

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

4 years (\$160,000) + 4 years (\$160,000)

5. Abstract (250 word limit)

Antarctica 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 change impacts. The outputs of this research will address some of the most pressing environmental challenges facing Antarctica, and support decision-making, policy response and development and effective environmental management. The initial core membership of Ant-ICON includes 45 members from 18 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 proposed Chief Officers of the SRP will be finalised in 2019. 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

The three research themes each have key research questions to prioritize targeted research. Outputs from the research themes will inform and guide the sub-themes and deliverables of the *Science synthesis for decision-making* theme.

A. Introduction

Antarctica 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 conservation and management of Antarctica, the Southern Ocean and the sub-Antarctic in the context of current and future change impacts.

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 utilized¹. Ant-ICON will be a central mechanism in maintaining and supporting 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 end users. Research outputs are also likely to be relevant to National Programs, the Council of Managers of National Antarctic Programs (COMNAP), the International Association of Antarctic Tour Operators (IAATO) and non-governmental organisations (NGOs).

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 vulnerable species, ecosystems and environments; quantify 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 the new 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 3 primary research themes (R1-R3), and one synthesis theme (S1), which will coordinate outputs for policy forums and decision-makers:

- 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 to inform 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 key 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
- Grow research capacity, through proactive mentoring of early-to-mid-career researchers.

¹ ATCM XLII SCAR Resolution (Resolution G 2019) and 2017 CCAMLR Performance review

B. Scientific Approach and Rationale

Antarctica has had a history of unique continent-wide protection, first through the Agreed Measures for Conservation of Antarctic Flora and Fauna (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, impacts on Antarctic ecosystems have been documented, particularly those near 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). 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. 2019). 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 inform 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. 2015 – see Box 1 for specific 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.

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

² Agreed Measures for Conservation of Antarctic Flora and Fauna. 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

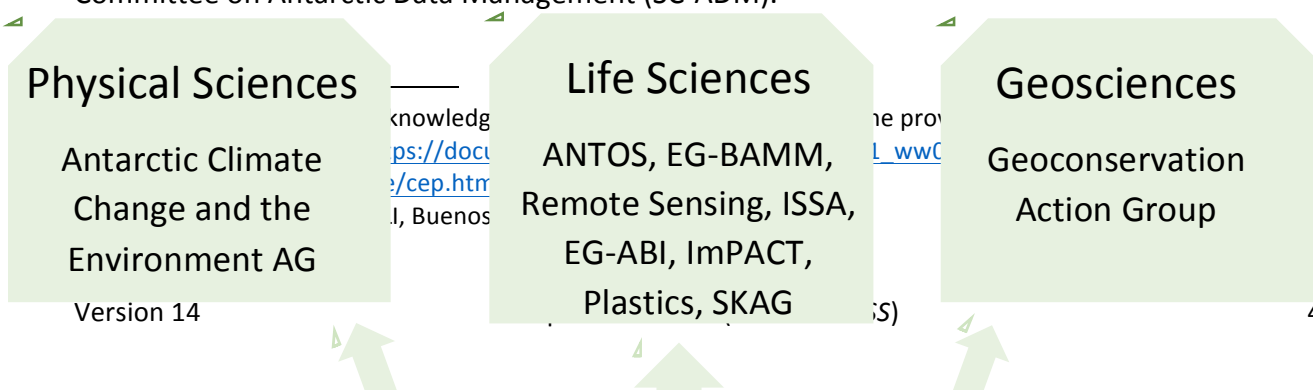
Q80: Better understanding of how diseases and pathogens change, will impact and adapt to the extreme Antarctic environment

come from both the Scientific Committee and its Working Groups, in particular the Working Group on Ecosystem Monitoring and Management.

The third mechanism for informing the scientific approach for Ant-ICON is the SCAR science community and other stakeholders, including National Antarctic Programs, conservation focussed non-governmental organisations (e.g. the Antarctic and Southern Ocean Coalition) and the International Association of Antarctica Tour Operators (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. In particular, the SCAR science community is a dynamic and productive source of ideas, 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, including the Standing Committee on the Antarctic Treaty System (SC-ATS), the Standing Committee on the Humanities and Social Sciences (SC-HASS) and the Standing Committee on Antarctic Data Management (SC-ADM).

