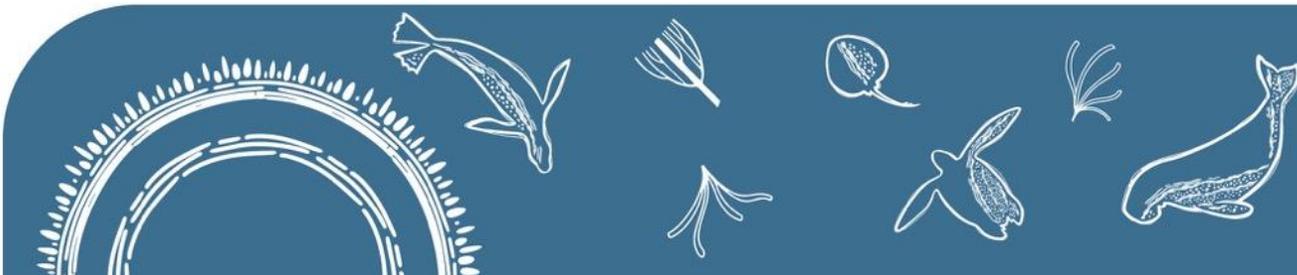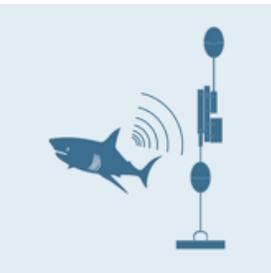*Retrospective: Tracking marine animals for ocean observing*

Acoustic Telemetry and Animal Tagging sub-Facilities

Rob Harcourt Facility Leader

IMOS acknowledges the Traditional Custodians and Elders of the land and sea on which we work and observe, and recognise them as Australia's first marine scientists and carers of sea Country. We pay our respects to Aboriginal and Torres Strait Islander peoples past and present.

I hear you: 20 years supporting acoustic tracking of marine animals in Australia by the IMOS Animal Tracking Facility

Aim. to support the research community to monitor the influence of climate change, provide indices of ecosystem change, understand trophic linkages and habitat selection, and assist in spatial conservation planning and fisheries management through collection and delivery of open-access animal tracking data.

Authors:
Rob Harcourt, Yuri Niella, Emma Bowen, Adam Barnett, Stacy Bierwagen, Stephanie Brodie, Paul Butcher, Leanne Currey-Randall, Ross Dwyer, Luciana Ferreira, Adrian Gleiss, Belinda Goddard, Eva Cougnon, Michelle Heupel, Daniel Hewitt, Jenna Hounslow, Daniel Ierodiaconou, Fabrice Jaine, Ian Jonsen, Elodie Ledee, Nicolas Lubitz, Jordan Matley, Phil McDowall, Mark Meekan, Victor Peddemors, Hugh Pederson, Colin Simpfendorfer, Matthew Taylor, Vinay Udyawer, Charlie Huveneers

CELEBRATING 20 YEARS OF SUSTAINED MARINE OBSERVING

IMOS Integrated **Marine Observing** System

Acoustic sub-facility

Goal:

Create and support a sustainable national network of animal telemetry researchers to facilitate research, foster collaboration and data sharing, build capacity, and promote best practice

IMOS/Vemco Acoustic Telemetry workshop 2007

How:

- maintain and coordinate a national network of acoustic receivers

- foster collaboration, and support early-career and established marine scientists through workshops, training, technical support and the development of innovative data products

- serve as the central data repository for researchers and organisations across Australia and the broader Oceania region, ensuring adherence to best practices in data management and quality control;

- contribute to international efforts through collaboration with the global Ocean Tracking Network and similar initiatives.

Acoustic sub-facility

How: supporting and maintaining a network

15,629 receivers - August 2006 - December 2025

IMOS and Community Receivers

15,028 transmitters - January 2001* - December 2025

*some species in the database were tagged before the facility was created
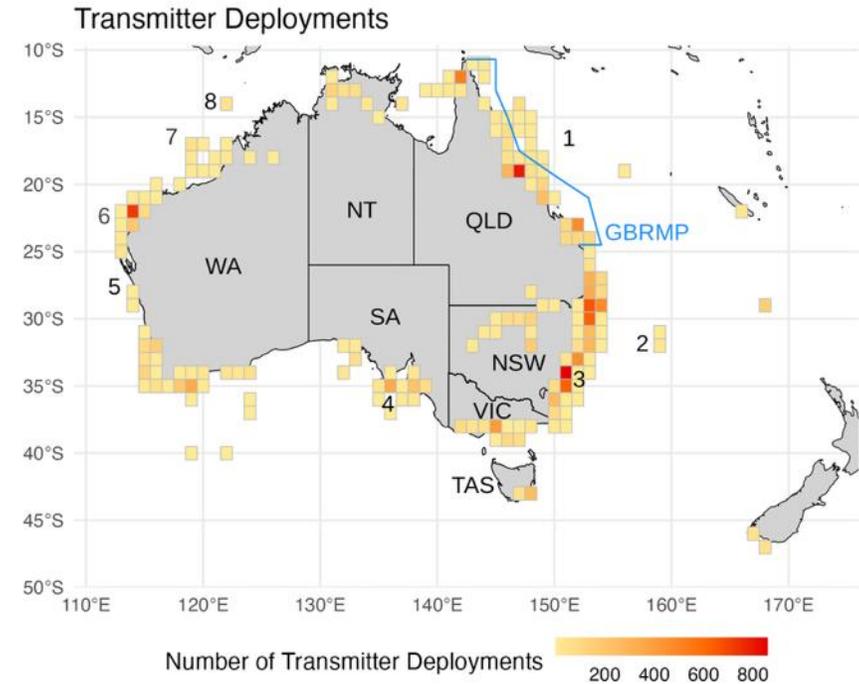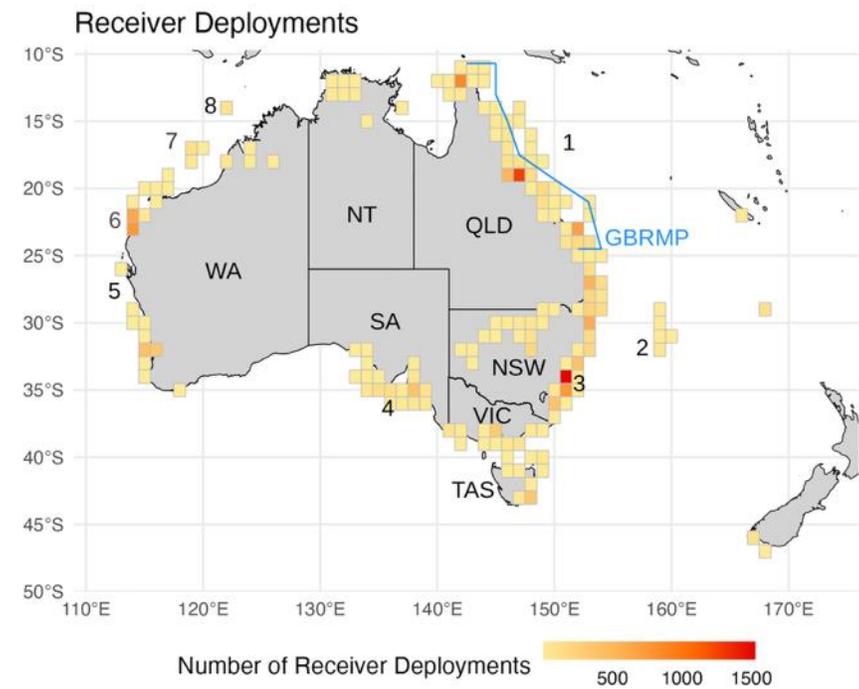
Acoustic sub-facility

