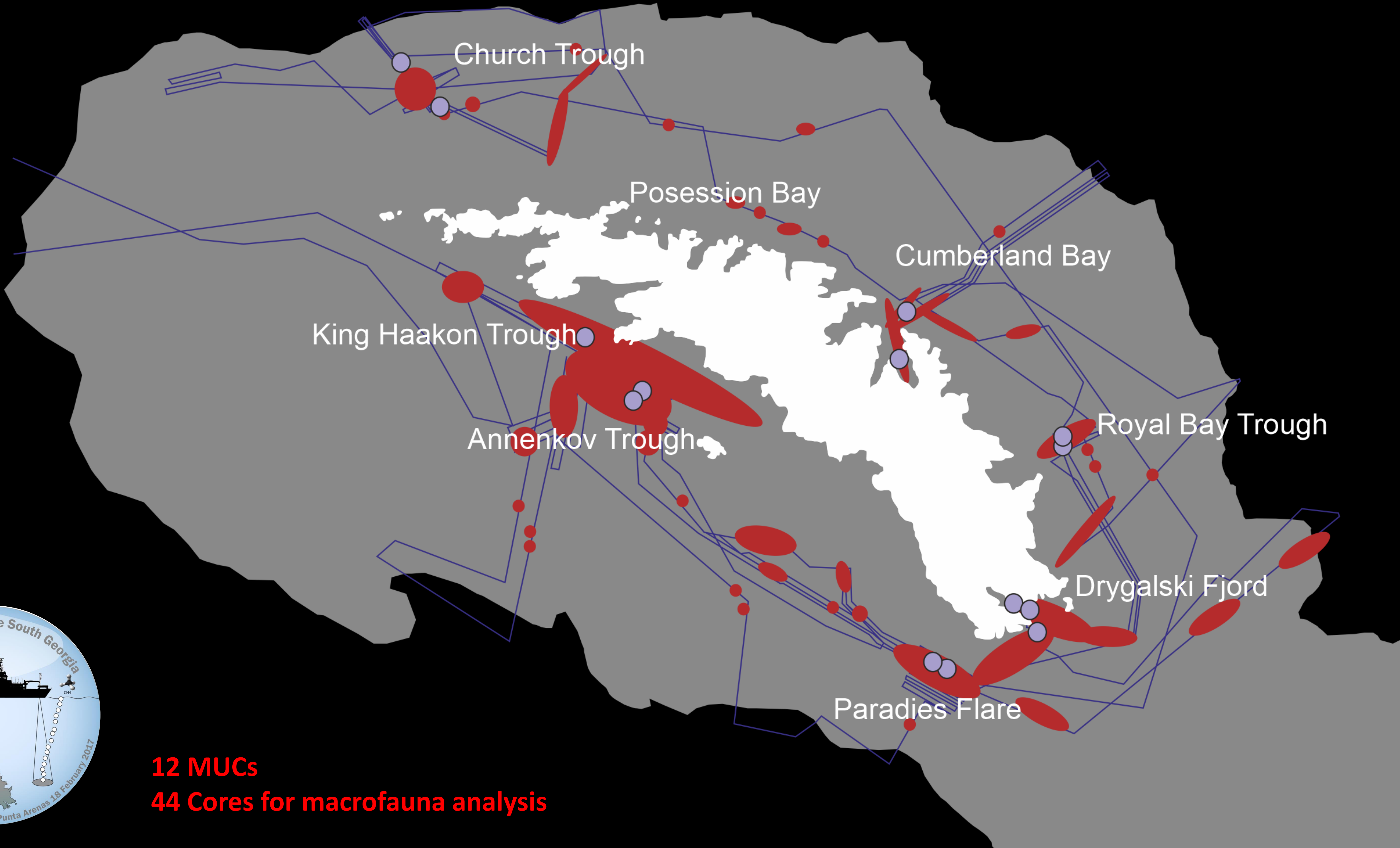



POLARSTERN



POLARSTERN
methane
seep
multi corer
