1. Name of SRP

Integrated Science to Inform Antarctic and Southern Ocean Conservation (Ant-ICON)

2. Names of Lead Proponents

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3. Sponsoring Scientific Groups

Life Sciences, Physical Sciences, Geological Sciences

4. Summary of duration and budgetary requests

2021-2024 ($120,000) with option to extend to 2025-2028 (budget to be confirmed)

5. Abstract

Antarctic and Southern Ocean environments are facing increasing pressure from multiple threats. At the same time, the Antarctic Treaty System is increasingly looking to SCAR for the provision of independent and objective advice to make informed decisions. The SCAR Scientific Research Programme (SRP) – Ant-ICON – will foster, facilitate and coordinate high-quality transdisciplinary research to inform conservation and management of Antarctica, the Southern Ocean and the sub-Antarctic in the context of current and future impacts. The outputs of this research will address some of the most pressing environmental challenges facing Antarctica, and support decision-making, policy response, policy development and effective environmental management. The initial core membership of Ant-ICON includes 47 members from 19 countries, representing the biological sciences, physical sciences, earth sciences, humanities, social sciences and a range of other Antarctic stakeholders – including policy makers and environmental managers. The makeup of the Ant-ICON Steering Committee will be similar in its diversity, and be finalised in late 2020. While there is a strong biological focus, Ant-ICON will integrate research from multiple disciplines and fields of study to build on and complement existing SCAR activities.

The SRP will focus on three research themes and one synthesis theme:

R1 – Current state and future projections of Antarctic systems, species and functions
R2 – Sustainability and impact mitigation of human activities in the Antarctic region
R3 – Socio-ecological approaches to Antarctic and Southern Ocean conservation

S1 –Science synthesis for decision-making and policy development

Each research theme has key research questions to guide and prioritize targeted research. Outputs from the research themes will inform the deliverables across several core areas of the *Science synthesis for decision-making* theme.

A. Introduction

Antarctic and Southern Ocean environments are facing increasing pressure from multiple threats. The SCAR Scientific Research Programme (SRP) – *Integrated Science to Inform Antarctic and Southern Ocean Conservation* (Ant-ICON) – will foster, facilitate and coordinate high-quality transdisciplinary research to support and inform conservation and management of Antarctica, the Southern Ocean and the sub-Antarctic.

The fundamental role of SCAR in the Antarctic Treaty System (ATS), as the primary provider of independent and objective scientific advice, is increasingly being recognised and utilized[1]. Ant-ICON will be a key provider of outputs to maintain and support this role, with the Committee for Environmental Protection (CEP) and the Scientific Committee for the Conservation of Antarctic Marine Living Resources (SC-CAMLR) being key stakeholders. Research outputs are also likely to be relevant to National Antarctic Programs (NAPs), the Council of Managers of National Antarctic Programs (COMNAP), managers of sub-Antarctic Islands, the International Association of Antarctica Tour Operators (IAATO) and non-governmental organisations (NGOs). Ant-ICON will work closely with the SCAR Standing Committee on the Antarctic Treaty System (SC-ATS) to ensure outputs are provided in a form suitable for policy forums and decision-makers.

The proposed research will build on work conducted under the existing generation of SRPs. Ant-ICON will assess current states, forecast change across multiple temporal and spatial scales, identify at risk species, ecosystems and environments, identify and quantify multiple stressors and threats, and inform the development of practical mitigation strategies. Research outputs will be used to inform contemporary and future decision-making regarding the environmental management of Antarctica, the Southern Ocean and the sub-Antarctic.

Ant-ICON research will complement existing SCAR Groups as well as new initiatives as they develop, including other SRPs. This complementarity will be achieved through cross-membership on Steering Committees, the joint development of key objectives, and the identification of potential synergies and collaborative research.

To address the objectives, Ant-ICON will be structured around three primary research themes (R1-R3), and one synthesis theme (S1):

R1 – Current state and future projections of Antarctic systems, species and functions
R2 – Sustainability and impact mitigation of human activities in the Antarctic region
R3 – Socio-ecological approaches to Antarctic and Southern Ocean conservation

S1 – Science synthesis for decision-making and policy development

Each theme will have key research questions, which will encompass SCAR Horizon Scan questions and other emerging issues that are considered priority research areas by end users, policy makers, the SCAR scientific community or other relevant stakeholders.

The SRP is strongly aligned with the SCAR Strategic Plan 2017-2022. It will:

-   Facilitate high-quality science to underpin SCAR's independent and objective advice
-   Strengthen and expand collaborations across disciplines and geographical boundaries
-   Effectively communicate research and raise public awareness of Antarctic issues

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[1] ATCM XLII SCAR Resolution (Resolution 7(2019)) and 2017 CCAMLR Performance review

- Grow research capacity, through proactive mentoring and targeted support of EMCRs

B. Scientific Approach and Rationale

Antarctica has had a history of unique continent-wide protection, first through the Agreed Measures for the Conservation of Antarctic Fauna and Flora (1964)[2] and more recently under the Protocol on Environmental Protection to the Antarctic Treaty (hereafter the Protocol)[3], which came into force in 1998. The Protocol provides a high level of environmental protection, including through a ban on mineral resource activities (other than for scientific research), a prohibition on the intentional introduction of non-native species, strict regulations on disturbance to native species, waste management controls and environmental impact assessment requirements. However, even under this level of protection, increasing impacts on Antarctic ecosystems have been documented, particularly those near to, or displaced by, high concentrations of human activity (e.g., Braun et al. 2012; Amaro et al. 2015).

The face of Antarctica is rapidly changing as threats increase across the region – primarily from climate change, biological invasions, pollution and the increasing footprint of human activity (Chown et al. 2012; Tin et al. 2013; Amaro et al. 2015; Stark et al. 2015; Lee et al. 2017; Avila et al. 2020; Cárdenas et al., 2020). Construction and operation of research stations are impacting on a wide range of environmental values (Brooks et al. 2019); fisheries are increasing and extending into new areas (Santa Cruz et al. 2018); and a broad-scale decline of wilderness areas has been reported (Leihy et al. in press). Furthermore, recent assessments have shown that conservation trajectories in Antarctica are similar to those occurring globally (Chown et al. 2017).

Here we propose a mechanism to better understand and address these threats and associated impacts with a robust and integrated scientific approach through a new SCAR Scientific Research Programme – Integrated Science to Inform Antarctic and Southern Ocean Conservation (Ant-ICON).