How: supporting tagging and data sharing through a centralised database

15,028 individual animals from 180 species tagged with acoustic transmitters by research groups in the IMOS network January 2001*- December 2025

*some species in the database were tagged before the facility was created

Acoustic sub-facility

How: supporting data sharing through automated quality control and encouraging open-access

IMOS Acoustic Task-Team

Proportion of projects and transmitters in the Database with open-access data 2006 - 2025

Acoustic sub-facility

How: refining network design and evolution of technology

CSIRO PUBLISHING

Marine and Freshwater Research
http://dx.doi.org/10.1071/MF16126

Optimising the design of large-scale acoustic telemetry curtains

Andre Steckenreuter[A,J], Xavier Hoenner[B], Charlie Huveneers[C], Colin Simpfendorfer[D], Marie J. Buscot[E], Katherine Tattersall[B], Russell Babcock[F], Michelle Heupel[G], Mark Meekan[G], James van den Broek[A], Phillip McDowall[A], Vic Peddemors[H] and Robert Harcourt[A,I]

Methods in Ecology and Evolution

Methods in Ecology and Evolution 2016, 7, 825–835   doi: 10.1111/2041-210X.12520

The influence of environmental parameters on the performance and detection range of acoustic receivers

Charlie Huveneers[1*], Colin A. Simpfendorfer[2], Susan Kim[3], Jayson M. Semmens[4], Alistair J. Hobday[5], Hugh Pederson[6], Thomas Stieglitz[7], Richard Vallee[6], Dale Webber[6], Michelle R. Heupel[8], Vic Peddemors[9] and Robert G. Harcourt[10]

Methods in Ecology and Evolution
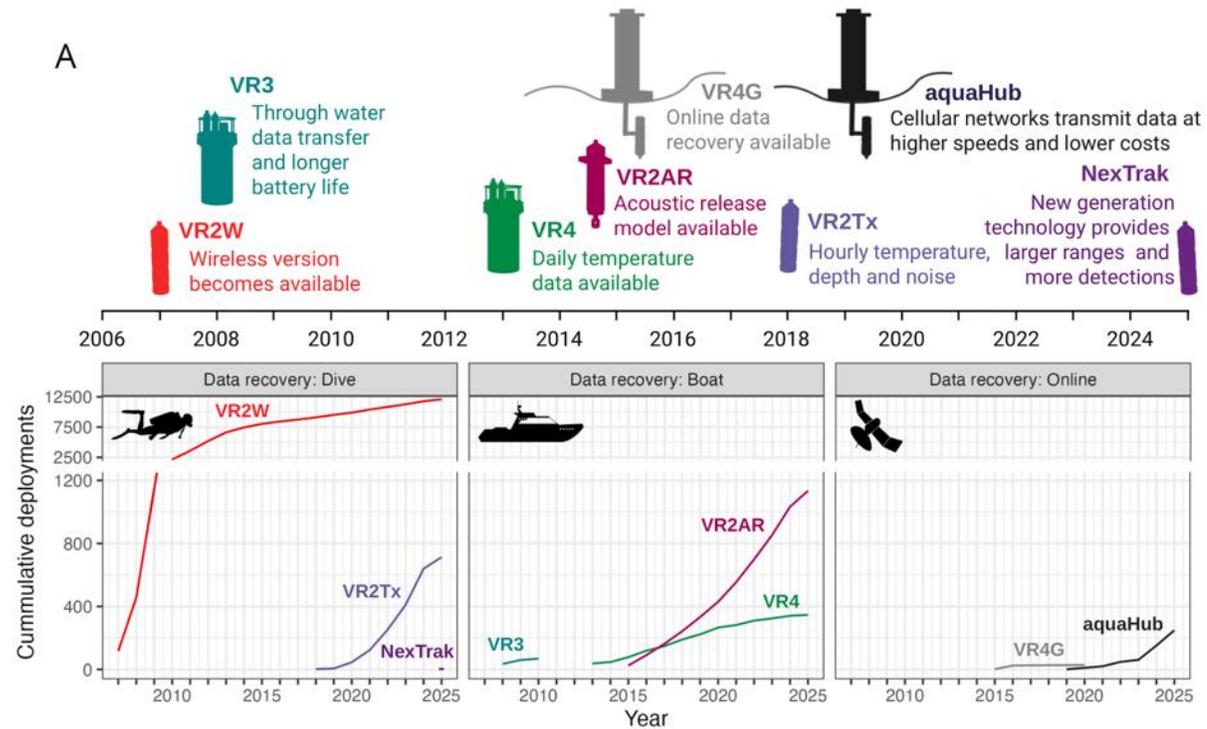
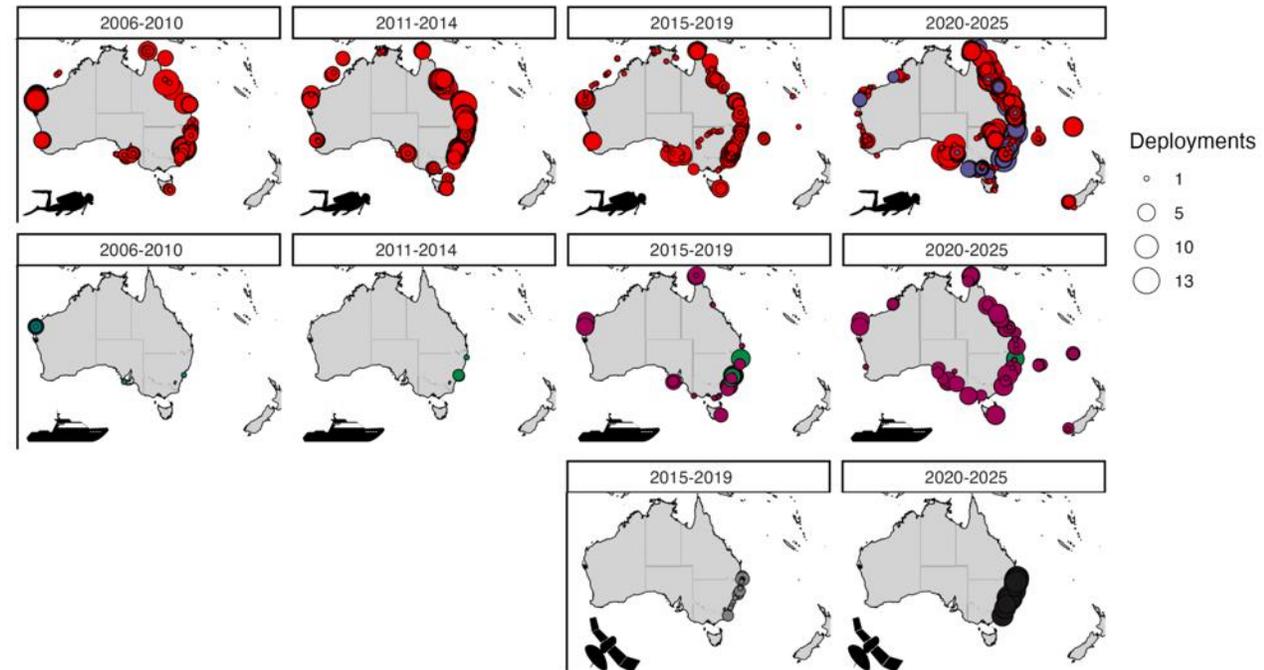Methods in Ecology and Evolution 2017   doi: 10.1111/2041-210X.12806