The 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 and will continue to make in this regard⁴. Furthermore, undertakings to make decisions on the basis of the best available science are enshrined in the Environmental 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 guide research priorities. For example, the CEP Five-year Work Programme⁵, the CEP Climate Change Response Work Programme⁶ (CCRWP) and the list of CEP science needs⁷. For CCAMLR, guidance will



Members of all three of these groups have been included in the Ant-ICON Programme Planning Group and will play an important role in the Steering Committee of Ant-ICON. This will facilitate iterative engagement with the Standing Committees, with regular communication ensuring that priority and emerging issues are identified, addressed and effectively communicated.

Ant-ICON will be a collaborative and cross-cutting Programme 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 and geopolitics, will be crucial for the successful 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 (e.g. see Nuno et al. 2014; Gruby et al. 2015; Mair et al. 2018; Moon et al. 2019, Yates et al. 2019). This integration requires 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 social-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 the 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 Environmental 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 Santiago Declaration ATCM XL; the Prague Declaration ATCM XLII; CCAMLR Conservation Measure CM 91-04 to establish a network of MPAs at CCAMLR) and other initiatives⁸ demonstrate and reinforce

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)

strong contemporary international will to improve conservation and management across the region. The science facilitated and coordinated by Ant-ICON will not only increase broader understanding of the diversity of ecosystems across Antarctica and the Southern Ocean, it will clarify and quantify the relative levels of risk that Antarctica and the Southern Ocean face, to support the Antarctic Treaty Parties and CCAMLR Members in meeting their policy commitments.

Examples of this work could include: research to support the current management and future designation of Antarctic and Southern Ocean protected areas; input into assessments of and response strategies for threatened species, ecosystems or environments; and monitoring to evaluate, assess, and mitigate anthropogenic impacts. Such an approach is consistent with the Protocol and the CAMLR Convention, and responds to increasing interest from policy makers to incorporate high-quality research in their decision-making, particularly around issues of environmental protection (e.g. Hughes et al. 2018, ATCM XLII Resolution 2019). Due to the complex and dynamic interactions among the myriad of threats that are facing Antarctica, understanding them, forecasting future states and developing strategies for mitigating impacts 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 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 (1.5 pages)

The Ant-ICON Scientific Research Programme will focus on innovative and high-quality research, underpinned by three overarching 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:

- What and where are the most vulnerable species, ecosystems and environments?
- How will they change over multiple time scales (years to decades) and spatial scales?
- What are the primary projected impacts of multiple stressors on Antarctic and Southern Ocean species, ecosystems and environments?
- What are the key change drivers – can tipping points, resilience, thresholds and irreversibility be identified?

⁹ This research theme and the key research areas will be developed in conjunction with the other developing SRPs – Antarctic Ice Dynamics and Sea Level Change (ACCSL) and Near-term Variability and Prediction of the Antarctic Climate System (AntClim^{now}).

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. It will involve spatial and temporal assessments, integrated forecasting, and data from remote sensing and on-ground surveys.

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

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

Research Theme 2 will require monitoring to establish baselines (in conjunction with R1) and measure change, forecasting and projecting risks and impacts through a range of quantitative techniques (including ecosystem assessments, models and conservation planning tools), evidence-based research on interacting biophysical and social factors to develop sustainable approaches to managing human activities in Antarctica and engaging with a range of stakeholders to develop practical mitigation strategies and mechanisms.

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

- Taking into consideration social-ecological connectivity, what are the social impacts and consequences of environmental change in Antarctica?
- What are the characteristics and implications of responsible and ethical governance for Antarctica 21st Century?
- What does social-ecological resilience look like in Antarctica and the Southern Ocean?
- What are the potential implications of global 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 (e.g. aesthetic or wilderness), describe and anticipate the drivers of social-ecological systems change and clarify the implications of 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, Coetsee et al. 2017) and will facilitate the development of systematic conservation planning (e.g. Coetsee et al. 2017) and build on lessons learnt in other parts of the world.