The multidisciplinary breadth of the SCAR research community, together with the mission of SCAR to provide objective independent scientific advice, makes SCAR the ideal, indeed the only, international organization that has the capability to support such an initiative.

The SCAR Strategic Plan and the SCAR Horizon Scan will underpin this scientific approach. Recognizing and mitigating human influences were included in the six top priorities to emerge from the Horizon Scan initiative (Kennicutt et al. 2014, 2015 – see Box 1 for relevant questions). Progress in answering some of these questions has been made through the current suite of SCAR Scientific Research Programmes (and other ongoing SCAR-related initiatives), but many remain unanswered, reinforcing the need for future scientific research on these important questions (Kennicutt et al. 2019).

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[2] Agreed Measures for the Conservation of Antarctic Fauna and Flora. https://ats.aq/e/ep_faflo.htm (1964).
[3] The Protocol on Environmental Protection to the Antarctic Treaty. https://www.ats.aq/e/ep.htm (1991).

Box 1: SCAR Horizon Scan Questions

Q48: Identification of vulnerable ecosystems and food webs

Q49: The impact of future environmental conditions on ecosystem functioning

Q50: Clarifying the synergistic effects of multiple stressors and environmental change drivers on Antarctic and Southern Ocean biota

Q52,53: Better understanding the impact of contaminants and pollutants

Q54,55: Clarifying non-native species pathways and associated impacts

Q56-58: Investigating climate-mediated impacts on Antarctic and Southern Ocean biota

Q75: Identification of the impacts of large-scale, direct human modification of the Antarctic environment

Q80: Better understanding of how diseases and pathogens will impact and adapt to the extreme Antarctic environment

As the end of the current suite of SRPs approaches, it is critical that SCAR develops capacity to build on their foundation with targeted and integrated research to underpin the protection, conservation and management of Antarctica and the Southern Ocean.

Key bodies of the Antarctic Treaty System, including the Committee for Environmental Protection (CEP) and the Scientific Committee for the Conservation of Antarctic Marine Living Resources (SC-CAMLR), will also guide Ant-ICON. These bodies have acknowledged both the importance of using high-quality science to inform decision making and the contribution that SCAR has made, and will continue to make, in this regard[4]. Furthermore, undertakings to make decisions on the basis of the best available science are enshrined in the Protocol (Article 10.1) and CAMLR Convention (Article IX.1 (f)). Ant-ICON will adopt mechanisms that are currently being used, or are in development, by these bodies to help guide research priorities, for example, the CEP Five-year Work Programme[5], the CEP Climate Change Response Work Programme (CCRWP)[6] and the list of CEP science needs[7]. For CCAMLR, guidance will come from both the Scientific Committee and its Working Groups, in particular the Working Group on Ecosystem Monitoring and Management.

In addition, the scientific approach taken by Ant-ICON will be driven by the SCAR science community along with a range of other stakeholders, including NAPs, conservation focussed non-governmental organisations (e.g., the Antarctic and Southern Ocean Coalition - ASOC) and IAATO. This bottom-up approach, in conjunction with the top-down approaches described above, will ensure that emerging issues are captured and used to highlight areas, environments or species that are vulnerable, threatened or in need of management attention. The SCAR science community is a dynamic and productive source of ideas and new, innovative methodologies, many of which are relevant to improving environmental protection and achieving conservation outcomes.

To assist in this community-driven approach, Ant-ICON will encourage and actively facilitate contributions from, and engagement with, all SCAR Science Groups and Standing Committees. Members of all three of these groups actively participated in the Ant-ICON

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[4] ATCM Resolution 7 (2019) acknowledging the importance of SCAR's role in the provision of scientific advice

[5] CEP Five-Year Work Plan https://documents.ats.aq/atcm42/ww/atcm42_ww005_e.pdf

[6] CEP CCRWP https://www.ats.aq/e/committee.html

[7] Working Paper 17, ATCM XLI, Buenos Aires (2018)

Programme Planning Group and will continue to play an important role in the Steering Committee of Ant-ICON (see Section D).
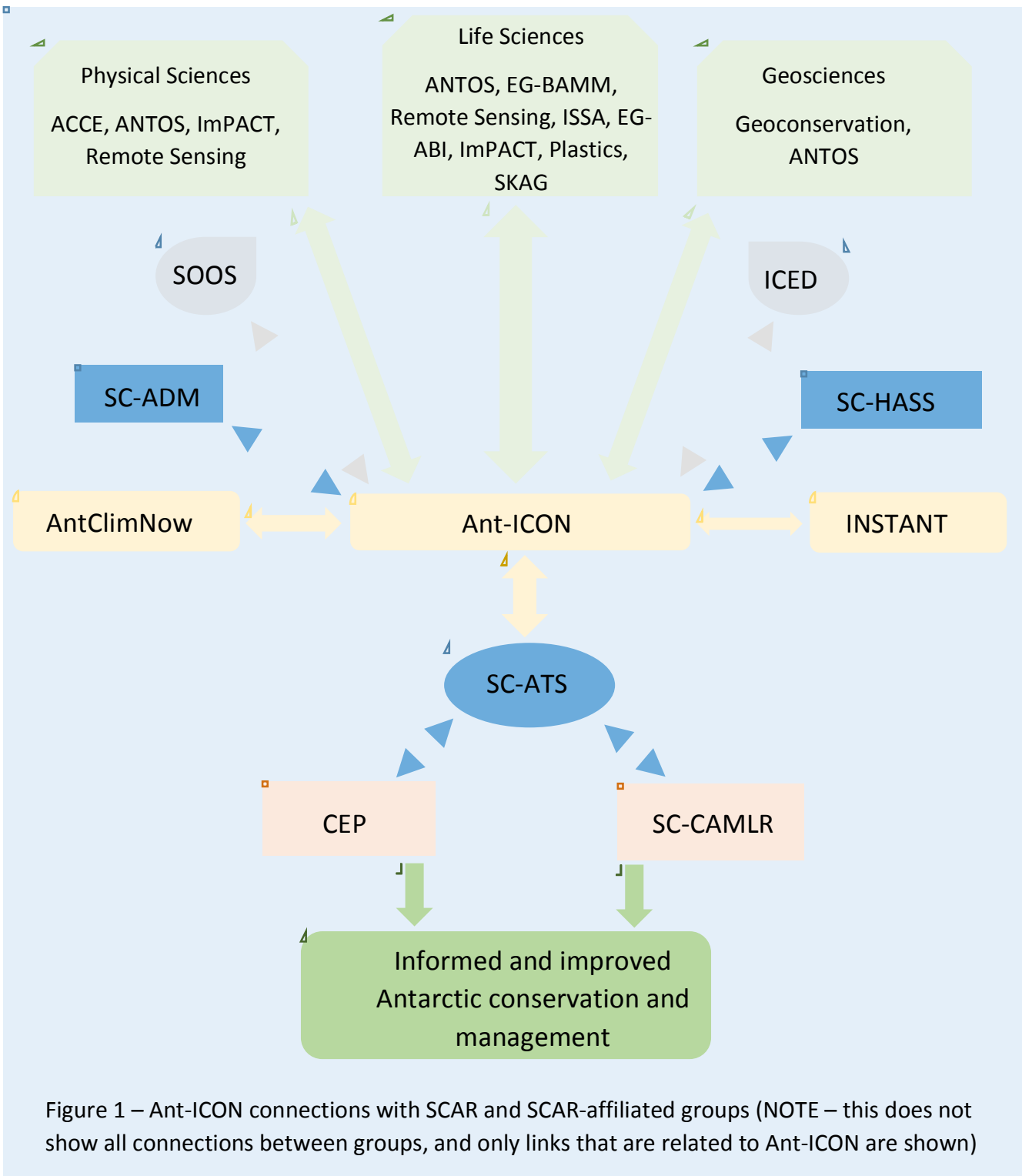