FORUM

Application of the Acoustic Propagation Model to a deep-water cross-shelf curtain

Charlie Huveneers[*,1], Kilian M. Stehfest[2], Colin A. Simpfendorfer[3], Jayson Semmens[2], Alistair J. Hobday[4], Hugh Pederson[5], Thomas Stieglitz[6], Richard Vallee[5], Dale Webber[5], Michelle R. Heupel[7] and Robert Harcourt[8]
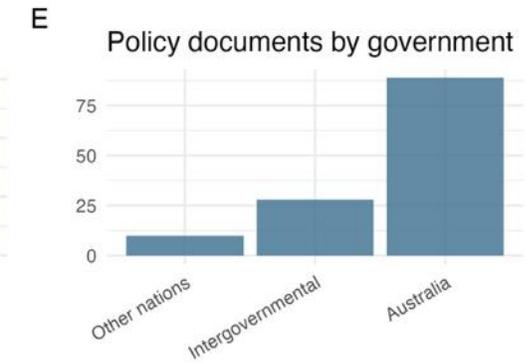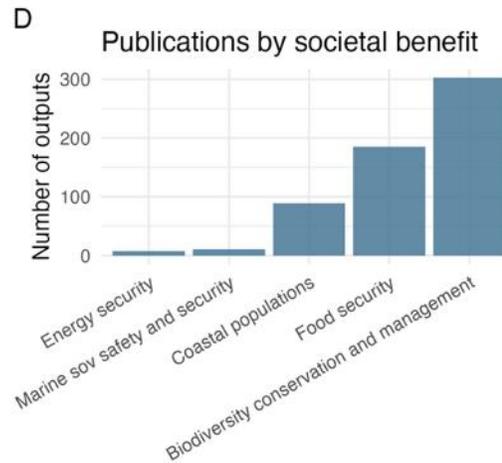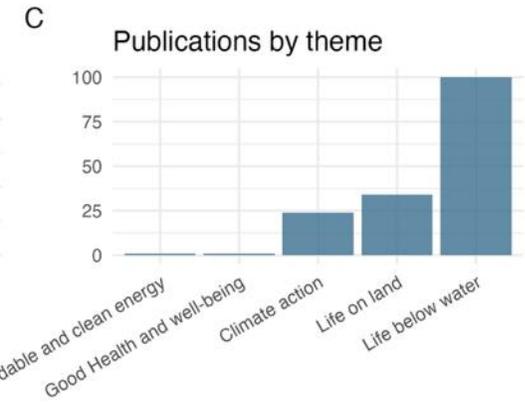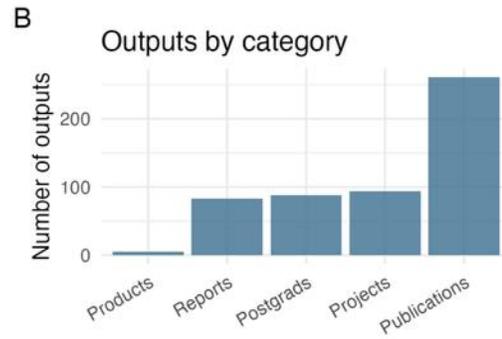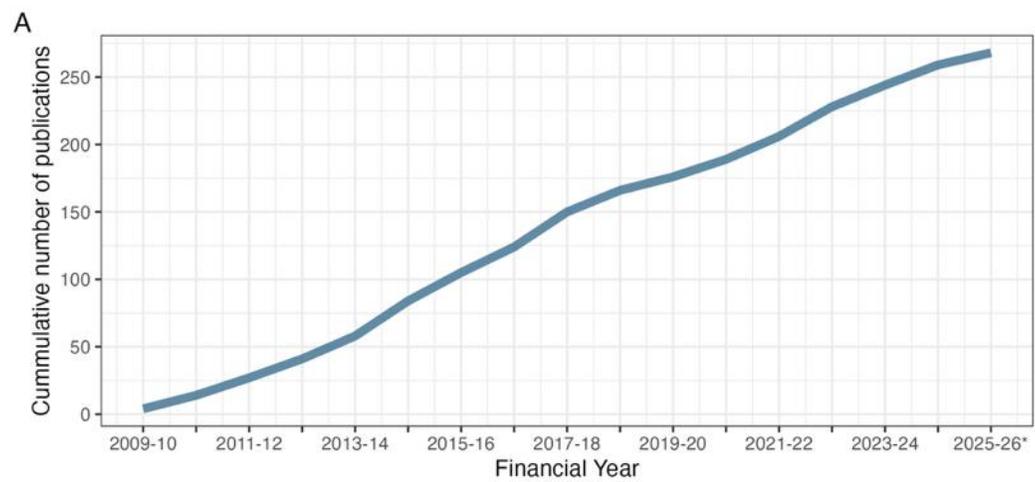
Acoustic sub-facility

Impact:

over 20 years
~300 researchers from 45 institutions
collected and shared ~210 million
detections
supported 268 scientific publications,
88 postgraduate theses
6 data products.

Animal tagging sub-facility

Will work for sardines: 20 years of animal-borne ocean observing by IMOS Animal Tagging

Aim. The world's ocean plays a central role in the global climate with approximately 90% of the excess heat energy due to anthropogenic global warming stored in the ocean. Wide-ranging, deep diving, seals and turtles can provide important complementary observing capacity from poorly observed and remote regions to the ocean operational and climate research communities

Authors:

Rob Harcourt, Clive McMahon, Ian Jonsen, Mark Hindell, Christophe Guinet, Sophie Bestley, Christopher Chapman, J-B Charassin, Luciana Ferreira, Dahlia Foo, Kim Goetz, Simon Goldsworthy, David Green, Rachel Holser, Sara Labrousse, Isobel Lerpiniere, Baptiste Picard, Natalia Ribeiro, Steve Rintoul, Fabien Roquet, Michele Thums, Mike Fedak
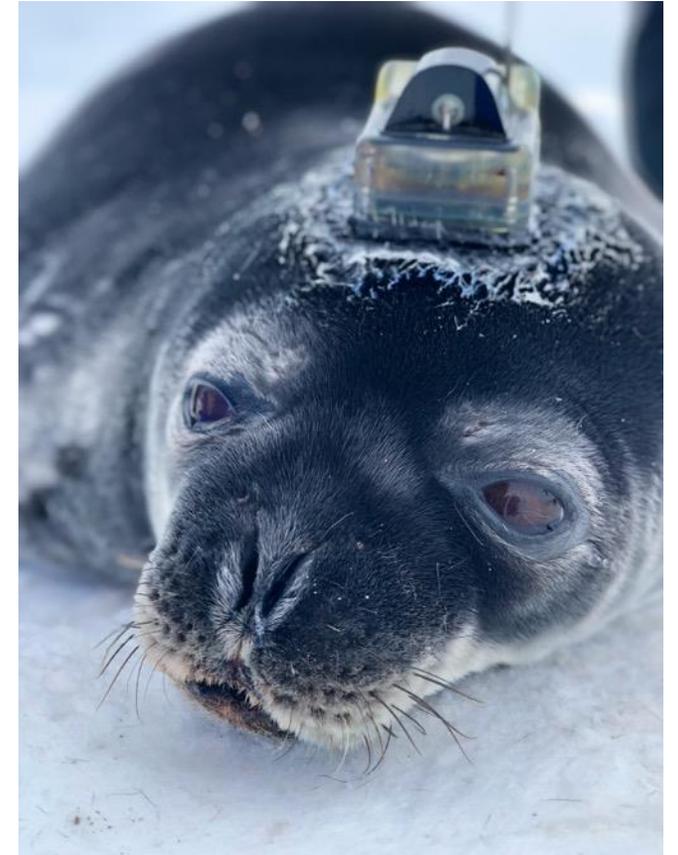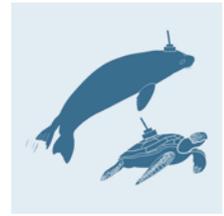
Animal tagging sub-facility

Goal:

provide key observations that can; (i) assist operational oceanography and improve mitigation of threats in a system changing at unprecedented rates, (ii) detect emerging climate-driven shifts and improve ocean and climate models (iii) enhance decision making to address conservation needs.

How:

- collect and make freely available a unified, quality-controlled, database of oceanographic profiles using animal-borne sensors
- To serve the marine and climate research community with free and timely access to quality assured observational data.
- playing a key leadership role in development and coordination of a global animal borne instrumentation observing network
- developing significant national and international and research collaborations

Animal tagging sub-facility

Deployed 1,023 tags on southern elephant (n = 746) and Weddell seals (n = 125), Australian sea lions (n = 50), Australian (n=8) and New Zealand (n = 24) fur seals; olive ridley (n = 44), green (n = 10), and flatback turtles (n = 16)