sub-seafloor methane reservoir

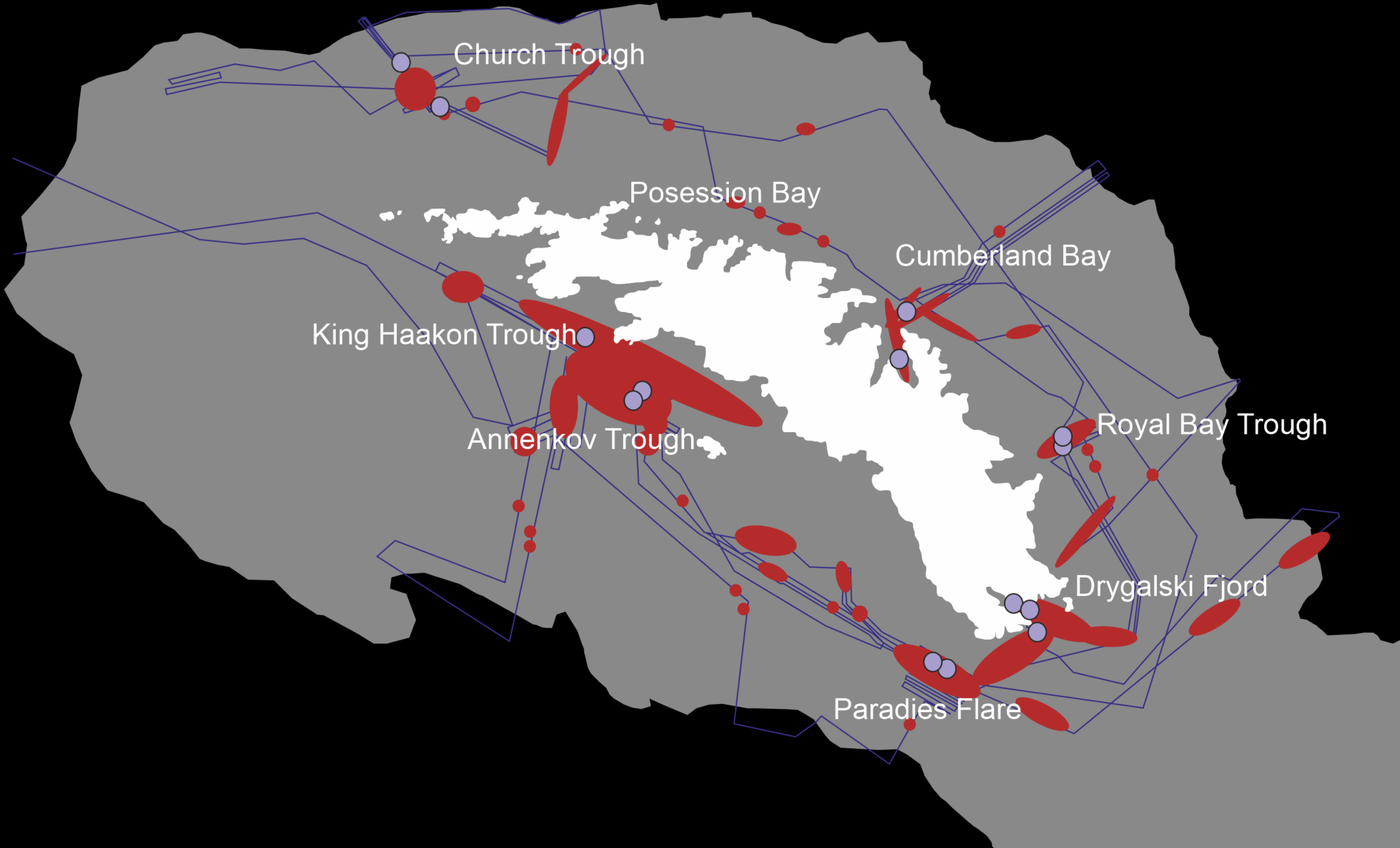




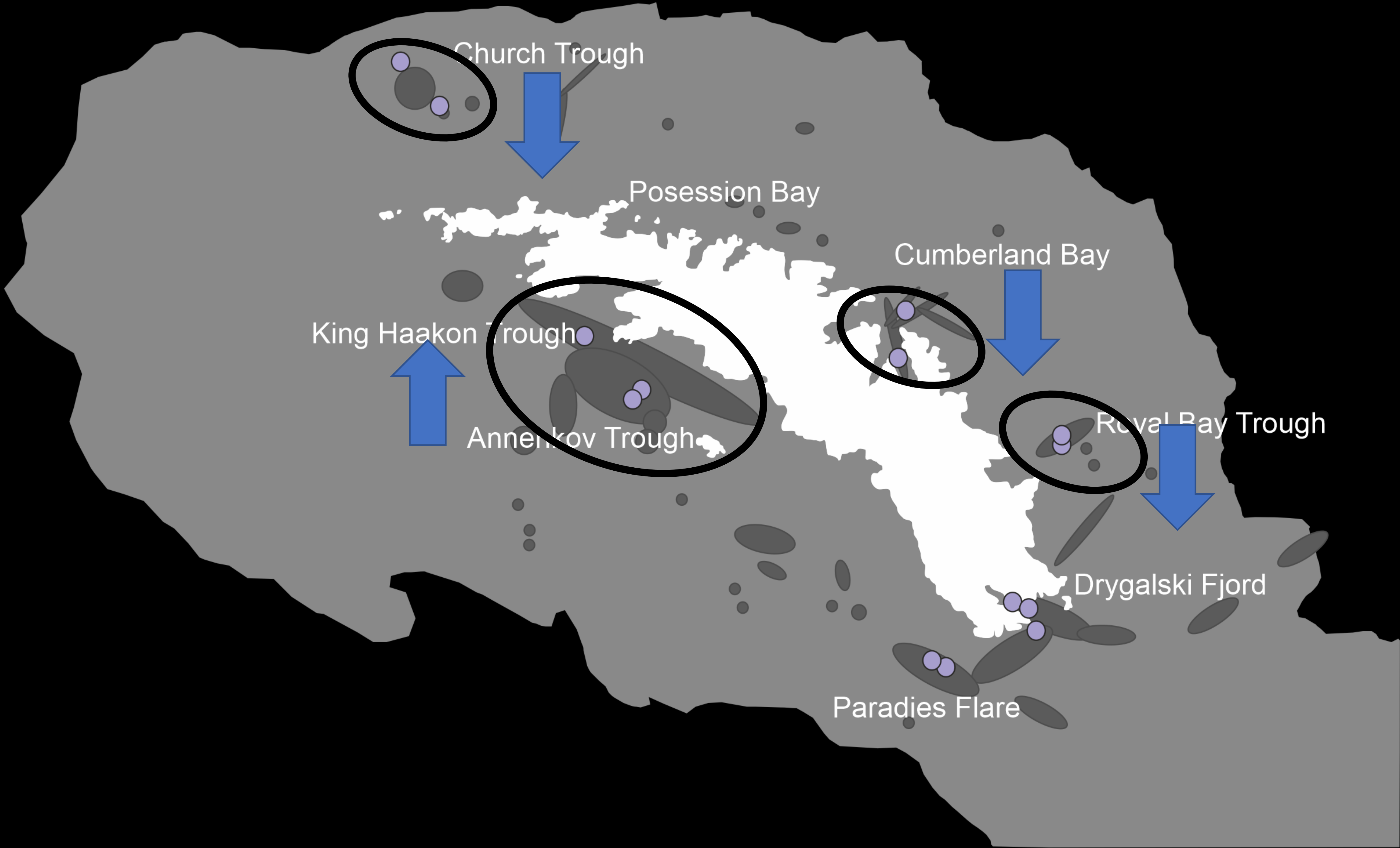
M 134
Methane South Georgia
16 January 2017 Port Stanley - Punta Arenas 18 February 2017