To align with one of SCAR 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 policy-makers and the general public?

Outputs from this theme could inform (for example): Systematic Conservation Planning, designation of specially protected species and areas, identification of vulnerable marine ecosystems, and the effective management of human activities. It will also require the 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 is responsible for coordinating the provision of this advice, but the ability of this committee 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 and key end-users to deliver science that will be 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 called for, prioritised by the Steering Committee and supported based on the level of community interest and relevance to Ant-ICON objectives. A limited amount of travel support will be offered to participants, particularly Early and Mid Career Researchers. Ant-ICON will also assist in planning for, and participating in, cross-programme workshops. In particular, discussions will be held with other (potential) SRPs (e.g. AntClim^{now} and AISSL) and existing initiatives (ICED, ANTOS, SOOS) to help develop ideas that might be most effectively addressed in a workshop setting. For example, Ant-ICON will work closely with AntClim^{now} to develop and utilise short term, high resolution climate forecasts for ecological models. Where possible, such workshops will be aligned with major conferences or events to minimise travel (and the associated carbon footprint). Remote attendance or web-based meetings will also be facilitated and encouraged.

In addition to funding workshops, Ant-ICON will use SCAR funding to leverage other resources, including from National Antarctic Programs that already have existing or developing research in areas that are aligned with the 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. the International Association of Antarctica Tour Operators), non-governmental organisations (e.g. WWF, the Pew Foundation), potentially fishery industry bodies (e.g. Association of Responsible Krill Fishers – ARK , Coalition of Legal Toothfish Operators – COLTO) and philanthropic sources.

D – Management and Reporting (1 page)

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 (4)
- EMCR Deputy 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 (EMCR) (1)

The Chief Officers will manage the day-to-day running of Ant-ICON, supported by the Deputy Chief Officers and Theme Leaders as required. 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. Relevant expertise, gender balance, ECMR representation and geographic coverage will be key considerations in the formation of this group.

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 key 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 the difficulty 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. An up-to-date list of participants will be publicly available, including their contact details and research interests. The sign-up process will include details of research interests and current projects to allow an 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 process.

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, deliverable (outputs and outcomes) and future plans. Regular, targeted reports will be developed for key end-users, including the CEP and SC-CAMLR 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, including Twitter, Facebook and Instagram. The latter will be facilitated by the designation of an Ant-ICON communications officers (preferably an EMCR), to manage the ongoing communication through these outlets, in conjunction with the Steering Committee.

E – Milestones, outcomes, outputs and benefits (1.5 pages)

Milestones

The primary milestones will be the annual report to the SCAR Executive Committee, biennial reports to the SCAR Delegates and a submission of key findings to SC-ATS at the end of each calendar year, for consideration as a submission to the CEP. The Ant-ICON Steering Committee will work closely with SC-ATS to stay informed of the priorities of key policy representatives, to ensure submission 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 regular workshops with high levels of participation.

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 policy making through high-quality science inputs. 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 focus on key areas of interest to the CEP and SC-CAMLR, Ant-ICON will ensure that its research is targeted and relevant to policy makers and ultimately that these policy makers 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 the Antarctic Environments Portal (www.environments.aq) and other forums as appropriate.

Outputs

i) Primary publications in peer-reviewed journals

Publications in peer-reviewed journals will be a key deliverable of Ant-ICON, again with a focus on the overarching research questions and research themes detailed above. 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 and National Delegations (where appropriate) to submit a range of Working Papers, Information Papers and Background Papers to the CEP, SC-CAMLR, CCAMLR Working Groups and workshop organised by these bodies.

iii) Workshops and conferences

Workshops will be an important focus of the Ant-ICON scientific programme each year. These will typically be associated with major SCAR conferences such as SCAR Open Science Conference, SCAR-Biology or SC-HASS Conferences. Ant-ICON workshops will typically have well-defined objectives and associated output(s). In addition to workshops, the Ant-ICON Steering Committee will propose, organise and convene sessions at each SCAR Conference that are aligned with the research themes.