420,000+ vertical profiles

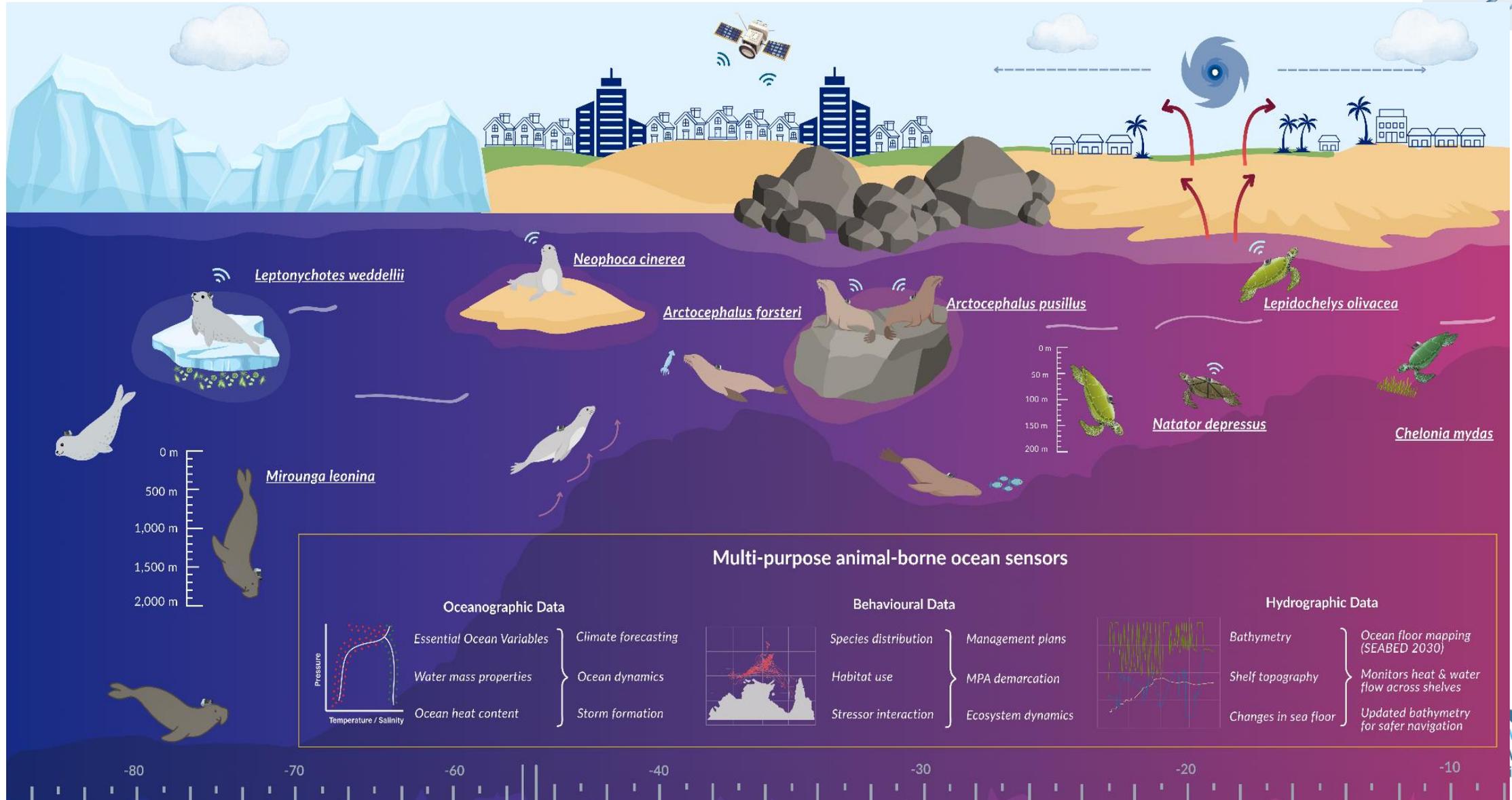A) Southern elephant seal (*Mirounga leonina*); B) Weddell seal (*Leptonychotes weddellii*); C) New Zealand fur seal (*Arctocephalus forsteri*); D) Australian fur seal (*Arctocephalus pusillus*); E) Australian sea lion (*Neophoca cinerea*); F) Green turtle (*Chelonia mydas*); G) Flatback turtle (*Natator depressus*); H) Olive Ridley turtle (*Lepidochelys olivacea*).
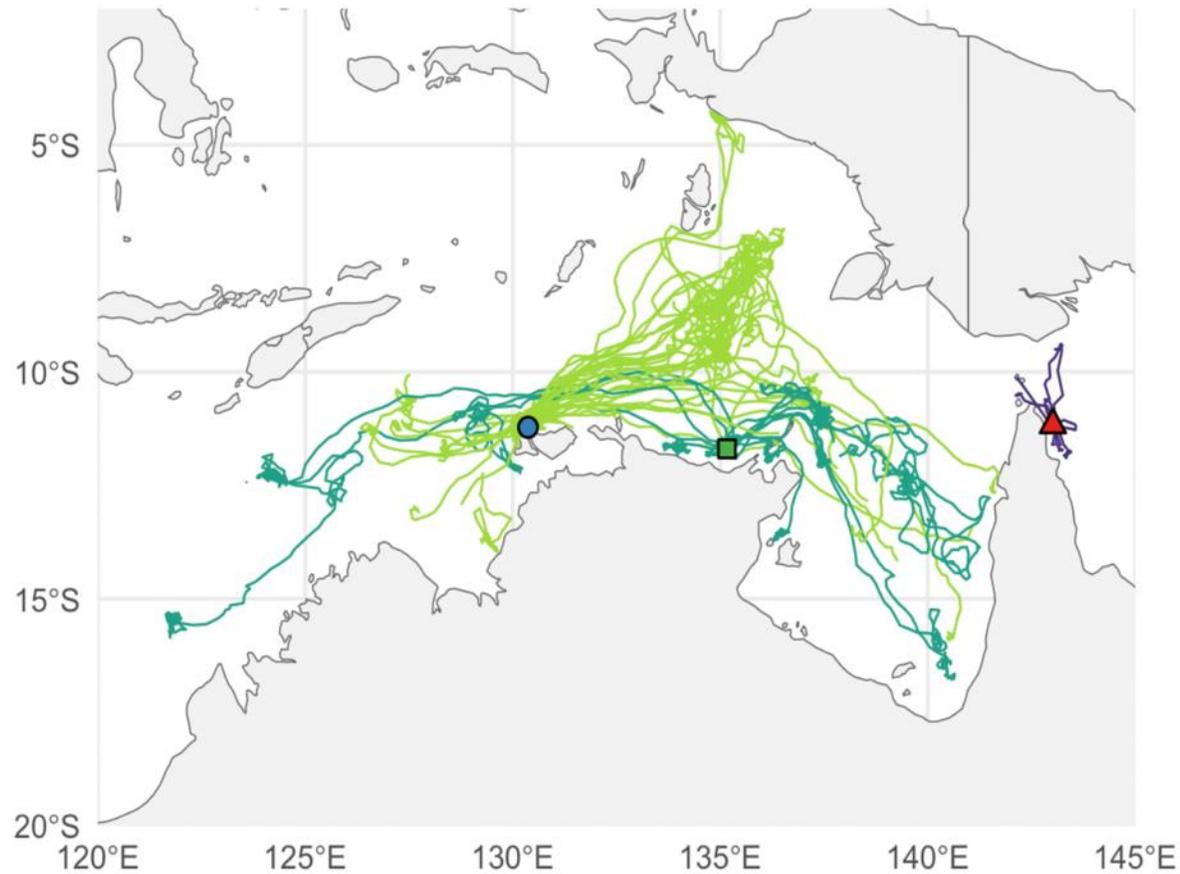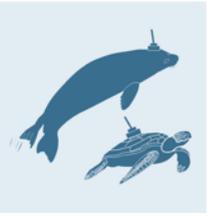
Animal tagging sub-facility
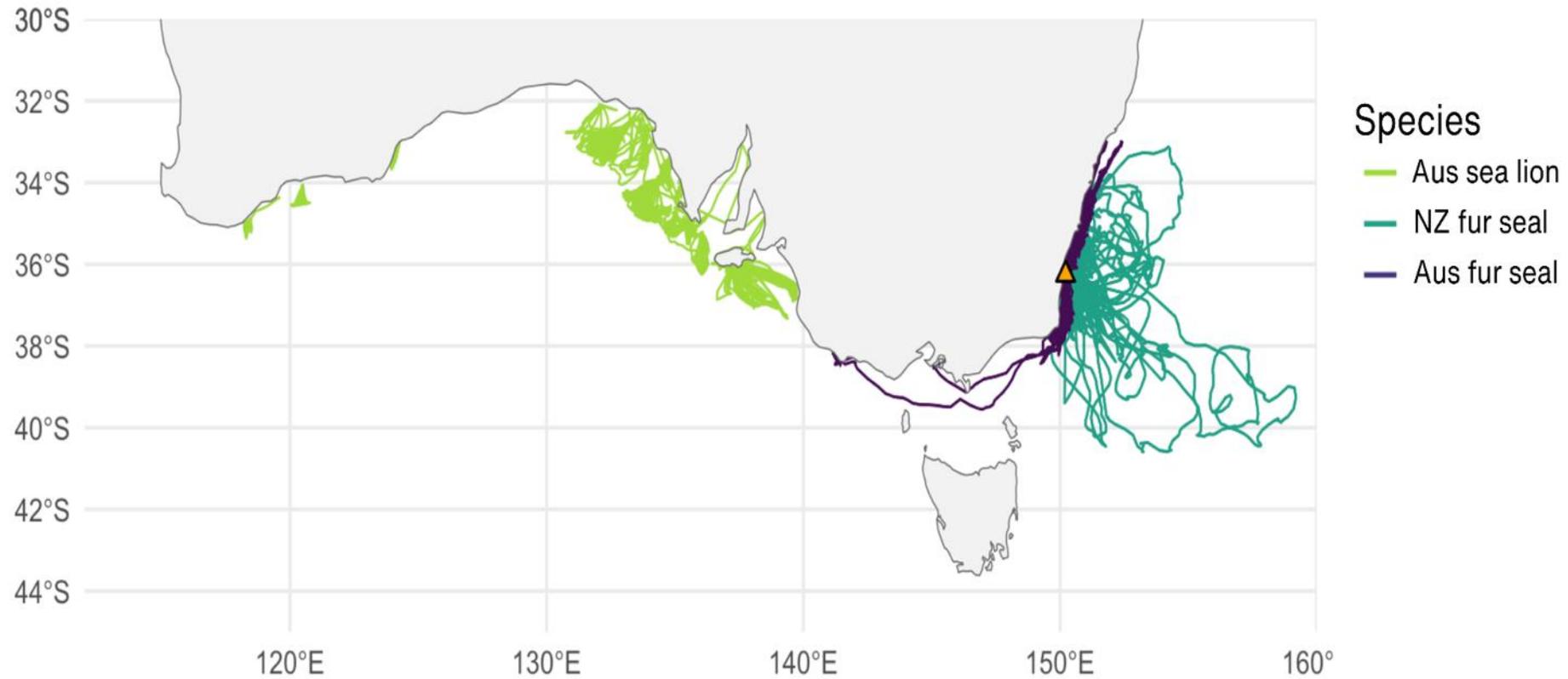
Animal tagging sub-facility
Turtles