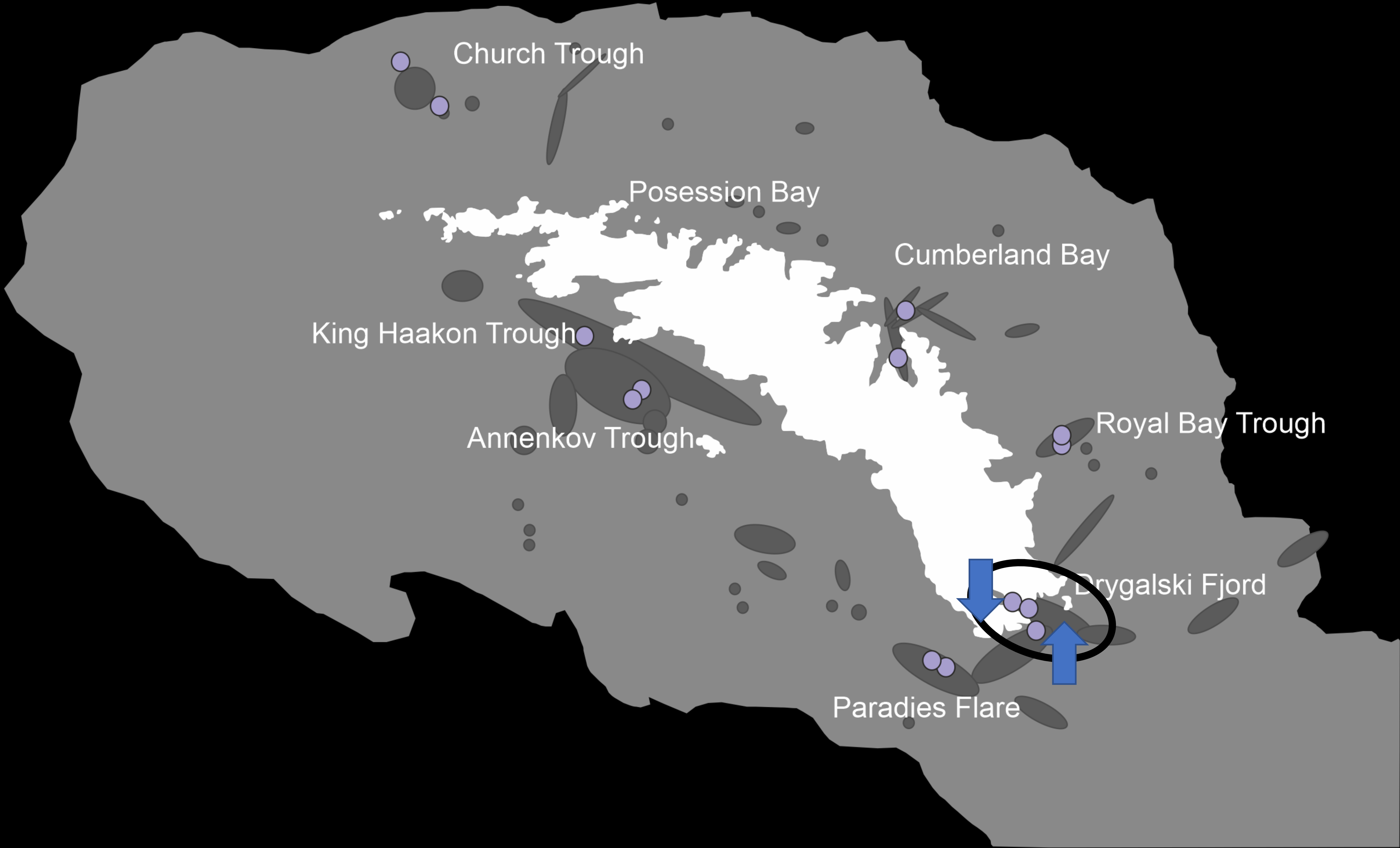
12 MUCs
44 Cores for macrofauna analysis


⩾110 macrobenthic species
⩾ 4000 individuals



Church Trough
Posession Bay
Cumberland Bay
King Haakon Trough
Annenkov Trough
Royal Bay Trough
Drygalski Fjord
Paradies Flare


Church Trough
Posession Bay
Cumberland Bay
King Haakon Trough
Royal Bay Trough
Annenkov Trough
Drygalski Fjord
Paradies Flare


Church Trough
Posession Bay
Cumberland Bay
King Haakon Trough
Annenkov Trough
Royal Bay Trough
Drygalski Fjord
Paradies Flare


