

## REPORTING FORM 2023 (August 2022-May 2023)

Please return completed form to [imber@dal.ca](mailto:imber@dal.ca) by 10<sup>th</sup> March (in order to give everyone enough time to collate and read all the reports before the April SSC meeting)

**REPORTING PERIOD: WHAT YOU HAVE DONE** since the annual report submitted for the SSC meeting held virtually in August 2022 ([Link to past annual reports](#))

and **PLANNED ACTIVITIES** over the next year (and beyond if details available)

**N.B.** The form focuses reporting on the research objectives (2022-2025) of the Grand Challenges (in order to align with how we are addressing IMBeR's commitments defined in the 5-year review process to SCOR and Future Earth)

**Thank you.**

*Insert name of IMBeR Regional Programme, Working Group, IMECaN, Endorsed Project, etc.*

*Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED).*

*Nadine Johnston, Eugene Murphy, Rachel Cavanagh*

### 1. Ongoing activities, in line with the IMBeR Grand and Innovation Challenges *(Among other uses, information will be used to update the Grand Challenge Factsheets)*

[www.iced.ac.uk](http://www.iced.ac.uk), follow us on Twitter @ICEDantarctic and @MEASO20

ICED is a multidisciplinary regional programme examining the response of Southern Ocean ecosystems to natural and anthropogenic change and feedbacks to the Earth System. ICED's coordinated circumpolar analyses unite a range of stakeholders to understand interactions between climate and ecosystem dynamics and generate scenarios and projections of the impacts of future change to support sustainable governance in this globally important ocean. Key outputs over the past year in relation to IMBeR's three Grand Challenges include:

#### 1.a. Grand Challenge I

*Understanding and quantifying the state and variability of marine ecosystems - with focus on Research Objectives 1 to 3:*

**Research Objective 1.** *Evaluate and predict the cumulative effect of multiple stressors*

**Research Objective 2.** *Integration of climate change and climate variability*

**Research Objective 3.** *Impacts on society – preparation for a changed future*

ICED has continued to develop whole ecosystem level understanding of the structure and functioning of Southern Ocean ecosystems, their variability and response to change across a range of spatial and temporal scales. Work has focused on detailed analyses of key species from phytoplankton to higher predators, and the structure of food webs. Studies continue to examine physical, biogeochemical, and biological interactions and the effects of past and recent variability and change, such as ocean warming, sea ice change and ocean acidification, and pollutants including plastics. Work in these areas is pivotal to guiding and informing our work under GC II and III. The outputs under GC I over the past year address **all three** Research Objectives. These include:

- **ICED-MEASO:** The Marine Ecosystem Assessment of the Southern Ocean ([MEASO](#)) has now completed and produced a series of papers in a MEASO Special Issue (e-book) on key species and drivers to support scenarios, projections and governance in a , with all papers now published. The collection of papers involves >200 authors from 19 countries, including many ICED scientists as lead and co-authors. This initiative, developed in response to the need to undertake a comprehensive marine ecosystem assessment of the Southern Ocean in support of raising global awareness of the impact of change on these unique ecosystems, understanding their role in Earth System processes and feedbacks, and underpinning policy decisions at the global and Southern Ocean scales. Many of these papers were directed at quantifying the state and variables of Southern Ocean ecosystems. A summary of this work was presented by Nadine Johnston at a series of meetings: 1) the UN Ocean Conference in July 2022 (see below 'UN Decade of Ocean Science section), 2) COP27 in November of 2022 (see detail given under GC III), and 3) The Challenger Society's Challenger 150 Conference, Session T10, London, UK, 6-8 Sep 2022. Work continues by the MEASO SC on a Summary for Policy Makers and peer reviewed synthesis paper. This work also addresses GC II and III.
- **ICED multi-year campaign on sea ice ecosystems:** ICED has continued work to campaign and plan for a focus on sea ice ecosystems, including a multi-year, multidisciplinary field work effort. This will form part of a wider oceanographic-ecosystem initiative '*Taking the pulse of the Southern Ocean: an internationally coordinated, circumpolar, and year-round mission*' as a contribution to the UN Decade of Ocean Science, collaboratively driven by ICED scientists Nadine Johnston, Eugene Murphy, and Stuart Corney and a range of other international oceanographers, led by Alex Haumann (AWI). ICED will contribute the ecosystems component of this initiative, focussing on sea ice ecosystems. Nadine Johnston and Stuart Corney are two of the leading convenors of a SOOS workshop at the Southern Ocean Observing System (SOOS) Symposium, Hobart, Aug 2023 to refine the scientific focus of this initiative and engage the wider scientific community (see Section 6 Planned Activities). This activity will also address GC II & III.
- **EU Horizon 2020 PolarRES:** ICED and a range of international scientists, led by Norway, are delivering an EU Horizon2020 programme, 'Polar Regions in the Earth System: the Role of Local and Regional Polar Processes in Changing the Polar Climate and the Global Climate System' ([PolarRES, 2021-2026](#)). PolarRES is a multi-partner project, and a member of the EU Polar Cluster and will link closely with those throughout. It will also link closely with ICED as a key stakeholder. Using understanding and data on the abundance and distribution of key species in the Southern (and Arctic) Ocean, it will generate future projections of their dynamics using outputs from high resolution physical models of the polar regions. The PolarRES annual General Assembly Meeting was held in Sep 2022, Bergen Norway. Work on selecting CMIP models that represent selected future storylines have been co-developed between Work Package 1 (Storylines) and WorkPackage 6 (Impact modellers) members.