Animal tagging sub-facility
Fur seals and sea lions
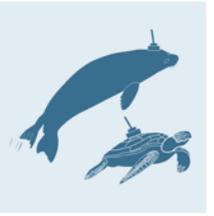
Animal tagging sub-facility
Southern elephant seals and Weddell seals

Animal tagging sub-facility
Deployment timelines

Animal tagging sub-facility

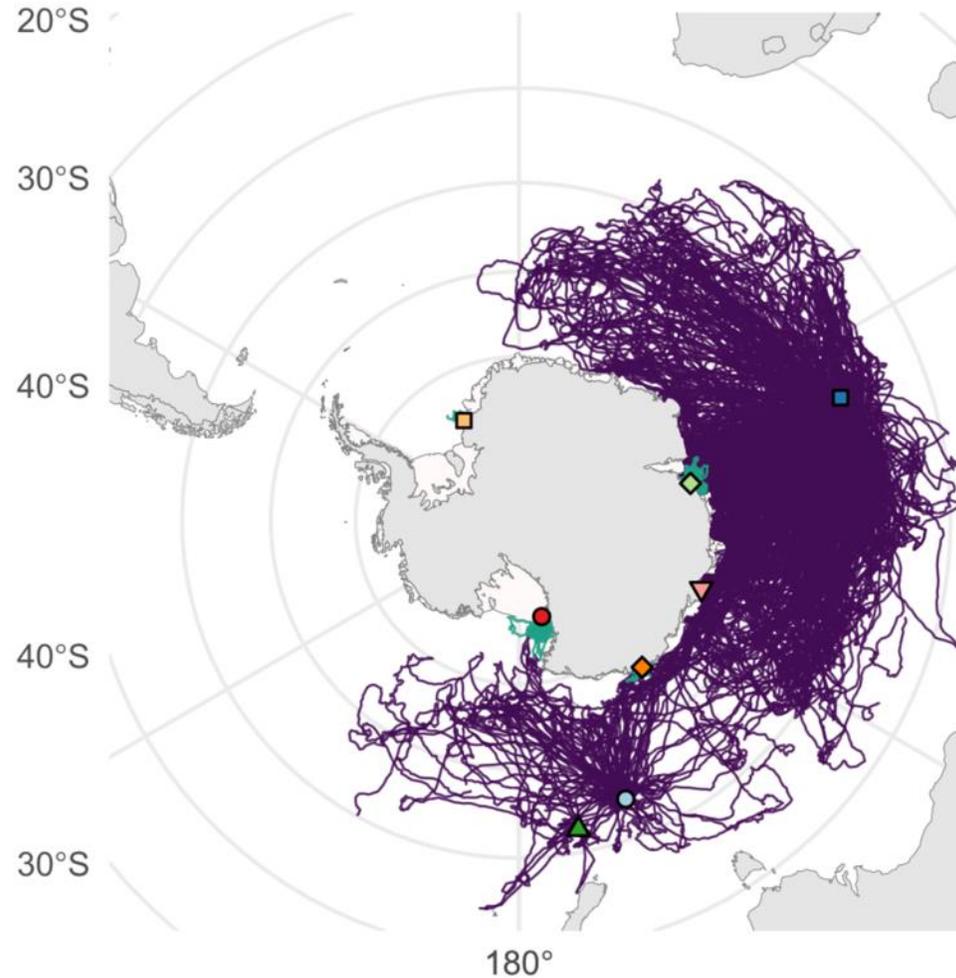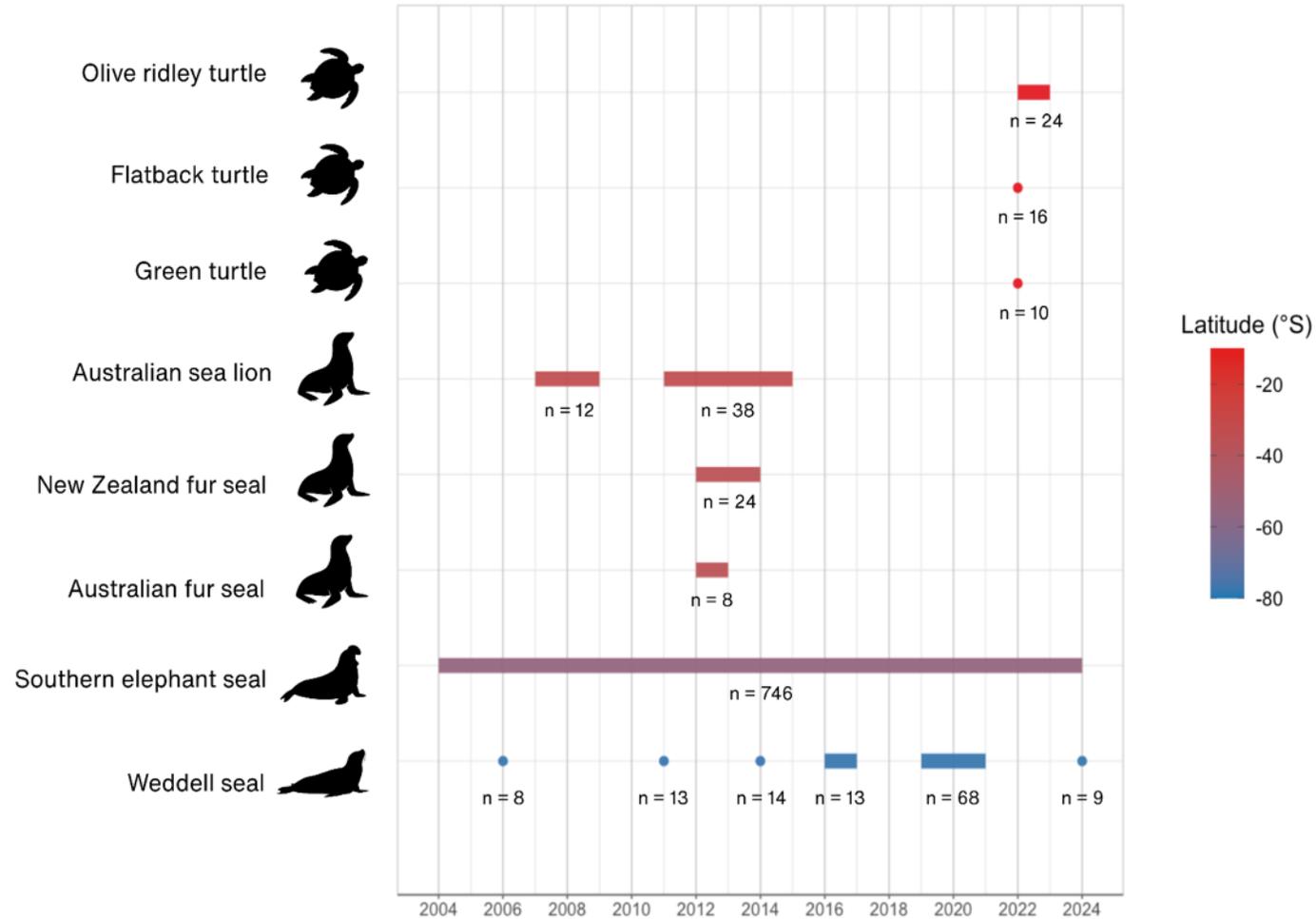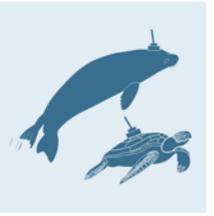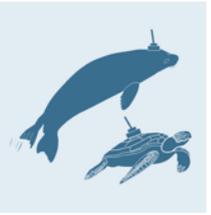Spatial distribution of data-days* per year from Argo floats and ship-based CTD profiles (Argo floats + CTDs; left) compared with instrumented marine turtles (IMOS; right, top and seals, right bottom)

