

# Working Group report

Progress Report, 13 September 2021

**WG number : 3**

**Targeted Societal Outcome : Sustainably Productive Ocean**

**WG chair(s) : Javier A. Arata**

**Ocean Decade Definition of the Outcome :** The ocean is the foundation for future global economic development and human health and wellbeing, including food security and secure livelihoods for hundreds of millions of the world's poorest people. Knowledge and tools to support the recovery of wild fish stocks, deploy sustainable fisheries management practices, and support the sustainable expansion of aquaculture, while protecting essential biodiversity and ecosystems, will be essential. The ocean also provides essential goods and services to a wide range of established and emerging industries including extractive industries, energy, tourism, transport and pharmaceutical industries. Each of these sectors has specific, priority needs in terms of increased knowledge, and support to innovation, technological development and decision support tools to minimize risk, avoid lasting harm, and optimize their contribution to the development of a sustainable ocean economy. Governments also require information and tools, for example via national accounts that incorporate ocean indicators, to guide development of sustainable ocean economies and promote marine sectors.

## References:

- 1st SOUTHERN OCEAN REGIONAL WORKSHOP, 16 February 2020, San Diego, CA USA. Prepared by E Hofmann, L Biddle, T de Bruin, C Brooks, S Corney, A Haumann, N Johnston, M Mazloff, E Murphy, C Reiss, J Russell, H Rosenthal, E Sikes  
➔ 30 participants, representing 11 countries
- Southern Ocean Task force [2021] Review of identified priorities for the Southern Ocean in the context of the UN Ocean Decade 2021. DOI: 10.5281/zenodo.4784227

## Background information:

- UNESCO-IOC (2021). The United Nations Decade of Ocean Science for Sustainable Development (2021-2030) Implementation Plan. UNESCO, Paris (IOC Ocean Decade Series, 20.)

## **Priorities Identified during the previous workshop:**

- I. Increase the suite, types and reliability of measurements, including those focused on ecosystem change, needed to inform management and policy
  - Identify and develop relevant ecological indicators to evaluate risks to the Southern Ocean and services it provides, and to monitor health and rates of ecosystem change and its interactions with human activities
  - Improve the understanding of the consequences of human-induced change on polar ecosystem services
  - Create guidelines for sustainable monitoring and regular assessments that enable us to assess our progress towards the desired states
    - Determine what principles are required to utilize data from ecosystem monitoring programmes as part of management
  - Improve our understanding of key mechanisms regulating the ecosystem in the winter
  - Assess how much ecosystem services of the Southern Ocean ecosystem contribute to a global budget, and whether they will change in space and time
  
- II. Achieve sustainable management of fisheries based on an ecosystem approach, including the recovery of overexploited species and the effect of climate change on ecosystems.
  - Improve understanding of fish stock sustainability and resilience integrating data on oceanographic, climate, ecosystem and harvesting interactions
  - Identify new methods to effectively integrate both quantitative and qualitative data, fill critical data gaps, and analyse the likely effects of crossing thresholds that are likely to be irreversible in the near term
  - Develop integrated stock assessments which take into consideration the ecosystem where the fishery operates.
  - Identify thresholds or abrupt or irreversible changes
  - Functional connectivity (in all cardinal directions)
  - Develop recovery strategy plans for overexploited species, considering the ecological role and current and future status of the ecosystem (which may affect their realized recovery abundance)
  - Understand the role of Myctophidae for consumers, producers and as an extractable resource
  - Understand the role of Mackerel icefish for consumers, producers and as an extractable resource
  - Improve knowledge on Antarctic krill's resilience to climate change.
  - Get a mechanistic understanding of seasonal krill flux in relation to currents, bottom topography and endogenous control via geophysical forcing.
  - Develop an integrated, spatially explicit, stock-recruitment population model for Antarctic krill
  
- III. Ensure science-based and effective spatial planning process, including MPAs, with consideration of sustainable fisheries management and tourism development
  - Assess the success of existing Southern Ocean Marine Protected Areas in meeting their conservation objectives, including as scientific reference areas, and determine additional requirements for the achievement of regional conservation and research objectives