Work will soon begin in WorkPackage 3 (High Resolution Ensemble Projections) on developing downscaled regional models of both poles using the selected CMIP models. This will input to GC's II and III.

- **NERC BIOPOLE:** ICED scientists are part of a new 5 year project 'Biogeochemical processes and ecosystem function in changing polar systems and their global impacts ([BIOPOLE, 2022-2027](#)). BIOPOLE will address a fundamental aspect of the Earth System – how nutrients in polar waters drive the global carbon cycle and primary productivity. Contribution to GC I includes the way in which polar ecosystems (particularly zooplankton) process nutrients, and the way in which these nutrients are supplied to the rest of the world's oceans. IMBeR (and its regional programmes, particularly ICED) is a key stakeholder in this programme. The first Annual Science Meeting was held in Northumbria 1-3 March, uniting all Project Members, Stakeholders, and Project Partners, to summarise work completed to date and future goals and activities. John Claydon (IMBeR Exec Director, IPO Canada) presented an overview of IMBeR and the relationships between IMBeR and BIOPOLE.
- **Joint research interests with other programmes and initiatives:** ICED continues to work with other key programmes and initiatives to outline future collaborations/links to improve understanding of the state and variability of Southern Ocean ecosystems, including with CCAMLR and IWC (see RC III) and SCAR's new Scientific Research Programmes [Ant-ICON](#) and [AntClim<sup>now</sup>](#) (see GC III), and the SCAR Krill Expert Group ([SKEG](#) , see RC II)
- **United Nation's Decade of Ocean Science for Sustainable Development (2021-2030):** Together with SCAR, the SOOS, BIODIVERSITY AQ, IAATO, EPB and a range of Task Force members, ICED has developed a [Southern Ocean Action Plan](#) in support of a range of societal outcomes for the Southern Ocean. A major contribution of ICED under the decade will be the multi-year sea ice campaign (see above). Activities will address all three GC's. Activities this year have included:
  - Together with the Arctic UN Decade Committee and As part of the Southern Ocean Task force, ICED co-convened a session on the Arctic and Antarctic Action Plans to the UN Ocean Conference, Lisbon, Portugal, 27 Jun - 1 Jul 2022 (led by R Badhe, European Polar Board). Nadine Johnston presented on contributions of ICED and other international programmes to these bipolar decade efforts
  - Supplemental information submitted to the UN Decade of the Ocean to complete approval process.
  - A second Southern Ocean focussed application has also been submitted to the UN Decade of the Ocean by a different group. We now await confirmation from the UN Decade Coordination Office about a merger or co existence of these two programmes, with SCAR potentially acting as a UN regional Decade Collaborative Centre. As of Feb 2023 we are still awaiting final confirmation re next steps
  - Work under the Southern Ocean Decade Working Groups has been progressing, with ICED members leading a number of them (Stuart Corney, Eugene Murphy, Predicted Ocean WG, Jose Xavier and Nadine Johnston (as Task Force Liaison) Healthy Ocean WG etc)
  - UN Decade Collaborative Centre (DCC) meeting on Ocean Prediction (January 2023). This was in association with activities of the UN Decade Southern Ocean Task Force. ICED scientists from the Southern Ocean Task force, Eileen Hofmann, Eugene Murphy and Stuart Corney, together with Liz Sykes, and Anton van de Putte, presented a series of talk on aspects of the Southern Ocean decade plans, aspects of modelling and prediction, observational systems and SOOS and ecological

prediction. The next stage requires the development of a Southern Ocean team on ocean prediction that will be linked to the UN DCC Ocean Prediction activities.

### 1.b. Grand Challenge II

*Improving scenarios, predictions and projections of future ocean-human systems at multiple scales - with focus on Research Objectives 4 to 6:*

***Research Objective 4.** Development of integrated data systems and approaches for predictions and projections*

***Research Objective 5.** Development of predictive models and projections for use at regional scales*

***Research Objective 6.** Development of alternative scenarios to bridge the gap between physical climate sciences and humanities*

ICED has continued its model development in support of creating a suite of models of physical dynamics (ocean circulation and climate), biogeochemical cycles, and biological dynamics (life histories, population dynamics, food web structure) within a hierarchical framework of models of different spatial, temporal and trophic resolution. The ultimate aim of these activities is to advance end-to-end ecosystem modelling approaches that integrate physical, chemical and biological processes and generate projections of Southern Ocean ecosystems. We have used our understanding of the drivers and impacts of climate change (under RC I) in the Southern Ocean to further our work on developing scenarios of key drivers and projections of ecological change. The outputs under GC II over the past year address **all three** Research Objectives. These include:

- See **ICED-MEASO** special issue above, which includes outputs on scenarios and projections. This is focussed on the development of the Science for Policy Makers (SPM) statement.
- See **UN Decade of Ocean Research for Sustainable Development** above, which includes a focus on scenarios and projections.
- **Joint research interests with other programmes and initiatives:** ICED continues to work with other key programmes and initiatives to outline future collaborations/links to improve scenarios and projections of Southern Ocean ecosystems, including with CCAMLR, IWC and SCAR's new Scientific Research Programmes [Ant-ICON](#) and [AntClim<sup>now</sup>](#) (see GC III)
- **ICED scenarios and projection:** ICED continues to develop work on projections. Further work on developing projections continues with CCAMLR and SCAR, including the SCAR Krill Expert Group ([SKEG](#), formerly SKAG)).
  - **Outputs from the ICED krill modelling workshop 2021 continue to be developed:** ICED (Murphy, Hofmann, Johnston, Thorpe, Corney), and SCAR (Brookes) scientists and B. Meyer from the SKEG and ICED ECRs (D. Veytia, A. Bahl, Z. Sylvester, D. Bahlburg) organised a virtual [ICED Antarctic krill Modelling Workshop](#) in May 2021. This aimed to unite the research community (particularly Early Career Researchers, ECRs) engaged in modelling Antarctic krill and its application to understanding their ecology, links and feedbacks with

Southern Ocean and Earth System processes, and input to conservation and management options.

- The ECRs involved in this leading the work have been developing two community papers (with the support of ICED mid-career and established researchers) to progress krill modelling.
- **ICED scientists were involved the UN Decade Collaborative Centre (DCC) meeting on Ocean Prediction (January 2023).** This was in association with activities of the UN Decade Southern Ocean Task Force. Eileen Hofmann, Eugene Murphy and Stuart Corney, Liz Sykes, and Anton van de Putte presented a series of talk on aspects of the Southern Ocean decade plans, aspects of modelling and prediction, observational systems and SOOS and ecological prediction. The next stage requires the development of a Southern Ocean team on ocean prediction that will be linked to the UN DCC Ocean Prediction activities.

### 1.c. Grand Challenge III

*Improving and achieving sustainable ocean governance - with focus on Research Objectives 7 to 9:*

*Research Objective 7. Develop knowledge on best practices for multilevel governance approaches to ocean climate adaptation and mitigation*

*Research Objective 8. Develop understanding on key ingredients for transformation towards more sustainable, equitable and inclusive governance approaches to fisheries and aquaculture*

*Research Objective 9. Support implementation of post-2020 biodiversity targets for marine spatial planning and marine protected areas*

ICED has worked with a range of stakeholders to ensure the science under GC I and II is relevant to, accessible to, and incorporated into adaptation, mitigation and sustainable management and conservation procedures, by improving communications, facilitating knowledge-exchange and enhancing understanding between science, policy, and society. The outputs under GC III over the past year address **all three** Research Objectives 7-9. These include:

- **Antarctic Treaty System:** ICED is continuing its work with the Antarctic Treaty Commission via SCAR, within which ICED is a 'Co-Sponsored Programme,' and with a number of Antarctic Treaty agreements including the Committee for Environmental Protection (CEP) and CCAMLR. ICED is also continuing to work with other international environmental treaties and organisations, conservation groups, and international committees, including the International Whaling Committee (IWC). [RO7]
- **Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR):** Over the past year, the CCAMLR Working Groups took place virtually (for the third year running), whereas the Scientific Committee and Commission meetings took place in person for the first time since 2019. In addition, CCAMLR held its five-yearly Scientific Committee Symposium which took place virtually. Key topics within CCAMLR over the past year have included krill management strategies and climate change. ICED scientists continue to have an important role taking the inter-sessional science forward in these and other priority areas, building on contributions and work undertaken by ICED to date, and there will continue to be an important role for ICED as this work progresses within CCAMLR. This is reflected in recommendations that CCAMLR continues to actively engage with ICED and SCAR, particularly with respect to krill research and climate

change. Preparations are now underway for the 2023 CCAMLR meetings. The focus will be on krill management strategies with important contributions from ICED scientists and activities listed above, while also keeping climate change, MPAs and other topics on the agenda. ICED scientists contributed to a large number of papers submitted to CCAMLR in 2022 and will be contributing to many more to be submitted in 2023 (through their national delegations) in support of conservation and management in the region. [RO7 and RO8].