*The data-days metric reflects the number of days in a year for which at least one profile is recorded within each 1° × 1° grid cell

Animal tagging sub-facility

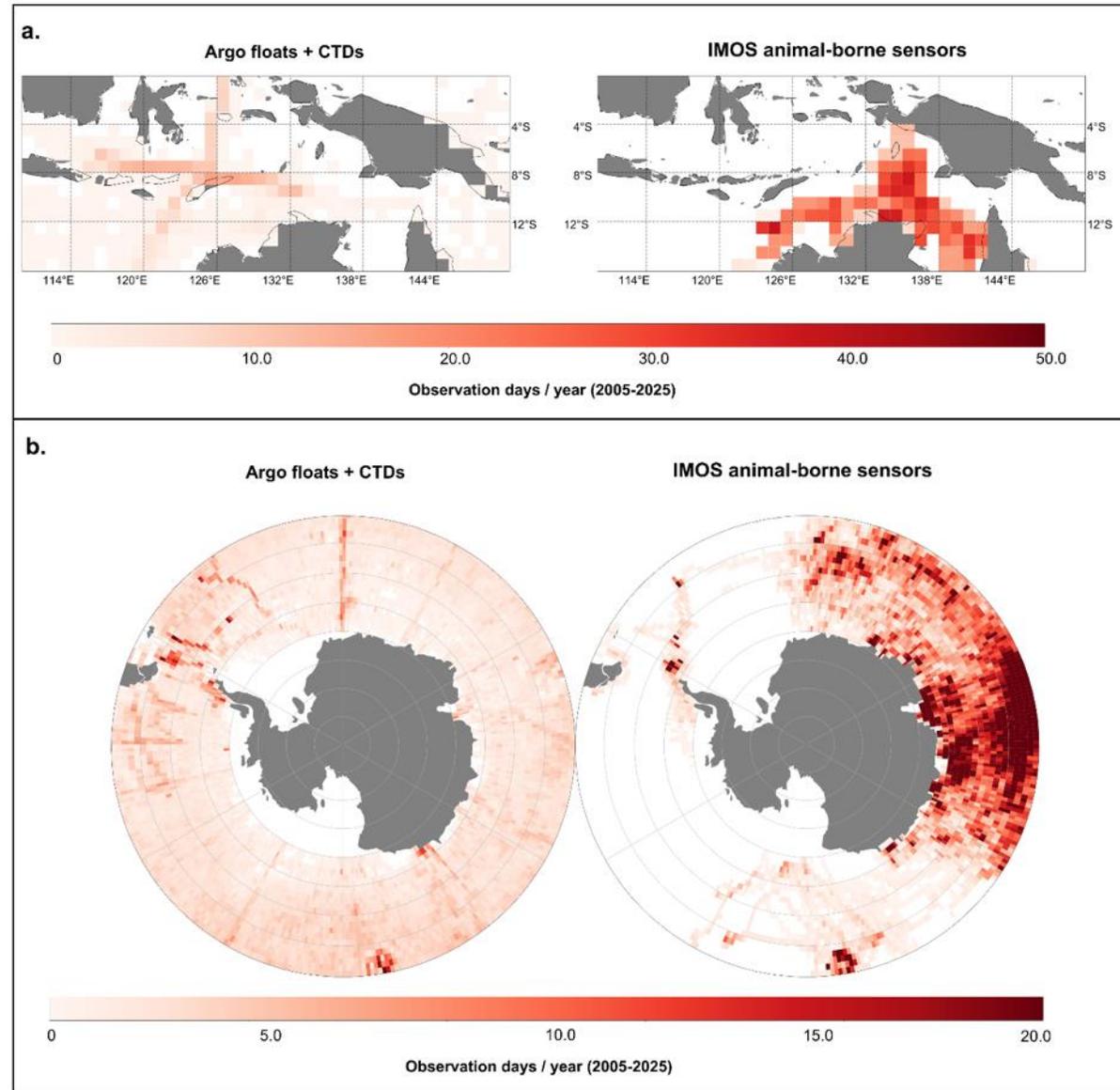**Selected key applications of animal-borne sensors for Antarctic ocean research**

(i) Identification of regions of Dense Shelf Water in Antarctica (salinity ≥ 34.4; γn ≥ 28.27 kg m^{-3}; θ ≤ −1.8 °C) from seal profile data 2011 to 2012.
Williams *et al.* (2016).

*(ii) Revelation of new bathymetry* - differences between seal dive depths and IBCSO v2 bathymetry. Red = dives deeper than the mapped seafloor.
McMahon *et al.* (2023).

(iii) Identification of water-mass properties derived from hydrographic profiles: historical (boat symbol 1956–1996) vs seal (2004–2016)
modified Circumpolar Deep Water (mCDW), maximum salinity of Dense Shelf Water (DSW), minimum potential temperature of Ice Shelf Water (ISW)
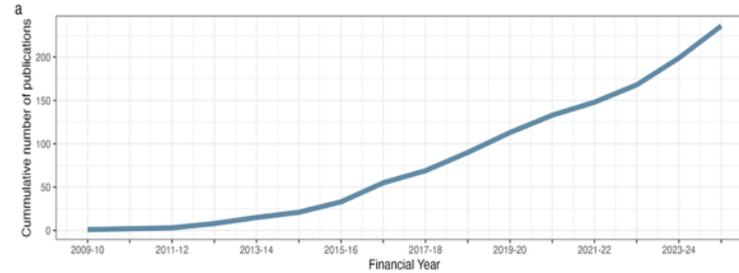Ribeiro *et al.* (2023).