Figure 1 – Ant-ICON connections with SCAR and SCAR-affiliated groups (NOTE – this does not show all connections between groups, and only links that are related to Ant-ICON are shown)

The continued involvement of these groups will facilitate iterative engagement with the SCAR community, with regular communication ensuring that priority and emerging issues are identified, addressed and effectively communicated.

Ant-ICON will be a collaborative and cross-cutting SRP that will not only make a unique contribution to fundamental science but also emphasise, and more importantly, facilitate a strong link to policy, which has been repeatedly called for by both the Antarctic Treaty Parties and the SCAR research community.

Humans play a fundamental role in impacting and managing the Antarctic environment. Therefore, understanding environmental issues in the context of socio-cultural factors, such as environmental values, ethics, justice, economics, law and geopolitics, will be crucial for the successful and effective conservation of the Antarctic environment. In this context, the integration of researchers from the social sciences and humanities is increasingly being recognized as important to achieving conservation outcomes (see, e.g., Nuno et al. 2014; Gruby et al. 2015; Mair et al. 2018; Moon et al. 2019, Yates et al. 2019). This integration is facilitated through the inclusion of a socio-ecological theme as a key element of Ant-ICON.

From a socio-ecological perspective, Ant-ICON will bring together a wide range of researchers from the humanities and social sciences to work with those from the life, physical and earth sciences. Such a union will facilitate our understanding of the interactions between humans and the Antarctic environment and how these interactions shape conservation and management decisions. Ant-ICON will facilitate research on socio-ecological systems as coupled systems of people and nature, where biophysical and socio-cultural factors are irrevocably intertwined (see, e.g., Folke 2006).

Ant-ICON is innovative as it is the first SCAR Research Programme to foster, integrate and coordinate transdisciplinary, conservation-focussed research.

The SRP will also ensure that objectives and outputs complement existing SCAR groups and related initiatives, including Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED), Integrated Science for the Sub-Antarctic (ISSA), the Marine Ecosystem Assessments for the Southern Ocean (MEASO), and Input Pathways of Persistent Organic Pollutants to Antarctica (ImPACT). It is anticipated that the Programme will also have strong links to SCAR-related monitoring groups, including the Southern Ocean Observing System (SOOS – see Newman et al. 2019) and the developing Antarctic and Nearshore and Terrestrial Observing System (ANTOS).

While the Protocol and CAMLR Convention themselves represent the most significant and enduring statements of Parties' commitments to conservation, recent commitments by Parties to protect the Antarctic environment (e.g., the ATCM's Santiago Declaration of 2016 (ATCM XXXIX); the ATCM's Prague Declaration of 2019 (ATCM XLII); CCAMLR Conservation Measure CM 91-04 to establish a network of MPAs) and other initiatives[8] demonstrate and reinforce strong contemporary international will to improve conservation and management across the region. The science facilitated and coordinated by Ant-ICON will not only enable a broader understanding of the diversity and functioning of ecosystems across Antarctica and the Southern Ocean, it will also clarify and quantify the relative levels of risk that Antarctica

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[8] CCAMLR Spatial Planning Workshop (2018), Joint SCAR/CEP Workshop on further developing the Antarctic Protected Area System (2019) and Joint SC-CAMLR-CEP Workshop (2016)

and the Southern Ocean face, to support the Antarctic Treaty Parties and CCAMLR Members in meeting their policy commitments.

Specific research examples could include: work to support the current management, future designation and implementation of Antarctic and Southern Ocean protected areas; input into assessments of and response strategies for threatened species, ecosystems or environments; and monitoring to assess and mitigate anthropogenic impacts. Such research is consistent with the Protocol and the CAMLR Convention and responds to increasing interest from policymakers to incorporate high-quality research in their decision-making, particularly around issues of environmental protection (e.g. Hughes et al. 2018, ATCM Resolution 7 (2019)). Due to the complex and dynamic interactions among the myriad of threats that are facing Antarctica, understanding them, forecasting future states, developing strategies for mitigating impacts and communicating the findings to policymakers and managers will require inputs from a range of disciplines.

A key challenge in informing environmental decision-making is that it often requires long-term commitments that should be designed with future, rather than present, conditions and scenarios in mind. Given that impacts on the Antarctic integrate economic, sociological, climatological and biological processes, even minimally adequate forecasts will require the kind of coordinated research proposed here. To be truly successful, these inputs should not be provided independently, but will need to be integrated through collaborative and transdisciplinary research. Ant-ICON is the mechanism to coordinate, produce and integrate these inputs.

C. Experimental section and methodologies

The Ant-ICON Scientific Research Programme will focus on innovative and high-quality research, underpinned by three research themes, each with a set of key research questions.