- Develop a framework for effective Southern Ocean spatial planning, including new MPAs, considering effects on ecosystem processes and resource extraction, historical changes and future projections on species distribution, and climate-driven change
  - Develop informed strategies for management adaptation and conservation priorities at different time-scales
  - Develop a framework to assess responsible and sustainable marine transport and tourism industries, in harmony with the spatial planning of the Southern Ocean
    - Investigate how transport and other marine activities can be developed to avoid disturbing current and future functions of marine protected areas
    - Identify what social, such as..., and environmental risks cruise ships and infrastructure development pose
    - Determine the scope for consistent and dedicated monitoring of tourism impacts, particularly at highly visited sites
- IV. Ensure a sustainably harvested and productive Southern Ocean by working towards a stronger interface between science, industry and policy
- Determine how the complexity and uncertainty in our understanding of the functioning of these ecosystems should be reflected in the preparation and delivery of management advice
  - Assess the need for sustainable resource utilization in light of changing environments and expanding human needs
  - Determine how the Southern Ocean can contribute to blue growth and a low carbon energy transition
  - Investigate what ways research and policy can effectively tackle the whole extraction cycle, from exploration to the final stage of closure of operations, and related remediation and reclamation activities
  - Identify the institutional, political and practical obstacles to adopting and implementing ecosystem-based management on a larger scale
  - Assess how external pressures and changes in the geopolitical configurations of power affect Antarctic governance and science
  - Knowledge enabling Antarctic operators to be leading contributors in developing a responsible strategy for, achieving economic gains with sustainable solutions and inclusive benefit from a green economy
  - Understand the science behind stock assessments of active fisheries, particularly 'research' fisheries in data poor areas, how the science can be improved (toothfish, icefish, krill - inclusion of climate change models? feedback management?), and what the management response should be if a fishery is found to be depleted or unsustainable. [move to Actions]

**Identify regional challenges that need to be overcome to achieve Southern Ocean priorities ([cfr report](#)) over the next 10 years in the context of your appointed Societal Outcome.**

- I. Increase the suite, types and reliability of measurements, including those focused on ecosystem change, needed to inform management and policy

*Research challenges (purely scientific)*

- *Challenge R1:* Identify and develop relevant ecological indicators to evaluate risks to the Southern Ocean and services it provides, and to monitor health and rates of ecosystem change and its interactions with human activities
  - R1.1. Identify key indicators for each particular ecosystem (trophic web) where the target species participate in, including the spatial and temporal scale at which the indicators must be measured. [Action: workshop]
  - R1.2. Develop predictive models of the target ecosystem (communities/trophic web)
  - R1.3. Assess the status of the indicators and evaluate the current, past and future states of the target ecosystems (communities/trophic web)
  - R1.4. Develop benchmarks to assess the health of target ecosystems.
  - R1.5. Identify and assess the ecosystem services provided by the Southern Ocean [cross-cutting] [WG2] [Action: workshop]
  - R1.6. Assess the status of the ecosystem services and evaluate the current, past and future states of key services provided by the Southern Ocean [cross-cutting] [WG2]
- *Challenge R2:* Improve the understanding of the consequences of human-induced change on polar ecosystem services
  - R2.1. Develop and integrate relevant approaches to explore life history of exploited species and its interactions with environmental dynamics and human activities
  - R2.2. Identify key approaches to reveal and monitor key life history processes of target species
  - R2.3. Develop new technologies, able to intergrate with existing ones, to improve the understanding of life history of target species and its responses to the changing habitats [Action: workshop]
  - R2.4. Develop predicitive models to help explain the habitat suitability of target species and its contribution to the structure and function of target ecosystems described in Challenge R1. [Action: workshop]
  - R2.5. Assess the impacts of human activities on sustainability of target species
  - R2.6. Develop models that incorporate direct and indirect impacts of human activities to inform decision making and the evaluation of management strategies
  - R2.7. Understand cumulative effects and extended causal relationships that play out over temporal and spatial scales, particularly interactions between people and nature
  - R2.8. Better knowledge of the effects of operations on natural and social environments???, with a focus on integrated effects, involving different environmental and social factors
- *Challenge R3:* Create guidelines for sustainable monitoring and regular assessments that enable us to assess our progress towards the desired states
  - R3.1. Determine what principles are required to utilize data from ecosystem monitoring programmes as part of management
- *Challenge R4:* Improve our understanding of key mechanisms regulating the ecosystem in the winter

- R3.1. lack essential information on zooplankton biology, trends, and how seasonal sea-ice influences these patterns and the ecosystem as a whole.
- *Challenge R5:* Assess how much ecosystem services of the Southern Ocean ecosystem contribute to a global budget, and whether they will change in space and time

*Logistical and technical challenges (funding, infrastructure, data accessibility, etc.)*