iv) Other reports

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

v) *Brochures and other PR material*

An Ant-ICON presentation has been prepared and is available for download at <https://scar.org/science/ant-ikon/resources/>

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

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 region
- Increased collaborations both within and between disciplines
- Improved integration of socio-ecological research
- Increased research capacity, particularly through the mentorship of EMCRs

All of these 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 scientists from a broad range of countries in research that contributes to decision-making in the Antarctic Treaty System. This can be addressed at different levels, including by mentoring young researchers, by identifying strengths and weaknesses of national programs and helping to increase capabilities based on common interests and understanding.

G - Capacity building, education and training plan

Ant-ICON will actively provide opportunities to early- and mid-career researchers in the development and implementation of research, activities and in leadership roles. Ant-ICON will take advantage of the 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. New and challenging perspectives will assist in identifying new opportunities for progress to be made. Ant-ICON will run workshops at SCAR meetings about the ATS and the means by which science can be used to inform policy, thereby widening the number of scientists aware of the policy mechanisms and how they can contribute.

Senior Ant-ICON leaders will encourage and proactively assist early-career researchers to make important contribution to Ant-ICON outputs, through the provision of opportunities for engagement and mentorship. Where possible, they will facilitate the presentation of ECR work to major policy bodies, such as the CEP and CCAMLR. Through the synthetic theme (S1) Ant-ICON will develop specific mentorship opportunities for early-mid career researchers who are interested in facilitating the transition from research results to policy change, in particular with regard to science to inform decision-making in the CEP and SC-CAMLR. 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 education through Polar Educators International who aim to highlight and share the global relevance of the polar regions with the broader community.

Ant-ICON and SCAR will benefit from an inclusive and cooperative research programme. Through actively cooperation with SCAR Capacity Building, Education and Training (CBET) Advisory Group, Ant-ICON will support training plans that raise national scientific capacities, especially in developing countries.

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 encouraged to provide both metadata and new data/spatial layers into existing repositories, in particular biodiversity.aq, the Microbial Antarctic Resource System (MARS), Antarctic Genetics Archive (AGAR), SCAR Biodiversity Database, SOOS Map, and the Data Centres of National Programs. This will be facilitated through regular interaction with the Standing Committee on Antarctic Data Management (SCADM) and the Expert Group on Antarctic Biodiversity Informatics (EG-ABI). Given the interdisciplinary nature of the Programme, other appropriate data repositories will be identified.

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

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 URL).

G – References

Amaro, E. et al. (2015) Assessing trace element contamination in Fildes Peninsula (King George Island) and Ardley Island, Antarctic. *Mar. Pollut. Bull.* 97: 523–527.

Braun, C., Mustafa, O., Nordt, A., Pfeiffer, S., Peter H-U (2012) Environmental monitoring and management proposals for the Fildes Region, King George Island, Antarctica. *Polar Research* 31(1): 18206.

Brooks, C.M. (2013) Competing values on the Antarctic high seas: CCAMLR and the challenge of marine-protected areas. *Polar J.* 3:277-300.

Brooks, S. T., Jabour, J., Van Den Hoff, J., & Bergstrom, D. M. (2019). Our footprint on Antarctica competes with nature for rare ice-free land. *Nature Sustainability*, 1.

Chown, S. L. et al. (2012) Challenges to the Future Conservation of the Antarctic. *Science.* 337: 158–159.

Chown, S. L. et al. (2017) Antarctica and the strategic plan for biodiversity. *PLoS Biol.* 15: e2001656.

Coetzee, B. W. et al. (2017). Expanding the protected area network in Antarctica is urgent and readily achievable. *Conservation Letters* 10: 670-680.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global environmental change*, 16(3): 253-267.

Gruby, R. L., Gray, N. J., Campbell, L. M., & Acton, L. (2016). Toward a social science research agenda for large marine protected areas. *Conservation Letters* 9(3): 153-163.