- **International Whaling Commission (IWC):** ICED scientists have continued to work with the IWC and this will be ongoing, including as interactions between CCAMLR and IWC increase. [RO7]
- **SCAR:** ICED is a co-sponsored programme of SCAR and as such interacts with a range of SCAR programmes and initiatives. Over the past year ICED has also contributed to meetings, activities and publications through SCAR's next generation of scientific research programmes [Ant-ICON](#) and [AntClim<sup>now</sup>](#), ensuring that they utilize the outputs of the ICED programme to avoid duplication of effort across the Southern Ocean and wider community, and encourage collaborations in areas of mutual interest across our research challenges. ICED scientists are represented on the steering committees of both these programmes. ICED also maintains interactions with the SCAR Expert Group on Antarctic Krill (see RC I and II). [RO7]
- **Conservation Groups:**
  - ICED scientists continue to co-lead a science-policy initiative between the British Antarctic Survey and the Cambridge Conservation Initiative based in Cambridge, UK.
- **Input to UN Oceans 2022**
  - See RC I
- **UN Decade of Ocean Science for Sustainable Development 2021-2030:** See RC I
- **Input to UNFCCC Conference Of the Parties 2022 (COP27):**
  - In Nov 2022 the work of ICED-MEASO was featured at COP27, Egypt. ICED scientist delivered a presentation in the Polar Oceans event as part of the 'Southern Ocean Ecosystems: Need for Augmented Understanding, Research Efforts and Protection' Session on Thursday 10th November at 18:00 Egypt time. This presentation focussed on past, present, and future changes in Southern Ocean ecosystems, drawing on the work of the world's first Marine Ecosystem Assessment for the Southern Ocean (ICED-MEASO, see RC I). This session featured the latest research and recommendations of the SCAR (of which ICED is a co-sponsored programme) [RO7]
- **IPCC:** ICED scientists contributed to IPCC AR6 via their MEASO papers (see RC I). ICED scientist Andrew Constable was also instrumental in the development of the IPCC's Working Group 2 report on the Polar Regions.

#### 1.d. Innovation Challenge 3

*To advance understanding of ecological feedbacks in the Earth System*

*See GC I Polar RES and BIPOLE projects*

### 1.e. Innovation Challenge 4

*To advance and improve the use of social science data for ocean management, decision making and policy development*

*Refer to activities under GC III*

### 1.f. Innovation Challenge 5

*Interventions to change the course of climate impacts*

- o *See direct ICED input to the UNFCCC Conference Of the Parties 2022 (COP27), UN Oceans Conference, and the IPCCs AR6 detailed in GC I and III.*

### 1.g. Innovation Challenge 6

*Sustainable management of Blue Carbon ecosystems*

*See activities under GC III and publications by ICED scientist in the MEASO special issue*

## 2. Selected highlights

1. **Input to UN Oceans Conference 2022/UN Decade of Ocean Science for Sustainable Development:** ICED co-developed and presented within a side event, organised by the European Polar Board (EPB), the Royal Belgian Institute of Natural Sciences (RBINS), the Scientific Committee on Antarctic Research (SCAR), the Southern Ocean Observing System (SOOS), the Scientific Committee on Oceanic Research (SCOR), the World Climate Research Programme (WCRP), Climate and Ocean - Variability, Predictability, and Change (CLIVAR), and the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED). This was designed to showcase the remit of the Southern Ocean Action Plan (of which ICED is a member of the Southern Ocean Task Force) and the Arctic Action Plans, and to encourage wider stakeholder engagement of the science communities in these two Ocean Decade Programmes. Ways of promoting cross cutting bipolar activities was also discussed. Nadine Johnston delivered a presentation on 'The contribution of ICED and other large scale Southern Ocean research programmes to the UN Decade of Ocean Science'.
2. **Input to UNFCCC Conference Of the Parties 2022 (COP27):** The work of ICED was featured in the **COP27 Conference MEASO** (see above) event at the Cryosphere Pavilion in the Blue Zone, Nov 2022, Sharm El-Sheikh, Egypt. ICED Programme Manager Nadine Johnston delivered a presentation in the Polar Oceans event as part of the 'Southern Ocean Ecosystems: Need for Augmented Understanding, Research Efforts and Protection' Session on Thursday 10th November at 18:00 Egypt time. This presentation focussed on past, present, and future changes in Southern Ocean ecosystems, drawing on the work of ICED and the world's first Marine Ecosystem Assessment for the Southern Ocean (ICED-MEASO).

This session featured the latest research and recommendations of 5 SCAR programmes and initiatives (including ICED).

## 2.a. Selected scientific highlights since last report (1-5)

*Last report was submitted to SSC meeting, August 2022*

1. **Final ICED-MEASO Synthesis (e-book):** See papers at <https://www.frontiersin.org/research-topics/10606/marine-ecosystem-assessment-for-the-southern-ocean-meeting-the-challenge-for-conserving-earth-ecosys>

## 2.b. Publications since last report

*Please add all publications since last report to the table below (see notes for details on “Class” and “Activity” fields).*

<b>Publication with DOI</b>	<b>Class 1, 2, 3</b>	<b>Activity*</b>
<i>ICED/IMBeR activity papers</i>		
All ICED-MEASO Special Issue Papers see details here: <a href="https://www.frontiersin.org/research-topics/10606/marine-ecosystem-assessment-for-the-southern-ocean-meeting-the-challenge-for-conserving-earth-ecosys">https://www.frontiersin.org/research-topics/10606/marine-ecosystem-assessment-for-the-southern-ocean-meeting-the-challenge-for-conserving-earth-ecosys</a>	1	Regional programme activity
<i>[Add more rows if needed]</i>		

*\*If appropriate, please list the IMBeR activity through / by / from / during which the publication arose*

### \*\*\*\* **Notes on publications** \*\*\*\*

Publications are logged in the IMBeR Zotero library which is publicly accessible online –

[Publications since 2019](#) | [Publications prior to 2019](#)

Publications are categorised by “Class” and linked to “Activities”:



**Class 1 publications** are specifically generated through/by/from/during **IMBeR activities** - for example, arising from IMBIZOs and IMBeR conferences such as the IMBeR open science meeting and the IMBeR West Pacific Symposium and from the activities of the working groups, regional programmes or other IMBeR entity.