Research Theme 1 (R1)[9] – Current state and future projections of Antarctic, Southern Ocean and sub-Antarctic systems, species and functions:

- How vulnerable are the different species, ecosystems and environments?
- How will they change over multiple time scales (years to decades) and spatial scales?
- What are the projected impacts of multiple stressors (e.g., human activities, climate change, non-native species) on Antarctic and Southern Ocean species, ecosystems and environments?
- What are the key change drivers – can tipping points, resilience, thresholds and irreversibility be identified?
- What is the role of Antarctic species/ecosystems and environments in mitigating global change, and how might that change under future projections?

Research Theme 1 will need to take into account cross-biome connections, for example, between the terrestrial, nearshore and pelagic realms, including the sub-Antarctic and

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[9] This research theme and the key research areas will be further developed in conjunction with the other developing SRPs – Instabilities and Thresholds in Antarctica (INSTANT) and Near-term Variability and Prediction of the Antarctic Climate System (AntClimNow).

develop consistent approaches to tracking changes across these biomes (e.g., clarifying the biotic and abiotic relationship between ice-fee areas and nearshore ecosystems and identifying mechanisms that define the vulnerability of species). It will involve spatial and temporal assessments (e.g., species distribution and habitat suitabability models,), integrated forecasting based on in-situ and experimental observations (including climate change impacts on species/ecosystems and physiological responses to climate change) and data from remote sensing and state-of-the-art ecological surveys and experiments.

Research Theme 2 (R2) – Sustainability and impact mitigation of human activities in Antarctica and the Southern Ocean:

- What is the current and projected future extent of human activities (including science, science support, tourism, bioprospecting, and fisheries)?
- What are the primary risks related to these human activities?
- What are the synergistic and cumulative impacts of human activities combined with other change drivers (including climate change) ?
- How can risks and impacts be mitigated?

Research Theme 2 will require monitoring to measure change in established and emerging baselines (in conjunction with R1) and clarify the relationship of this change to key stressors including emerging and increasing infrastructure, human visitation, climate change and non-native species. Ant-ICON will facilitate the development of new bespoke monitoring programs, and will faciliate research to inform and assist existing monitoring programs, including those for Marine Protected Areas. Results of monitoring will be combined with forecasting and projecting risks and impacts through a range of quantitative techniques (including ecosystem assessments, environmental impact assessments, functional response models) and conservation planning tools (such as the implementation of Systematic Conservation Planning frameworks). Through Theme 2 Ant-ICON will coordinate evidence-based research on interacting biophysical and social factors to develop sustainable approaches to managing human activities in Antarctica (including the concept of ecosystem services) and engage with a range of stakeholdersto develop practical mitigation strategies and mechanisms.

The proposed research in both Research Themes 1 and 2 will build on the legacy of previous SCAR Programs (e.g. AnT-ERA, AntClim21 and AntEco) in the spirit of multidisciplinary collaborations outlined in Gutt et al. (2018). Key areas of research from these prevous SRPs, including species abundance and distributions, ecosystem vulnerabilities, non-native species impacts, biogeographical insights, climate predictions and functional responses of species will form an important foundation for much of the research proposed through Ant-ICON.

Research Theme 3 – Socio-ecological approaches to Antarctic and Southern Ocean conservation:

- Taking into consideration socio-ecological connectivity, what are the socio-political and economic impacts and consequences of environmental change in Antarctica?
- What are the characteristics and implications of responsible and ethical governance for Antarctica in the 21st Century?

- What does socio-ecological resilience look like in Antarctica and the Southern Ocean?
- What are the potential implications of global social, health and economic shifts for Antarctic activities?

Research Theme 3 will examine linkages between scientific research and policymaking, develop integrative frameworks on Antarctic ecosystem dynamics and their interactions with management practices and cultural values, investigate the socio-economic implications and cultural dimensions of change and/or management strategies, better understand less tangible values specified in the Protocol (e.g., aesthetic or wilderness), describe and anticipate the drivers of change in socio-ecological systems and clarify the implications of political, economic and socio-cultural changes on current and future activities.

The importance of these research questions and their policy relevance is clear. The research will not only inform and help to directly answer SCAR Horizon Scan questions but is also aligned with the science needs and priorities of the CEP and SC-CAMLR (Section B). The research will also address questions that have been raised regarding the efficacy of environmental management across the region (Shaw et al. 2014; Hughes et al. 2016, Coetzee et al. 2017) and will facilitate the development of systematic conservation planning (e.g., Coetzee et al. 2017) and build on lessons learnt in other parts of the world.

To align with one of SCAR's fundamental roles – the provision of independent and evidence-based advice to the Antarctic Treaty System – Ant-ICON will also include a synthesis theme:

S1 – Science synthesis to inform decision-making and policy development:

- How can science address key Antarctic conservation goals?
- What multiple outputs can be most effectively integrated to inform decision making?
- How can science be used to evaluate decision-making frameworks, management strategies and vulnerability assessments?
- How can we assist in quantifying and dealing with biases and uncertainties in decision-making?
- What are the most effective mechanisms for developing science literacy amongst policymakers and the general public?
- How can science be targeted and communicated to increase uptake by decision makers?

Outputs from this theme can inform, for example, Systematic Conservation Planning, the designation of specially protected species, the designation and management of protected areas, the identification of vulnerable marine ecosystems, and the effective management of human activities. It will also facilitate an improved and more effective communication of published scientific results, prioritization of science inputs and awareness and identification of geopolitical sensitivities.

The SCAR Standing Committee on the Antarctic Treaty System (SC-ATS) is responsible for coordinating the provision of this advice, but the ability of SC-ATS to directly facilitate the research that is required is very limited. As such, there can be a mismatch (both temporally

and in substance) between the research that is required and the advice that can be delivered. Ant-ICON will directly address this deficiency and work closely with SC-ATS, key policy and management entities and other stakeholders to deliver science that will underpin SCAR's advice in the short, medium, and long-term.

A key component of the research planning, coordination and implementation will be transdisciplinary workshops. Workshop ideas will be prioritised by the Steering Committee and supported based on the level of community interest and relevance to Ant-ICON objectives. Ant-ICON will also assist in planning for, and participating in, cross-programme workshops. In particular, discussions will be held with other SRPs (e.g., AntClimNow and INSTANT) and existing initiatives (ICED, ANTOS, SOOS) to help to develop ideas that might be most effectively addressed in a workshop setting and through collaborative initiatives. For example, Ant-ICON will work closely with AntClimNow to develop and utilise short-term, high-resolution climate forecasts for ecological models. In addition to cross –representation on respective Steering Committees, regular virtual meetings will be held to ensure that synergies are identified and outputs integrated wherever possible.