Church Trough
Posession Bay
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King Haakon Trough
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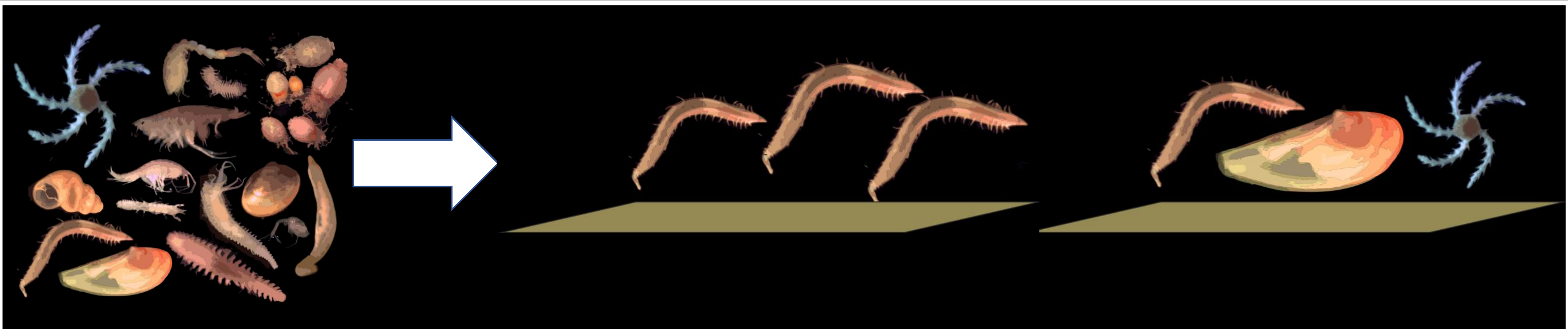