**Class 2 publications** are on topics relevant to the IMBeR Science Plan that benefitted from some interaction with IMBeR or **IMBeR activities**, for example by IMBeR symposium attendees, past and present SSC members, working group, regional programme and endorsed project members, or national contacts.

**Class 3 publications** are on topics relevant to the IMBeR Science Plan but for which there is no direct link to or benefit from an IMBeR activity. These might include publications by SSC members, working group, regional programme or endorsed project members or members of the IMBeR international community that were written as part of the normal scientific activity of the authors and would have occurred irrespective of IMBeR's existence. You can report Class 3 publications, but they will no longer be logged in the IMBeR database.

[See "[What is an IMBeR publication?](#)" for further information]

**Why list 'Class' and 'Activity'?** This helps us to declare authentically which publications IMBeR has helped to generate, and it makes it easier for us to demonstrate the value of the Regional Programmes, the Working Groups, and IMBeR in general, and it helps us to justify support for IMBeR activities when we can list tangible outputs.

## 2.c. Events, Meetings, and Workshops

*List all international and national events, meetings and workshops. Describe the level of participation: e.g. chairing session/workshop, organising meeting. Include Regional Programme / Working Group committee meetings and workshops.*

*See details under GC I-III*

## 3. International collaboration and links

*See GC I-III*

## 4. Input to management, policy and SOCIETY\* over the last year

*Add anything that is not covered under "1.c. Grand Challenge III"*

*\*As previous reporting forms requested 'input to management and policy' only, please add any 'input to society' not captured in previous reports*

*See Southern Ocean Action Plan under GC I, which is linked to addressing 7 Societal Outcomes of the UN Decade of Ocean Science for Sustainable Development.*

*See input to UNFCCC COP27 under GCI and III, which is linked to managing climate change*

*See input to UN Oceans Conference 2022, which is linked to managing global oceans*

## 5. Education, Outreach and Capacity Development

SEE examples under GC I-III and Appendix

## 6. Planned activities

GC I:

- **ICED multi-year campaign on sea ice ecosystems:** ICED will continue to develop a plan for a focus on sea ice ecosystems, including a multi-year, multidisciplinary field work effort with SCAR as a contribution to the UN Decade of the Ocean.
- **ICED-MEASO outputs**
  - Summary of MEASO for policy maker's document
  - Summary paper on the major outcomes of MEASO in a high-profile peer reviewed journal (e.g., Nature)
  - Presentation of outcomes of MEASO at IMBeR IMBIZO Rabat Nov 2023, potentially in an ICED Session
- **Southern Ocean Decade:**
  - Submission of Southern Ocean Action plan to the UN Decade of Ocean Science for Sustainable Development to become an endorsed programme
  - Submission of a session proposal on the Arctic and Antarctic Action Plans to the UN Ocean Conference, Lisbon, Portugal, 27 Jun - 1 Jul 2022 (led by R Badhe, European Polar Board)
- **IMBeR IMBIZO Nov 2023, Rabat ,Morocco:**
  - Potential ICED Session featuring MEASO outputs TBC
- **SCAR Biology Conference, 2023 July Hobart:**
  - Joint ICED-AntICON session on 'State and Variability of Antarctic and Southern Ocean ecosystems' (to input into Session 2 of the SOOS Conference Lead Convenors: Svenja Halfter, Nadine Johnston, below, TBC
- **Southern Ocean Observing System Open Science Conference, 2023 Hobart, Aus:**
  - Session 1 (co-sponsored by ICED, SOOS and others): *Taking the pulse of the Southern Ocean: an internationally coordinated, circumpolar, and year-round mission'* Lead convenors: Alex Haumann, Stuart Corney, Nadine Johnston, co convenors including international representatives and ECRS
  - Session 2 (co-sponsored by ICED, SOOS and others): *'Observations to improve predictions of Southern Ocean ecosystems in the global context'* Lead convenors: Stuart Corney, Eileen Hofmann, Eugene Murphy, and ECRs David Green and Zephyr Sylvester
- **ICED PICES Zooplankton Symposium, Mar 2024, Hobart, Aus:**
  - Joint ICED-SKAG-AntICON session on Antarctic krill
  - ICED SSC Meeting
- **PolarRES 2nd Annual Meeting** Sep 2023, location TBC
- **BIOPOLE 2<sup>nd</sup> Annual Science Meeting** 6-8<sup>th</sup> Mar 2024, Cambridge UK
- **Develop further understanding** of the role of biology and ecosystem processes in biogeochemical cycling and on primary and secondary production (through research projects such as BIOPOLE)

## CH I & II

- **Completion of outputs from the ICED Krill Modelling Workshop, May 2022:** ECR led Papers on;
  - 1 - Overwintering and recruitment in sea ice environments (led by Alexis Bahl and Dominic Bahlburg)
  - 2- Modelling sea ice –krill recruitment (led by Zephyr Sylvester and Devi Veytia)
- **Develop stronger links** to the physical scientists engaged in heat and carbon research. This will facilitate the inclusion of ecological feedback processes in their models, and the uptake of their model outputs (particularly on the 3D nature of oceanic processes, variability in small scale processes such as storm events, MLD and eddies, and horizontal and sub-mesoscale structure) to examine the influence of physics and biogeochemistry on zooplankton (and other key species) in the Southern Ocean and their subsequent role in carbon and heat cycling. Initiatives such as the BIOPOLE project (of which ICED is a key stakeholder) will provide access to relevant individuals and research groups.