Holdgate, M. W. (1998) The Antarctic protected areas system in the new Millennium. in *Antarctic Protected Areas Workshop* (ed. Njåsted, B.) Norsk Polarinstitutt Rapportserie

Hughes, K. A. et al. (2016). Assessing the effectiveness of specially protected areas for conservation of Antarctica's botanical diversity. *Conservation Biology* 30: 113-120.

Hughes, K. A. et al. (2018) Antarctic environmental protection: Strengthening the links between science and governance. *Environmental Science & Policy*, 83: 86-95.

Kennicutt, M. C. et al. (2014). Six priorities for Antarctic science. *Nature* 512: 23-25.

Kennicutt, M. C., Chown, S. L., Cassano, J. J., Liggett, D., Peck, L. S., Massom, R., ... & Allison, I. (2015). A roadmap for Antarctic and Southern Ocean science for the next two decades and beyond. *Antarctic Science*, 27(1): 3-18.

Lee, J. R. et al. (2017) Climate change drives expansion of Antarctic ice-free habitat. *Nature* 547: 49–54.

Leihy, RI, Coetzee, BWT, Morgan, F., Raymond, B, Shaw, J., Terauds, A, and Chown, SL (Preprint) Antarctic's wilderness has declined to the exclusion of its biodiversity. *bioRxiv Preprint*
doi: <https://doi.org/10.1101/527010>

Mair, L., Mill, A. C., Robertson, P. A., Rushton, S. P., Shirley, M. D., Rodriguez, J. P., & McGowan, P. J. (2018). The contribution of scientific research to conservation planning. *Biological conservation* 223: 82-96.

Newman, L., Heil, P., Trebilco, R., Katsumata, K., Constable, A.J., van Wijk, E., Assmann, K., Beja, J., Bricher, P., Coleman, R. and Costa, D., 2019. Delivering sustained, coordinated and integrated observations of the Southern Ocean for global impact. *Frontiers in Marine Science*, 6:433.

Nuno, A., N. Bunnefeld, and E. Milner-Gulland. 2014. Managing social–ecological systems under uncertainty: implementation in the real world. *Ecology and Society* **19**(2): 52.
<http://dx.doi.org/10.5751/ES-06490-190252>

Pertierra, L. R. & Hughes, K. A. (2013) Management of Antarctic Specially Protected Areas: permitting, visitation and information exchange practices. *Antarct. Sci.* 25: 553–564.

Santa Cruz, F. et al. (2018) Spatial and temporal dynamics of the Antarctic krill fishery in fishing hotspots in the Bransfield Strait and South Shetland Islands. *Fisheries Research* 208: 157-166.

Shaw, J. D. et al. (2014). Antarctica's protected areas are inadequate, unrepresentative, and at risk. *PLoS Biology* 12(6): e1001888.

Stark, J. S. et al. (2015) Physical, chemical, biological and ecotoxicological properties of wastewater discharged from Davis Station, Antarctica. *Cold Reg. Sci. Technol.* 113: 52–62.

Wilkinson, M.D., Dumontier, M., Aalbersberg, I.J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.W., da Silva Santos, L.B., Bourne, P.E. and Bouwman, J. (2016) The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3.

Yates, K. L., Clarke, B., & Thurstan, R. H. (2019). Purpose vs performance: What does marine protected area success look like? *Environmental Science & Policy*, 92: 76-86.

Appendix 1 Membership of Ant-ICON 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 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 Àvila	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 ecology
George Watters	USA	Fisheries
Heather Lynch	USA	Quantitative ecology
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)
Megumu Tsujimoto *	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	Behavior/network analysis
Ryan Reisinger *	South Africa	Marine Ecology
Sergey Kakareka	Belarus	Terrestrial impacts

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Thomas Saucedo	France	Marine ecology
Tom Bracegirdle	United Kingdom	Physical sciences
Yan Ropert-Coudert	France	Marine ecology

* = early mid-career
researcher