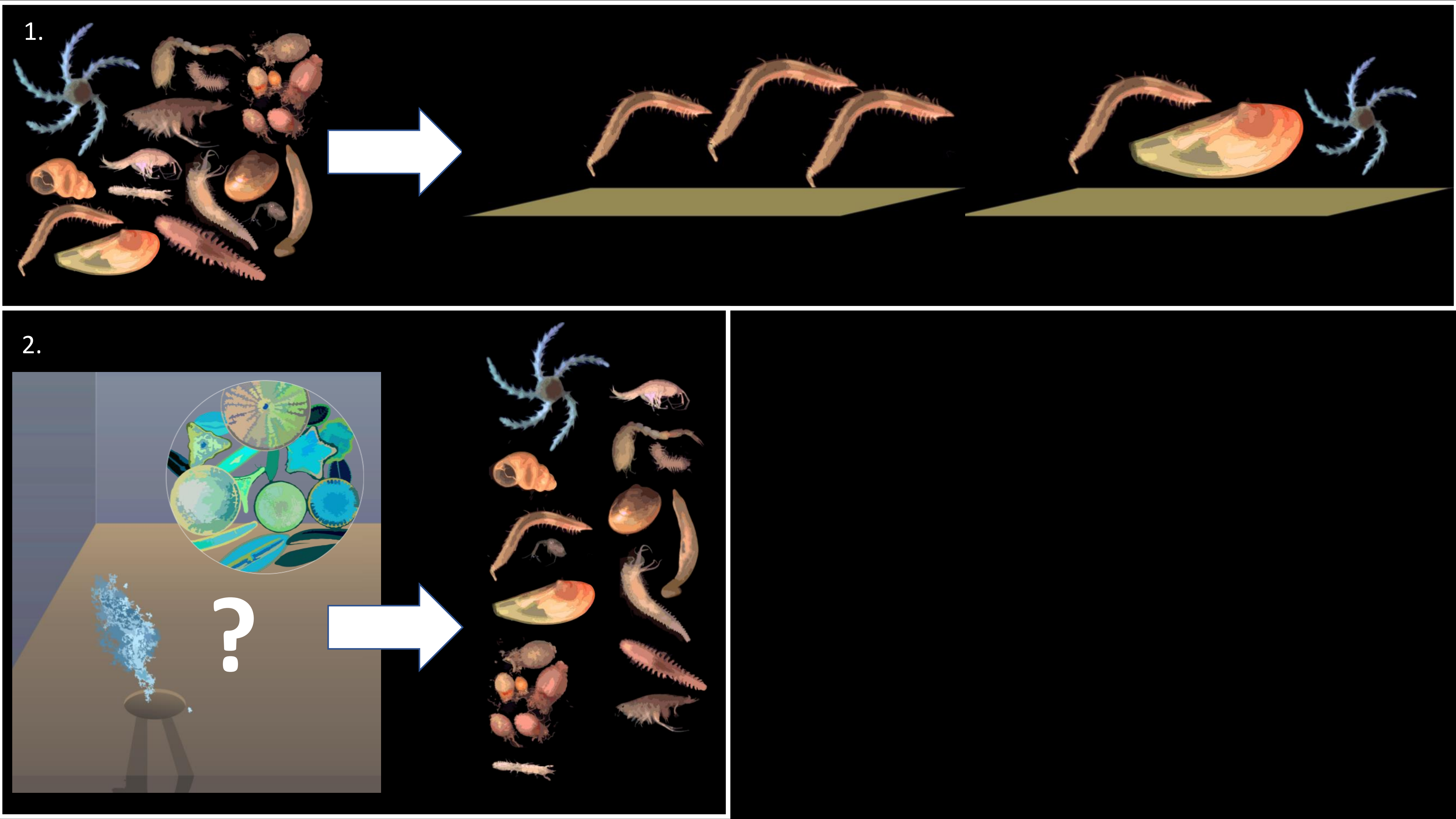
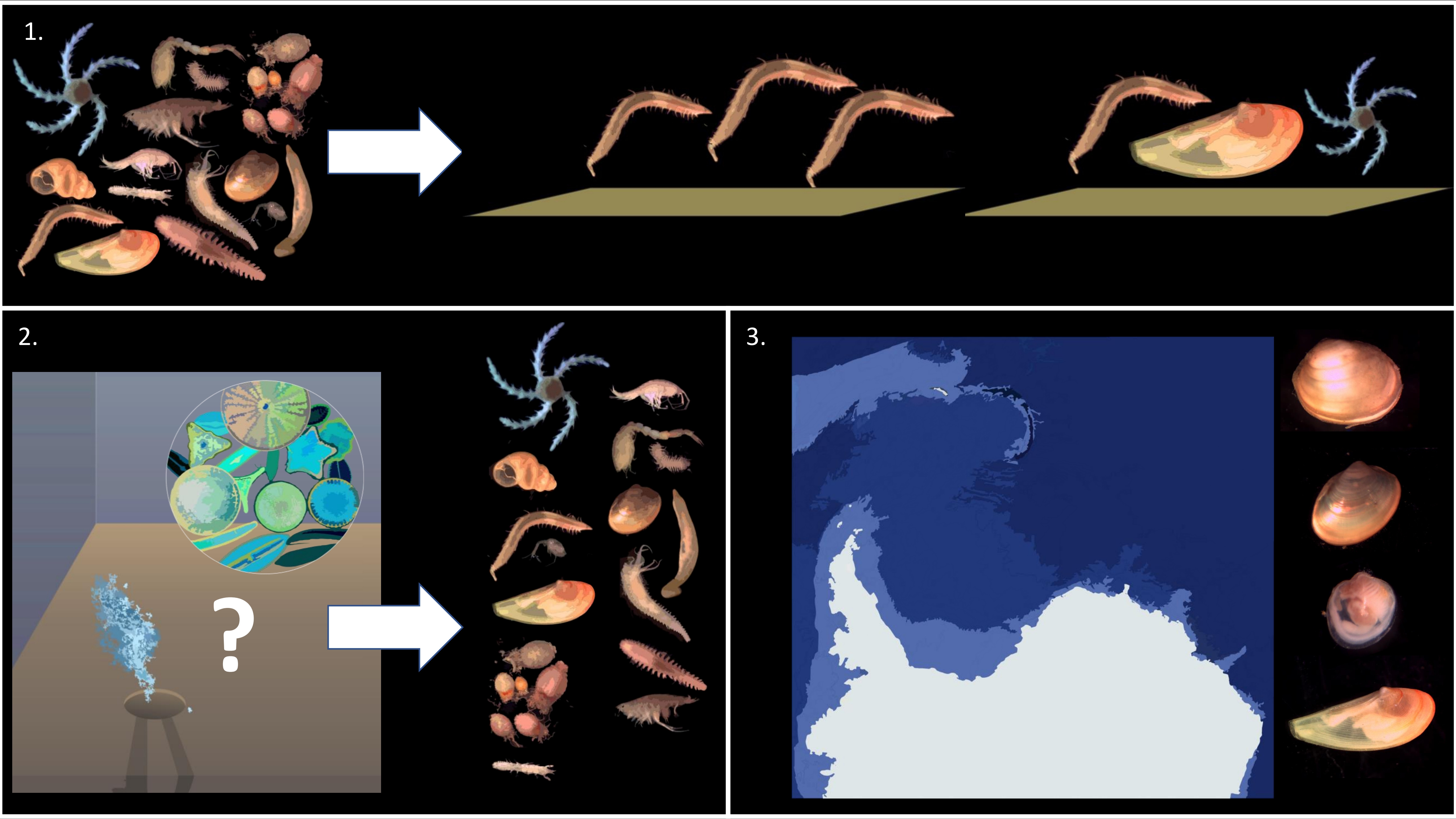
Drygalski Fjord
Paradies Flare




1.
2.
?


1.
2.
?
3.

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Ian Parker, Unsplash