Workshops will typically be associated with major SCAR conferences such as SCAR Open Science Conference, SCAR-Biology, SCAR-Earth Sciences or SC-HASS Conferences. Where possible, travel (and the associated carbon footprint), will be minimised. Remote attendance or web-based meetings will be facilitated and encouraged and will be the primary mechanism for meetings, especially while travel restrictions remain in place. Ant-ICON workshops will have well-defined objectives and outputs and may include practical training to facilitate capacity building. To complement these workshops, the Ant-ICON Steering Committee will propose, organise and convene sessions to align and showcase research themes at each SCAR Conference.

Workshops planned for the first year include i) a programme initiation workshop, with a range of stakeholders (including representatives from the Ant-ICON Steering Committee and policymakers from the CEP and SC-CAMLR) and ii) a cross-SRP workshop, to identify synergies and plan collaborations between the new SRPs.

Following year one, the Ant-ICON Steering Committee will build on and develop ideas and outputs from all Themes, and use these develop workshop ideas. Potential topics that will be considered for inclusion in the broader suite of proposed workshops include: i) the integration of science and associated outputs across geographic boundaries, ii) continent wide data collection, including remote sensing and coordinated surveys, iii) principles and applications of data science, machine-learning and deep-learning, iv) ecosystem services in Antarctica, v) data visualisation and outreach techniques and vi) effective capacity building (in conjunction with APECS).

The participation of EMCR will be supported and encouraged in all workshop initiatives (see also Supporting Material).

In addition to funding workshops, Ant-ICON will use SCAR funding to leverage other resources, including from NAPs that already have existing or developing research in areas aligned with Ant-ICON's key research themes. Ant-ICON will also foster and develop new

collaborations which may include (where appropriate) additional funding. Potential collaborative partners include the tourism industry (e.g., IAATO), non-governmental organisations (e.g., WWF, the Pew Foundation, ASOC), fishing industry bodies (e.g., Association of Responsible Krill Fishers [ARK], Coalition of Legal Toothfish Operators [COLTO]), and philanthropic sources.

D. Management and Reporting

Management

Ant-ICON will be overseen by a Scientific Steering Committee, whose membership will comprise:

- Chief Officers (2)
- Two Deputy Chief Officers (2)
- Theme leaders (8)
- EMCR Theme Leaders (4)
- Delegates from SCAR Scientific Groups (3)
- Delegates from SCAR Standing Groups (3)
- Ex-officio delegates from other SCAR SRPs (2+)
- Communications Officer (1)

The Chief Officers will manage the day-to-day running of Ant-ICON, supported by the Deputy Chief Officers and Theme Leaders. This core group will assess proposals for the use of Ant-ICON funds (e.g., for workshops, travel) and make recommendations to the Steering Committee for approval. Consideration will also be given to including representatives of key SCAR affiliated groups, including ICED and SOOS. Relevant expertise, gender balance, ECMR representation and geographic coverage will be important considerations in the formation of this group. Further details on the proposed makeup of the Steering Committee is provided in the Supporting Materials.

Reporting

Reporting will be both external and internal. Internal communication and reporting will be facilitated through the Ant-ICON mailing list. Transparency will be a fundamental principle of Ant-ICON decision-making, and frequent communication will ensure that members of the Ant-ICON community have regular opportunities to contribute, both in the development and the implementation of ideas and initiatives. A deficiency that has been acknowledged in SCAR SRPs to date is that it is difficult for individuals to identify as part of a SCAR SRP. Ant-ICON will address this by providing a link on the dedicated website (https://scar.org/science/ant-icon/home/) where researchers can sign up to the Ant-ICON programme, while ensuring compliance with local and international rules on data protection and privacy. An up-to-date list of participants will be publicly available and research interests (in conjunction with appropriate consent). Sharing information on research interests and current projects will facilitate a more efficient overview of potential connections and synergies. Researchers will also be able to log their research outputs as

Ant-ICON contributions, increasing international visibility of their work while assisting in the Ant-ICON reporting processes.

External reporting will take the form of annual reporting to the SCAR Executive Committee, and biennial reporting to the SCAR Delegates, detailing progress against milestones, deliverables (outputs and outcomes) and future plans. Regular, targeted reports will be developed for key stakeholders, including the CEP and SC-CAMLR (via SC-ATS) at their annual meetings. Initiative-specific reports will also be submitted to the Steering Committee, for example, at the completion of workshops. All reports will be made available on the Ant-ICON website. Ongoing reporting, in the form of membership statistics and output summaries, will be undertaken through regular updates posted on the Ant-ICON website. More informal reporting will be facilitated by the use of social media (and associated hashtags), including Twitter, Facebook and Instagram. The latter will be facilitated by the designation of an Ant-ICON communications officer to manage communication through these outlets in conjunction with the Steering Committee.

E. Milestones, outcomes, outputs and benefits

Milestones

The primary milestones will be i) the annual report to the SCAR Executive Committee, ii) biennial reports to the SCAR Delegates and a iii) an annual report to SC-ATS at the end of each calendar year, which includes a summary of relevant findings for consideration in submissions to the CEP and SC-CAMLR. The Ant-ICON Steering Committee will work closely with SC-ATS to stay informed of the priorities of key policy representatives, and to ensure submissions are targeted most appropriately and effectively.

Regular publication of results in international peer reviewed journals will also be a key milestone.

The engagement of members will also be assessed as an annual milestone. This could be assessed through coarse metrics such as the number of and diversity of researchers signed up to the Ant-ICON Programme, website visit metrics, and potentially more nuanced metrics of engagement like levels of participation at regular workshops.

Outcomes

The primary objective of Ant-ICON is to improve the protection of Antarctic and Southern Ocean ecosystems, species, and environments based on the best available science and thereby maintain and strengthen SCAR's reputation as the key provider of independent scientific advice to the Antarctic Treaty System.

One of the most effective mechanisms for achieving this outcome is to inform and support policymakers through high-quality science outputs. Ant-ICON recognises the importance of high-quality and up-to-date scientific advice to support policy-making but also acknowledges, anticipates and appreciates the role socio-cultural, economic and political factors play in political decision-making.

Through a recognition of these complex and interrelated factors, Ant-ICON will not only deliver content to support the delivery of scientific advice, but also inform mechanisms to improve its effective delivery.