- *Challenge L1: Funding*
  - L1.1. Long-term funding of existing programs
  - L1.2. Need to increase the sampling sites, particularly in remote areas to cover a range of environmental conditions
  - L1.3. Funding, including in-kind from responsible operators, to access sampling sites
  - L1.4. Funding of workshops, symposia, and similar
  - L1.5. Funding of new technological development
- *Challenge L2:* Need to coordinate across multiple national-run programs and incorporate vessels of opportunity from various industries that operate in the southern ocean (i.e. fishing vessels, tourism vessels)
- *Challenge L3: Technical*
  - L3.1. Maintain year-round (and high resolution data) sampling sites, while providing prompt delivery of data and samples
  - L3.2. Develop new generation of remote data sensors and ... [cross-cutting] [WG6]
  - L3.3. Develop a reliable and affordable network for data transfer
- *Challenge L4:* Generate a specific platform to identify key data gaps by compiling existing observations for different spatial and temporal scales
  - L4.1. Using the knowledge in L3 to drive conversations with engineering and polar operations experts to identify how best overcome current limitations
  - L4.2. Instigating a community wide, co-ordinated effort to design year-round sampling operations which takes advantage of new marine technology.
  - L4.3. Identify the best use to get benefit in using commercial (touristic, industrial) boat to expand sampling regions (in the time and space)
  - L4.4. Create a Mooring networking to coordinate at international level the deployment and recovering of moored platforms
- *Challenge L5:* Data accessibility outside respective management organisations
  - L5.1. Develop protocols for data access and sharing [cross-cutting] [WG6]

*Uptake challenges (effective communication between stakeholders, engaging the public)*

- *Challenge U1:* Agree with partners which data gaps are most urgent and most feasible to address
  - U1.1 Gain experience from Arctic management of resource
- *Challenge U2:* Bring on expertise from other disciplines
- *Challenge U3:*

Identify tangible actions that would be able to address these challenges. Delineate the scope of suggested actions (leading organization, involved stakeholders, funding, timeline, implementation).

*Action 1.1*

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               | Southern Ocean Decade Funding Program  |
| <b>Related challenge</b>            | ALL  |
| <b>Short description</b>            | Exploring different funding agencies to launch national and multinational funding programs in support of the SO Decade |
| <b>Key stakeholders to consider</b> | National Funding Agencies, EU Agencies, International Cooperation Agencies,  |
| <b>Timeline</b>                     | 2022-2023  |
| <b>Potential resources</b>          |  |
| <b>Other comments</b>               |  |

*Action 1.2*

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               | Workshop to Identify and Develop relevant ecological indicators to evaluate risks to the Southern Ocean and services it provides             |
| <b>Related challenge</b>            | R1, L1.1, L1.2, L1.3, L2, L3.1, L4.2, L4.3, L4.4, U1, U2   |
| <b>Short description</b>            | Initial WS to assemble existing capacities, identify relevant indicators, knowledge, and technological gaps, and set a roadmap to develop R1 |
| <b>Key stakeholders to consider</b> | Coordinators of monitoring programs, such as CEMP, LTERs; ICED, SOOS (modelers);   |
| <b>Timeline</b>                     | 2022   |
| <b>Potential resources</b>          |  |
| <b>Other comments</b>               |  |

*Action 1.3*

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               | xx   |
| <b>Related challenge</b>            | R4, R5, L1.1, L1.2, L1.4, L2, L3, L4, U1, U2   |
| <b>Short description</b>            | Generate a Framework providing recommendations for the design of future sampling operations  |
| <b>Key stakeholders to consider</b> | Commission for the Conservation of Marine Living Resources (CCAMLR), the Polar Data Centre, the Southern Ocean Observing System (SOOS), the Integrated Climate and Ecosystem Dynamics (ICED) modelling community, National |

|                            |                    |
|----------------------------|--------------------|
|                            | Antarctic Programs |
| <b>Timeline</b>            | 2022-2023          |
| <b>Potential resources</b> |                    |
| <b>Other comments</b>      |                    |

#### Action I.4

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               | Regional Model Integration   |
| <b>Related challenge</b>            | R1.2, R2.4, R4, R5, R6, L1, L3.2, L4, L5, U2   |
| <b>Short description</b>            | Progress in most sectors of Antarctica has been made in developing some degree of Minimally Realistic Models (ROMS NPZD, EwE, Atlantis, qualitative networks etc). Formalizing and connecting these models (even if only qualitatively) to provide a start-point for considering circum-Antarctic connectivity and linkages north of the SO boundary are going to be needed to stimulate conversations about characterising knowledge gaps and giving policy the ability to evoke the precautionary approach to management where needed. |
| <b>Key stakeholders to consider</b> | SOOS (as good as any to define the geography of each regional MRM). SCAR SRP's (draw in research groups that are «inwardly focussed' on their own regions). ICED (technical integration).  |
| <b>Timeline</b>                     | 2022-2030. This initiative will be an ongoing / never-ending process. Goal should be a « straw man » model before the end of the decade.   |
| <b>Potential resources</b>          | Regional funding (ERC / NSF scale)   |
| <b>Other comments</b>               |  |