## CH III

- **Antarctic Treaty System:**
  - Input to 2023 Working Group and Scientific Committee meetings of CCAMLR, as well as inter-sessional activities related to key CCAMLR topics including climate change and krill management, and Climate Change Workshop (Sep 2023)
  - Input to the 2023 Antarctic Treaty Consultative meetings and meetings of the Committee for Environmental Protection (CEP), via ICED's input to SCAR
- **International Whaling Commission:** Input to 2023 meetings of the IWC, as well as inter-sessional activities.
- **Develop stronger links** with social scientists and economists with respect to supporting conservation and management decision making

### 6.a. Activities and Outreach and how they link to the Challenges (including, but not limited to convening sessions, meetings, summer schools, workshops, etc)

See 6.

### 6.b. Upcoming papers (Community-Position-Review-etc)

See 6.

## 7. Funding

See GC I

### 7.a. Funding from external sources

*Add text...*

### 7.b. Funding proposals in progress or planned

*Add text...*

### 7.c. Funding requested from IMBeR for 2023-2024

*Include a brief budget and justify requests*

- Funding to support ICED SSC meeting alongside ICES/PICES Zooplankton Symposium Mar 2024
- Funding to support publication of 2 ICED community papers resulting from ICED Antarctic krill modelling workshop
- Funding to support keynote speakers/ECR attendance at ICED Conference sessions at SOOS 2022, SCAR Biology 2022, and ICES/PICES Symposium 2024

## 8. Changes to Organisational Structure (e.g. SSC) of RP / WG / IMECaN

*Add text...*

## 9. Images / Figures

*\*\*\*\*It is always good to have some recent photos / figures / infographics to create more exposure for the Regional Programmes, Working Groups, etc. These can range from those suitable for a very scientific audience, to those that would engage the general public. IMBeR would use these, on the website (e.g. <http://www.imber.info/> and <http://www.imber.info/en/news>), in tweets (@imber\_ipo), in presentations, etc. In addition, Future Earth (one of our sponsors) regularly asks us to provide high quality images for their glossy reports. These can highlight the activities of IMBeR and their other Global Research Projects (see pdfs of past Future Earth reports here <https://futureearth.org/publications/annual-reports/>)*

*So, please provide any images that you might think are useful. These can be pasted in this document or emailed as an attachment to [imber@dal.ca](mailto:imber@dal.ca).\*\*\*\**



MEASO @MEASO20 · 11 Nov 2022

...

Yesterday @ #COP27 the MEASO team contributed to "Southern #Ocean #ecosystems: need for augmented understanding, research & protection" @COP27P Cryosphere Pavilion.

@SOOSocean @SCAR\_Tweets @BEPSII\_seaice @imber\_ipo

@AntarcticaSouth @ICEDantarctic

Catch up in the link below!



MEASO @MEASO20 · 10 Nov 2022



The MEASO - Marine Ecosystem Assessment of the Southern Ocean - presentation at #COP27 begins with input from over 200 scientists from 19 countries around the world! @SOOSocean @SCAR\_Tweets @BEPSII\_seaice @imber\_ipo @AntarcticaSouth ...



**Blanca Figuerola** @BlancaFiguerola · 10 Nov 2022

...

Glad to be part of this assessment which aims to harmonise this scientific information to inform policy makers at local, national, and global scales.

An international collaboration of > 200 researchers:

[frontiersin.org/research-topic...](https://frontiersin.org/research-topic...) #MEASO #COP27 #SouthernOcean #Antarctica

**MEASO** @MEASO20 · 10 Nov 2022

The MEASO - Marine Ecosystem Assessment of the Southern Ocean - presentation at #COP27 begins with input from over 200 scientists from 19 countries around the world! @SOOSocean @SCAR\_Tweets @BEPSII\_seaice @imber\_ipo @AntarcticaSouth @ICEDantarctic @BAS\_News



**Southern Ocean ecosystems: status, change, and global importance**

On behalf of the MEASO Team (>200 scientists, 19 countries)



ALT



IMBeR



SOOS

BEPSII



IMAGES: ICED scientists Nadine Johnston, Andrew Constable, and Jilda Caccavo (representing SCAR AntiCON on this occasion) together with Sian Henley (SOOS) and Sebastian Moreau (Biogeochemical exchanges at Sea Ice Interfaces, BEPSII) at the Cryosphere Pavilion Egypt, Nov, 2022. ICED presented on Status, Change and global importance of Southern Ocean ecosystems. This session delivered key messages on conservation measures, management and a global reduction in CO2 emissions needed to protect these ecosystems.