Ant-ICON will focus on key areas of interest to the CEP and SC-CAMLR and ensure that research is targeted and relevant to policymakers and ultimately that these policymakers are better educated about the relevant, available science. These links will be developed and strengthened through the life of Ant-ICON and manifested through content that will inform the submission of Working Papers, Information Papers and Background Papers to the CEP, SC-CAMLR, CCAMLR Working Groups, as well as through publications on SCAR's Antarctic Environments Portal (www.environments.aq), and other outlets as appropriate.

Outputs

    i)   Primary publications in peer-reviewed journals

Publications in peer-reviewed journals will be a key deliverable for Ant-ICON affiliated researchers, again with a focus on the research themes and key research questions. Ant-ICON will encourage and support collaborations across disciplines and groups to prepare and progress these papers, with members of the Steering Committee playing a key role in establishing and developing such collaborations. The Ant-ICON website will have a mechanism to capture peer-reviewed publications (see above).

    ii)   Submissions to the bodies of the Antarctic Treaty System

Ant-ICON will work closely with SC-ATS to submit a range of Working Papers, Information Papers and Background Papers to the CEP, SC-CAMLR, CCAMLR Working Groups and workshops organised by these bodies. These will be facilitated through an annual Ant-ICON report to SC-ATS, detailing current and developing outputs of interest to key policy stakeholders. Through the Steering Committee, Ant-ICON will work with the other SRPs (INSTANT and AntClimNow) to ensure that where possible, relevant outputs from all SRPs can be included in this reporting.

    iii)   Other reports

Although publications in peer-reviewed journals and submissions to international bodies (as described above) will form the majority of Ant-ICON outputs, other reports and grey literature will be prepared as required. These could take the form of policy-ready summary documents (see also below) or emerging issues syntheses for initiatives such as the Antarctic Environments Portal or reports to NAPs, government bodies or institutions.

    iv)   *Brochures and other PR material*

An Ant-ICON presentation has been prepared and is available for download at https://scar.org/scar-library/search/science-4/research-programmes/ant-icon/5244-ant-icon-overview/

This presentation has already been used to promote Ant-ICON to SCAR Delegates, the SCAR Executive and to attendees of international conferences/workshops that were also attended by Ant-ICON Programme Planning Group members.

Outreach, through the dissemination of accessible scientific summaries, will be a key focus of Ant-ICON's outputs and may include infographics, short videos, online lectures or webinars. A portion of the Ant-ICON budget each year will be allocated to professional services to assist with the production of these materials, and they will be disseminated through the Ant-ICON website and social media outlets as appropriate.

Benefits

The overall benefits of Ant-ICON will be:

- Improved integration of the best available science outputs and policy needs
- Increased level of high-quality research to support decision-making
- A better understanding of threatened and vulnerable systems and species across the Antarctic region
- Increased collaborations both within and between disciplines
- Improved integration of socio-ecological research
- Increased research capacity, particularly through the practical training and mentorship of EMCRs

All of these will contribute to improved conservation and management of Antarctica, the Southern Ocean, and the sub-Antarctic.

An important aspiration of Ant-ICON will be to encourage and support the involvement of a diversity of scientists (including a range of nationalities and experience) in research that contributes to decision-making in the ATS. This can be addressed at different levels, including by mentoring young researchers, by identifying strengths and weaknesses of NAPs and helping to increase capabilities based on common interests and understanding.

F. Data Management Plan

Ant-ICON will proactively encourage the development and application of good data curation and propagation practices. Authors of Ant-ICON-supported products will be required to develop a data management plan from the onset of their activities and deposit both metadata and new data/spatial layers into exis ting repositories. These could include the SCAR Antarctic Biodiversity Portal (biodiversity.aq), the 'Omics Links in Arctic-Antarctic-Alpine (A3) Research (POLA$_3$R), the Antarctic Genetics Archive (AGAR), the SCAR Biodiversity Database, SOOS Map, and the Data Centres of NAPs. In line with the current SCAR data Policy a copy of the metadata will also be made available in the Antarctic Master Directory. This will be facilitated through regular interaction with SCAR's Standing Committee on Antarctic Data Management (SC-ADM), which will be represented on the Ant-ICON Steering Committee. Given the interdisciplinary nature of the SRP, other appropriate data repositories will be identified as required.

To ensure efficient long-term data management, the FAIR principles will be followed where possible (Wilkinson et al. 2016), ensuring that research data are *Findable, Accessible, Interoperable and Reproducible*. Biological material will be deposited in public repositories, such as museums and public culture collections wherever possible.

Through SC-ATS, new data will be made available to both the CEP and SC-CAMLR in accessible and user-friendly formats (e.g., through a short video summary or infographics).

G. Inclusion, capacity building, education and training plan

Ant-ICON will actively provide opportunities to early-and mid-career researchers and researchers from developing countries in the development and implementation of research, activities, and in leadership roles, including on the Ant-ICON Steering Committee. Ant-ICON will take advantage of existing well-established networks of junior scientists (e.g., the Association of Polar Early Career Researchers [APECS]) to ensure EMCRs are aware of these opportunities. These networks will also be used to ensure that the emerging cohorts of up-and-coming scientists are not only aware of, but excited by, the research priorities of Ant-ICON and the opportunities that are available through collaborations within the Ant-ICON network.

Policy meetings differ greatly from scientific meetings. While high-quality science can provide the foundation for strong management decisions, it must be communicated effectively. Ant-ICON will deliver both cutting-edge research and novel perspectives on its transmission tp policymakers. To communicate these to a wide audience, Ant-ICON will run workshops or symposia at SCAR meetings on the ATS and the means by which science can be used to inform policy, thereby widening the number of scientists aware of key policy mechanisms and how they can contribute.

Senior Ant-ICON leaders will encourage and proactively assist early-career researchers to make important contributions to Ant-ICON, through the provision of opportunities for engagement and mentorship. Where possible, they will facilitate the presentation of EMCR work to major policy bodies, such as the CEP and CCAMLR. Through the synthesis theme (S1), Ant-ICON will develop specific mentorship opportunities for EMCRs who are interested in facilitating the transition from research results to policy, in particular with regard to science to inform decision-making in the CEP and SC-CAMLR. In conjunction with SC-ATS and the SCAR Executive Committee, mechanisms for the potential inclusion of EMCRs on SCAR Delegations to ATCM/CEP Meetings will be explored, including the provision of funding to support participation. Ant-ICON will also support SCAR and CCAMLR fellowship recipients by providing links to relevant research groups and researchers from SCAR.