IMOS
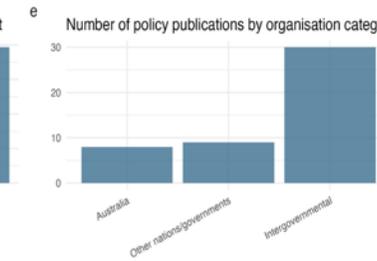Integrated **Marine**
Observing System
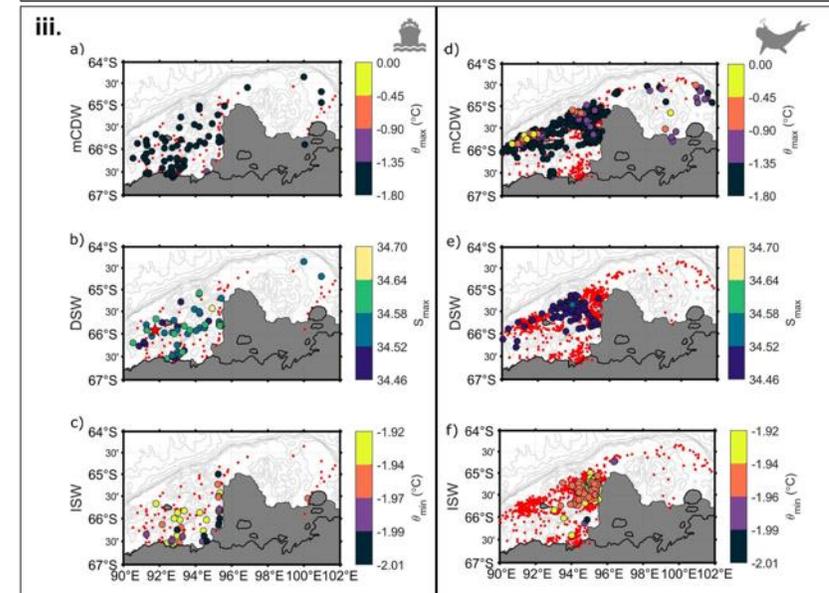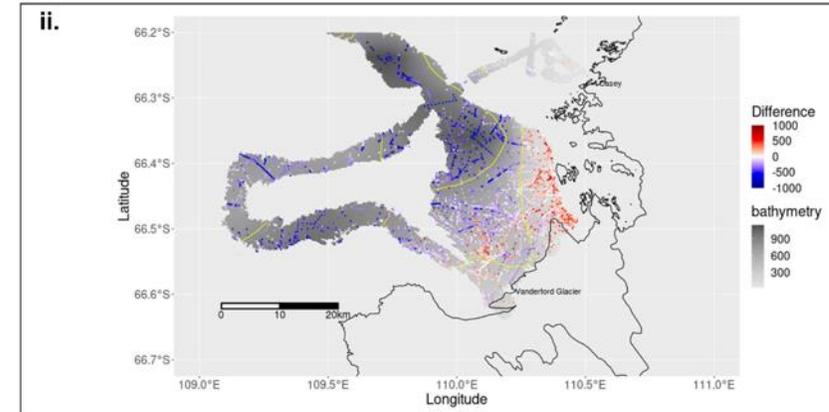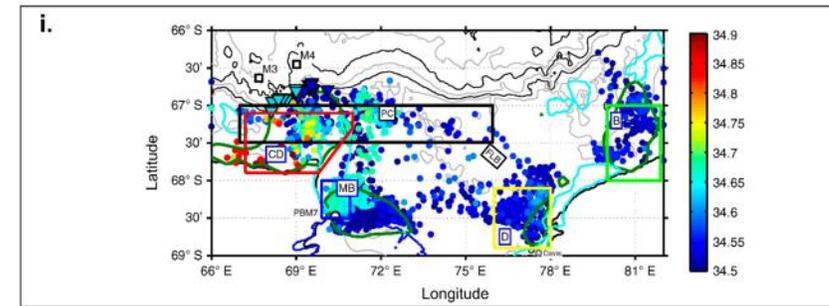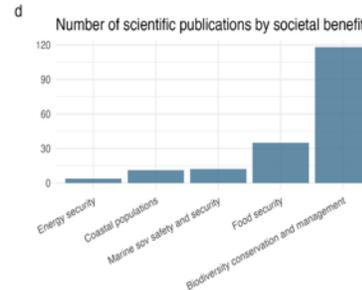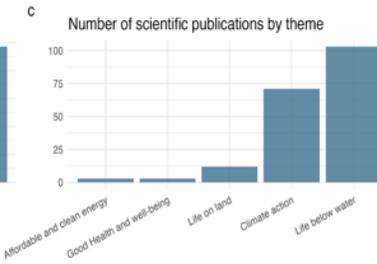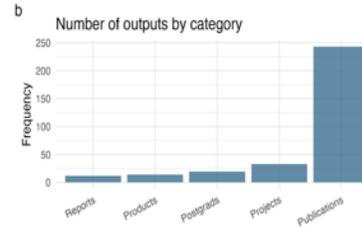
Animal tagging sub-facility

Impact:

over 20 years
1,023 deployments
420,000+ profiles
supported 243 scientific publications, 11 articles in *Nature*, 2 in *Science*
58 of these publications have been used by 84 national and international agencies to develop policy documents
3 data products.

AniBOS implementation status
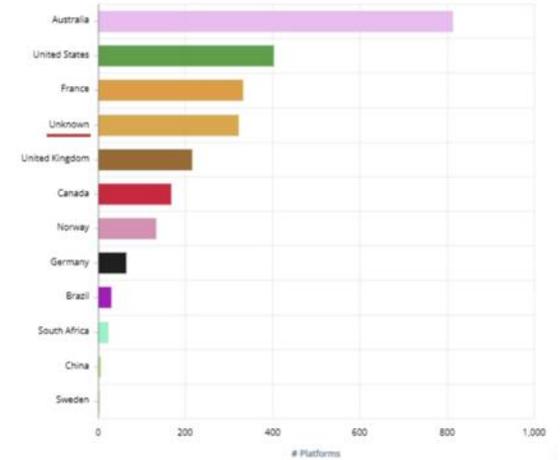
National contribution to AniBOS 2004 - 2026

Article
Tracking of marine predators to protect Southern Ocean ecosystems

METHODOLOGY ARTICLE

A continuous-time state-space model for rapid quality control of argos locations from animal-borne tags

Methods in Ecology and Evolution

aniMotum, an R package for animal movement data: Rapid quality control, behavioural estimation and simulation

communications
earth & environment
ARTICLE

Southern Ocean pinnipeds provide bathymetric insights on the East Antarctic continental shelf

NCRIS
National Research
Infrastructure for Australia
An Australian Government Initiative

Australia's Integrated Marine Observing System is enabled by the National Collaborative Research Infrastructure Strategy (NCRIS). It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent.

PRINCIPAL PARTICIPANTS

UNIVERSITY *of* TASMANIA
(Lead Agent)

Australian Government

AUSTRALIAN INSTITUTE OF MARINE SCIENCE

Australian Government
Bureau of Meteorology

CSIRO

Government of South Australia

SARDI
South Australian Research and Development Institute

THE UNIVERSITY OF WESTERN AUSTRALIA

sims
sydney institute of marine science

UTS

THE UNIVERSITY OF SYDNEY

MACQUARIE University

UNSW SYDNEY

SIMS is a partnership involving four universities

ASSOCIATE PARTICIPANTS

Curtin University

Australian Government
Department of Climate Change, Energy, the Environment and Water
Australian Antarctic Division

AUSTRALIAN ANTARCTIC PROGRAM

DEAKIN UNIVERSITY

THE UNIVERSITY OF MELBOURNE

IMOS thanks the many other organisations who partner with IMOS, providing co-investment, funding and operational support, including investment from the Tasmanian and Western Australian Governments.