## 10. Update on Action Items from 2022 SSC meeting

*Please update the [table of Action Items](#)*

*Add text...*

## 11. Anything not covered above

*Add text...*

## 12. How to improve this form

*Please give suggestions on how to improve this form and make it better next time.*

*Add text...*

## 13. Appendices

*Add appropriate meeting / workshop reports and include URLs (this helps to track where online content is missing)*

### ICED Annual Report to IMBeR Appendix 1

#### ICED Education and Outreach August 2022 to April 2023:

##### Work to be highlighted

Beal M, Catry P, Phillips RA, Oppel S, Arnould JP, Bogdanova MI, Bolton M, Carneiro AP, Clatterbuck C, Conners M (2023) Quantifying annual spatial consistency in chick-rearing seabirds to inform important site identification. *Biological Conservation* 281:109994 DOI: 10.1016/j.biocon.2023.109994

Xavier JC, Golikov AV, Queirós JP, Perales-Raya C, Rosas-Luis R, Abreu J, Bello G, Bustamante P, Capaz JC, Dimkovikj VH, González AF, Guímaro H, Guerra-Marrero A, Gomes-Pereira JN, Kubodera T, Laptikhovskiy V, Lefkaditou E, Lishchenko F, Luna A, Liu B, Pierce GJ, Pissarra V, Reveillac E, Romanov EV, Rosa R, Roscian M, Rose-Mann L, Rouget I, Sánchez P, Sánchez-Márquez A, Seixas S, Souquet L, Varela J, Vidal EAG, Chereil Y (2022) The significance of cephalopod beaks as a research tool: An update. *Frontiers in Physiology* 13. DOI: 10.3389/fphys.2022.1038064

Reisinger, R.R., Brooks, C.M., Raymond, B., Freer, J.J., Cotté, C., Xavier, J.C., et al. (2022). Predator-derived bioregions in the Southern Ocean: Characteristics, drivers and representation in marine protected areas. *Biological Conservation* 272, 109630. doi: <https://doi.org/10.1016/j.biocon.2022.109630>

3 key papers from our team:

Queirós JP, Machado JF, Pereira E, Bustamante P, Carvalho L, Soares E, Stevens DW, Xavier JC (2023) Antarctic toothfish *Dissostichus mawsoni* as a bioindicator of trace and rare earth elements in the Southern Ocean. *Chemosphere*:138134 DOI: 10.1016/j.chemosphere.2023.138134

Queirós JP, Bartolomé A, Piatkowski U, Xavier JC, Perales-Raya C (2023) Age and growth estimation of Southern

Ocean squid *Moroteuthopsis longimana*: can we use beaks collected from predators' stomachs? *Mar Biol* 170:1-15. DOI: 10.1007/s00227-022-04156-2

Xavier, J.C., Phillips, R.A., and Takahashi, A. (2022). "Antarctic seabirds as indicators of climate change," In *Seabird Biodiversity and Human Activities*, eds. J.A. Ramos & L. Pereira. Boca Raton, CRC Press: 189-210. ISBN 1003047521 (book chapter)

### Work relevant to policy making

2022 – Portugal and Spain. Information on chemical pollution at Port Foster, Deception Island. ATCM XLIV/IP4 (José Xavier was the coordinating-contributor from Portugal). ISBN (complete work): 978-987-8929-19-4

2022 – Portugal, Sweden and World Meteorological Organization (WMO). UN Ocean Conference 2022 in Lisbon, Portugal. ATCM XLIV/IP3 (José Xavier was the coordinating-contributor from Portugal). ISBN (complete work): 978-987-8929-19-4

2022 – Portugal and United Kingdom. Microplastics in the Antarctic marine food web: evidence from penguins. ATCM XLIV/IP1 (José Xavier was the coordinating-contributor from Portugal). ISBN (complete work): 978-987-8929-19-4

2022 – Portugal and United Kingdom. Effects of climate change on Antarctic marine food webs: new evidence from squid. ATCM XLIV/IP2 (José Xavier was the coordinating-contributor from Portugal). ISBN (complete work): 978-987-8929-19-4

2022- Bulgaria, Belgium, Brazil, Chile, Portugal, Spain and United Kingdom. Fifth report of the Intersessional Contact Group on Education and Outreach. ATCM XLIV/WP23 (José Xavier was the coordinating-contributor from Portugal). ISBN (complete work): 978-987-8929-19-4

### Education and outreach initiatives

#### Coordinating conferences/workshops

2022 – Atmospheric sciences and social sciences session (Vieira, G. and Xavier, J. C.; Chairs). XIV Portuguese Conference on Polar Sciences, University of Algarve

2022 – Priestley, R., Salmon, R., Roop, H. and Xavier, J. C. (2022). Public engagement with Antarctica in a changing climate II. 10<sup>th</sup> Open Science SCAR Conference, India (online)



2022- Xavier, J.C., Lau, S., Henley, S., Johnston, N. and Janssen, A. (2022). UN Southern Ocean Decade laboratory: A healthy and resilient Southern Ocean – where marine ecosystems are understood and managed. Online, 10 March