SCAR is committed to promoting the incorporation of Antarctic science in education at all levels. Ant-ICON will encourage (together with APECS where appropriate) the education of school students through Polar Educators International (PEI) who aim to highlight and share the global relevance of the polar regions with the broader community.

Through Ant-ICON, SCAR will benefit from an inclusive and collaborative research programme, which will proactively cooperate with the SCAR Capacity Building, Education and Training (CBET) Advisory Group to support training plans for students and researchers that enhance national scientific capacities, especially in countries with developing Antarctic programmes. Where possible, these capacity building initiatives will be developed in collaboration with other SRPs to maximise reach and the efficient use of SCAR resources.

In conjunction with the Steering Committee, the Communications Officer will facilitate outreach and education through different social media accounts (e.g., Twitter, Facebook, and Instagram), including the dissemination of images and video from field work and events such as workshops and training courses. Ant-ICON will also develop and share infographics of publications. The dissemination of material will also be targeted to other key stakeholders (e.g., IAATO; NGOs). Ant-ICON will budget for and host webinars and produce training or educational videos and guides to increase education and outreach within and beyond the SCAR community.

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Supporting Information

i.   Leadership Group

Chief Officers

Dr Mercedes Santos is a Research Scientist in the Top Predators Department of the Instituto Antártico Argentino. Her research interests focus on penguin population dynamics and the conservation of the Southern Ocean, particularly on marine spatial planning and socio-ecological systems. https://www.cancilleria.gob.ar/es/iniciativas/dna/instituto-antartico-argentino/nuestro-personal/santos-maria-mercedes

Dr Aleks Terauds is a Principal Research Scientist with the Australian Antarctic Division. He leads research across a range of taxa and biomes, with a focus on spatial ecology and developing and delivering the scientific foundation for spatial management and environmental protection in Antarctica. http://www.antarctica.gov.au/science/meet-our-scientists/dr-aleks-terauds

Deputy Chief Officers

Dr Alvaro Soutullo served as Director of Scientific Coordination and Environmental Management at the Instituto Antártico Uruguayo from September 2016 to April 2020 and teaches several postgraduate programs at the University of the Republic (Uruguay). His research interests include biodiversity conservation, ecosystem services and conservation planning.

Prof Bettine van Vuuren is Head of the Department of Zoology, University of Johannesburg and Director - Centre for Ecological Genomics and Wildlife Conservation. Her research focuses on molecular ecology and understanding genetic patterns and their drivers across spatial scales.

Theme Leaders

R1: **Dr Heather Lynch** is the Institute for Advanced Computational Sciences Endowed Chair for Ecology & Evolution at Stony Brook University. Her research focus on the distribution and abundance of Antarctic wildlife and the development of survey methods integrating computer vision and satellite imagery. www.lynchlab.com

R2. **Dr Kevin Hughes** is the Environmental Research and Monitoring Manager at the British Antarctic Survey and has broad research and policy interests including non-native species, pollution, area protection, environmental impact assessment and expansion of human footprint.

R2. Dr Adrian Howkins teaches Environmental History at the University of Bristol and is co PI on the McMurdo Dry Valleys LTER .

R2: **Dr Jasmine Lee** (EMCR) is a postdoctoral researcher at Monash University in Melbourne interested in understanding and mitigating threatening processes in the Antarctic.

R3: **Dr Daniela Liggett** is a senior lecturer in the School of Earth and Environment at the University of Canterbury, New Zealand. Her research interests include the governance of human activities in the Antarctic and Southern Ocean and the complex and dynamic linkages between science and policy.

S1: **Dr Hyoung Chul Shin**, a biological oceanographer by training, has broad interests in polar science and policy connections, including management of marine living resources. He has served in various capacities in relation to the Antarctic Treaty, CCAMLR, COMNAP and SCAR.

S1: **Dr Neil Gilbert** has worked on Polar issues in various roles for over 30 years attending numerous meetings of the Antarctic Treaty including the CEP and CCAMLR. Neil is currently leading an Expert Group on the science-policy interface as part of New Zealand's Antarctic Science Platform.

Note that these are indicative at this stage. Theme Leader positions and representatives from Scientific and Standing Groups are still under discussion and will be finalized by late 2020.

ii. Justification for SCAR Sponsorship

Ant-ICON seeks to facilitate and coordinate high quality science to inform the conservation and management of Antarctic through transdisciplinary collaborations. This is the first time a programme of this nature has attempted to bring together such a diverse range of researchers across such a range of disciplines. The multidisciplinary breadth of the SCAR research community, together with the mission of SCAR to provide objective independent scientific advice, makes SCAR the ideal, indeed the only, international organization that has the capability to support such an initiative.

Increasing variability in the Antarctic environment and the associated ecosystem impacts mean that many National Antarctic Programs have prioritised studies that relate to conservation and management. The alignment of the Ant-ICON research themes and key priorities with those of National Programs (see below) means that the seed funding provided by SCAR will greatly assist in leveraging support from larger funding sources to achieve common objectives.

Funding Ant-ICON will provide SCAR with focused resources to assist in the delivery of high quality scientific advice through an inclusive and diverse SRP that involves researchers from a wide range of countries with a clear focus on capacity building, gender equity and increased opportunities for young scientists.

iii. International involvement and partnerships

The geographic spread of the Programme Planning Group (47 Members from 19 countries – Appendix 1) represents strong evidence of the international commitment to the science proposed under Ant-ICON. The objectives of Ant-ICON are aligned with research priorities and objectives of numerous National Antarctic Programs and mutual connections between Ant-ICON and these programmes will provide unparalleled opportunities to facilitate partnerships between these organisations and value add to proposed collaborations. Potential collaborations and areas of alignment between researchers, their institutions and Ant-ICON are already under discussion. This alignment will allow Ant-ICON to develop broad collaborations across multiple countries and research programmes.

There is also strong alignment between recent, large (multi-million dollar) Antarctic focussed research grants and the objectives of Ant-ICON. Two specific examples include the recently funded Australian Special Research Initiative – Securing Antarctica's Environmental Future and the New Zealand Antarctic Science Platform. Ant-ICON will have representatives on both of these Programmes, through Chief Officer Aleks Terauds and nominated Theme Leaders Neil Gilbert and Daniela Liggett. Common representation of this nature will facilitate the identification of synergies and collaborative outputs. These are only two specific examples and other, similar opportunities will be identified and developed in year one of Ant-ICON's implementation.

Other potential partnerships, including with SCAR Groups, NGOs, and industry and policy makers are detailed in the Science and Implementation Plan (Section C)

iv.   Budget justification (see Section C for other potential funding sources)

The below budget is formulated in the shadow of considerable uncertainty around the potential for international travel, particularly in 2021 and 2022. The cost in brackets represents the lower bound if international travel has not resumed to normal levels and remains restricted. While we have noted these potential reductions, we would like to reserve the opportunity to redirect some of these funds to other areas if this eventuates.

Workshop costs includes venue, catering, remote access, and travel support for leadership group members from countries with less developed Antarctic Programs and EMCRs. Broad details of workshops are provided below with more details provided in Sections C of the Science and Implementation Plan.

One of our key capacity building initiatives is to fund a scholarship each year for an active Ant-ICON EMCR to join the SCAR Delegation to CEP/ATCM and/or CCAMLR. We would like the SCAR Capacity Building, Education and Training Group (CBET) to consider matching this contribution each year to facilitate the participation of an EMCR in both meetings. To support Ant-ICONs commitment to improving inclusion and diversity in Antarctic science, we intend to fund targeted support for groups that have been identified as previously or currently disadvantaged. This support has been identified in the below budget, but the exact nature has not been specified, and will be finalised by the Steering Committee. Potential examples include small grant research support for mid-career women and travel support for researchers from countries with less developed Antarctic Programs.

Due to funding uncertainty, no budget for 2025-2028 has been provided, but Ant-ICON will seek an extension for funding over this period with similar allocations.

Year	Activity	Budget allocation (USD)
2021	Workshop 1 (Ant-ICON Programme Initiation: planning and implementation) combine with SCAR Biological Symposium	$10,000 ($5,000)
	Targeted stakeholder engagement (IAATO, COMNAP, NGOs)	$2,000
	Ant-ICON science - policy EMCR scholarship	$6,000 ($3,000)
	Workshop 2 – Cross SRP linkages and outputs	$10,000 ($5,000)
	Outreach (infographics, webinars, online learning/lectures)	$2,000
	TOTAL 2021	**$30,000 ($17,000)**
2022	Workshop 3 (cross-theme) – combine with SCAR OSC	$14,000 ($7,000)
	Targeted ravel support to attend SCAR OSC (4 * $2K)	$8,000 ($4,000)
	Ant-ICON science – policy EMCR scholarship	$6,000 ($3,000)
	Outreach (infographics, webinars)	$2,000
	Total 2022	**$30,000 ($16,000)**
2023	Workshop 4 (cross-theme)	$13,000
	Ant-ICON science - policy EMCR scholarship	$6,000
	Outreach (infographics, webinars, online learning/lectures)	$2,000
	Targeted research support grants (3 * $3K)	$9,000
	Total 2023	**$30,000**
2024	Workshop 5 (wrap up and synthesis of first 4 years) combine with SCAR OSC	$10,000
	Ant-ICON science - policy EMCR scholarship	$6,000
	Travel support for EMCR researchers to attend SCAR OSC (5*$1K)	$5,000
	Workshop 6 (Cross-SRP workshop with AntClimNow)	$5,000

	Outreach (infographics, webinars, online learning/lectures)	$4,000
	Total 2024	**$30,000**
	TOTAL (2021-2024)	**$120,000 ($93,000)**

Appendix 1 – Programme Planning Group

Name	Country	Discipline/focus
Aleks Terauds	Australia	Quantitative ecology (CO)
Alvaro Soutullo	Uruguay	Marine/Terrestrial ecology
Andres Barbosa	Spain	Marine/terrestrial ecophysiology
Andrew Lowther	Norway	Marine ecology
Annick Wilmotte	Belgium	Terrestrial biodiversity and ecology
Anton van de Putte	Belgium	Data (SCADM, biodiversity.aq)
Antonio Quesada	Spain	Terrestrial ecology
Bettine van Vuuren	South Africa	Terrestrial Ecology
Cassandra Brooks	USA	Marine ecology and policy
Cath Waller	United Kingdom	Intertidal/nearshore ecology
Charlene Guillaumot *	France	Quantitative Ecology
Charlotte Havermans*	Germany	Marine Ecology
Christina Braun *	Germany	Terrestrial ecology
Conxita Avila	Spain	Marine Ecology
Craig Cary	New Zealand	Terrestrial ecology
Daniela Liggett	New Zealand	Social sciences and humanities
Diana Wall	USA	Terrestrial ecology
Elle Leane	Australia	Social sciences and humanities
Fraser Morgan	New Zealand	Terrestrial ecology
Gabriela Mataloni	Argentina	Terrestrial biodiversity and ecology
George Watters	USA	Fisheries
Heather Lynch	USA	Quantitative ecology
Hyoung Chul Shin	South Korea	Biological oceanography
Huw Griffiths	United Kingdom	Marine ecology
Jasmine Lee *	Australia	Terrestrial ecology
Jeronimo Lopez-Martinez	Spain	Geology
Juan Salazar	Australia	Social sciences and humanities
Justine Shaw	Australia	Terrestrial ecology
Kevin Hughes	United Kingdom	Terrestrial ecology and policy
Luis Pertierra *	Spain	Terrestrial ecology
Luis Valentin Ferrada	Chile	Antarctic policy/international Law
Luiz Rosa	Brazil	Microbiology
Manuela Bassoi	Brazil	Marine ecology
Marcelo Regeuro	Argentina	Earth sciences
Mecha Santos	Argentina	Marine ecology (CO)
MegumuTsujimoto *	Japan	Terrestrial ecology
Nadine Johnston	United Kingdom	Marine ecology
Neil Gilbert	New Zealand	Antarctic policy
Pete Convey	United Kingdom	Terrestrial Ecology
Phillipe Koubbi	France	Marine Ecology
Prabir G Dastidar	India	Behaviour/network analysis
Ryan Reisinger *	South Africa	Marine Ecology

Sergey Kakareka	Belarus	Terrestrial ecology and human impacts
Stefano Schiaparelli	Italy	Marine biodiversity and ecology
Thomas Saucede	France	Marine ecology
Tom Bracegirdle	United Kingdom	Physical sciences
Yan Ropert-Coudert	France	Marine ecology

* = early mid-career researcher