2022 - Santo, M. E., Fialho, P., Silva, P. & Xavier, J. C. (2022). V National Workshop on Education & Outreach: from polar research to the classroom. Online, Portugal (6 March)

Talks related to education/outreach (under POLAR WEEKS APECS/PEI WORLD INITIATIVE)

Xavier, J. C. (2022). Science talks on polar research in schools or events in Portugal (ES Severim de Faria (Évora), x2 EB & S Canelas x2, BLUEWAVE Project talk, Instituto Superior Técnico, Bebday University Coimbra talk, FORUM OCEAN talk, UN Ocean Decade talk, Agrupamento de Escolas de Mirax2, PEI Workshop PT, Escola Fernando Mendes Pinto (Almada), IEC talk, ES Dr Gomes Ferreira Alves (Valadares), Instituto Superior de Lisboa e Vale do Tejo, TEDx University of Coimbra talk (<https://www.youtube.com/watch?v=MlijPjM7Ws>), Penguin Day Ocean University talk (in EB2,3 Pedrosa Veríssimo (Figueira da Foz), Agrupamento de Escolas Professor Ruy Luís Gomes, DcV University Coimbra talkx2, EB & S Tomás de Borba (Angra do Heroísmo (Açores), POLAR DATE- PEI event talk, University Coimbra Masters courses presentations, Science Festival UC – ES Afonso Lopes Vieira) Brasil (Ensino Médio “Novo Espaço (São Paulo), Escola Nossa Senhora das Graças (São Paulo)).

#### Bulleted list of international programmes and initiatives

- . SCAR EGBAMM (as coordinator of the trophic interactions working group)
- . SCAR Development Council (as member)
- . SCAR Capacity Building, education and Training (as coordinating member)
- . ACM (as Head of delegation of Portugal). UN Southern Ocean Decade (Co-chair of working group 2)

#### Papers 2022-2023

Queirós JP, Machado JF, Pereira E, Bustamante P, Carvalho L, Soares E, Stevens DW, Xavier JC (2023) Antarctic toothfish *Dissostichus mawsoni* as a bioindicator of trace and rare earth elements in the Southern Ocean. *Chemosphere*:138134 DOI: 10.1016/j.chemosphere.2023.138134

Beal M, Catry P, Phillips RA, Opper S, Arnould JP, Bogdanova MI, Bolton M, Carneiro AP, Clatterbuck C, Connors M (2023) Quantifying annual spatial consistency in chick-rearing seabirds to inform important site identification. *Biological Conservation* 281:109994 DOI: 10.1016/j.biocon.2023.109994

Queirós JP, Bartolomé A, Piatkowski U, Xavier JC, Perales-Raya C (2023) Age and growth estimation of Southern Ocean squid *Moroteuthopsis longimana*: can we use beaks collected from predators' stomachs? *Mar Biol* 170:1-15. DOI:10.1007/s00227-022-04156-2

Golikov AV, Ceia FR, Hoving HJ, Queirós JP, Sabirov RM, Blicher ME, Larionova AM, Walkusz W, Zakharov DV, Xavier JC (2022) Life History of the Arctic Squid *Gonatus fabricii* (Cephalopoda: Oegopsida) Reconstructed by Analysis of Individual Ontogenetic Stable Isotopic Trajectories. *Animals* 12:3548. DOI: 10.3390/ani12243548

Xavier JC, Golikov AV, Queirós JP, Perales-Raya C, Rosas-Luis R, Abreu J, Bello G, Bustamante P, Capaz JC, Dimkovikj VH, González AF, Guímaro H, Guerra-Marrero A, Gomes-Pereira JN, Kubodera T,

Laptikhovsky V, Lefkaditou E, Lishchenko F, Luna A, Liu B, Pierce GJ, Pissarra V, Reveillac E, Romanov EV, Rosa R, Roscian M, Rose-Mann L, Rouget I, Sánchez P, Sánchez-Márquez A, Seixas S, Souquet L, Varela J, Vidal EAG, Cherel Y (2022) The significance of cephalopod beaks as a research tool: An update. *Frontiers in Physiology* 13. DOI: 10.3389/fphys.2022.1038064

Xavier, J.C., Phillips, R.A., and Takahashi, A. (2022). "Antarctic seabirds as indicators of climate change," In *Seabird Biodiversity and Human Activities*, eds. J.A. Ramos & L. Pereira. Boca Raton, CRC Press: 189-210. ISBN 1003047521 (book chapter)

Ceia, F.R., Xavier, J.C., Carreiro, A.R., Dos Santos, I., and Cherel, Y. (2022). "Conventional and modern approaches to study seabird trophic ecology and diet" in *Seabird Biodiversity and Human Activities*, eds. J.A.Ramos & L. Pereira. Boca Raton, CRC Press: 19-35. (book chapter)

Reisinger, R.R., Brooks, C.M., Raymond, B., Freer, J.J., Cotté, C., Xavier, J.C., et al. (2022). Predator-derived bioregions in the Southern Ocean: Characteristics, drivers and representation in marine protected areas. *Biological Conservation* 272, 109630. doi: <https://doi.org/10.1016/j.biocon.2022.109630>