#### Action I.5

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               |   |
| <b>Related challenge</b>            | R1, L4,   |
| <b>Short description</b>            | Mega project to address R1                                |
| <b>Key stakeholders to consider</b> |   |
| <b>Timeline</b>                     | 2023-2030.  |
| <b>Potential resources</b>          | Regional funding (ERC / NSF scale), Multinational Funding |
| <b>Other comments</b>               |   |

### Action 1.6

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               |   |
| <b>Related challenge</b>            | R1, R2, L4,   |
| <b>Short description</b>            | Mega project to address R2                                |
| <b>Key stakeholders to consider</b> |   |
| <b>Timeline</b>                     | 2023-2030.  |
| <b>Potential resources</b>          | Regional funding (ERC / NSF scale), Multinational Funding |
| <b>Other comments</b>               |   |

### Action 1.7

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               | Summit to Assess the past and future contribution of the SO to the global budget |
| <b>Related challenge</b>            | R1.6, R2.5, R5, L1, L5, U2   |
| <b>Short description</b>            | Cross-cutting WS   |
| <b>Key stakeholders to consider</b> |  |
| <b>Timeline</b>                     | 2028-2029  |
| <b>Potential resources</b>          |  |
| <b>Other comments</b>               |  |

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**Describe already-existing activities and stakeholders who are presently working towards resolving these challenges.**

|                             |   |
|-----------------------------|---|
| <b>Name of Action</b>       | Due South   |
| <b>Related challenge</b>    | L2  |
| <b>Short description</b>    | SOOS /initiative to share and coordinate surveys. |
| <b>Leading organisation</b> |   |
| <b>Key stakeholders</b>     |   |
| <b>Timeline</b>             |   |
| <b>Resources</b>            |   |
| <b>Other comments</b>       |   |

Rank suggested actions in order of priority while taking into account feasibility and timeline. The highest ranking actions will be included in the Southern Ocean Action Plan and will most likely require additional notes.

| Order of priority | Action number & name |
|-------------------|----------------------|
| 1                 | ex: Action 2         |
| 2                 |                      |
| 3                 |                      |
| ...               |                      |

- II. Achieve sustainable management of fisheries based on an ecosystem approach, including the recovery of overexploited species and the effect of climate change on ecosystems

#### *The krill fishery*

The Southern Ocean is the one of the last almost pristine environments. In the pelagic realm at the Peninsula, the ongoing environmental changes (warming, ice-loss) are accompanied by large biomass shifts of the most important microzooplankton grazers in the Southern Ocean Antarctic Krill (*Euphausia superba*) and Salps (*Salpa thompsoni*). On the other hand, cetacean populations are currently recovering (10% increase of humpbacks and 2-8% increase of Antarctic blue whales over the past decade) and rely almost exclusively on krill as food source. We have only started to comprehend how this shift in key organisms impacts the ecosystem structure and functioning with emphasis on the effectiveness of the biological carbon pump in terms of carbon sequestration of the Southern Ocean, which is one of the most important carbon sinks on our planet. The effect of sea-ice changes on cryo-pelagic coupling, especially on krill, is still poorly constrained. In addition, economic interests in terms of fisheries and tourism are steadily increasing at the Peninsula and pose a threat not only to cetacean, but to all secondary consumers in the krill-based food web.

#### *The toothfish fisheries*

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**Identify tangible actions that would be able to address these challenges. Delineate the scope of suggested actions (leading organization, involved stakeholders, funding, timeline, implementation).**

#### *Research challenges (purely scientific)*

- *Challenge R1:* Improve understanding of fish stock sustainability and resilience integrating data on oceanographic, climate, ecosystem and harvesting interactions
  - R1.1. Determine spatial and temporal relationship between spawning and recruitment sections of the stocks, for all exploited species
  - R1.2. Develop a timely, responsive strategy for estimating stock distribution, abundance and connectivity
  - R1.3. Develop multispecies model, including effect of key environmental drivers, to assess fish stock sustainability
- *Challenge R2:* Identify new methods to effectively integrate both quantitative and qualitative data, identify critical data gaps, and analyse the likely effects of crossing thresholds that are likely to be irreversible in the near term
  - R2.1. Estimate the long-term effects of fishing on the trophic web structure and functioning; in particular, the effect of reducing target stocks to 50% or 75% of B<sub>0</sub> (as per CCAMLR targets)
- *Challenge R3:* Develop integrated stock assessments which take into consideration the ecosystem where the fishery operates
  - R3.1. multispecies
  - R3.2. Spatial planning
  - R3.3. Ecosystem change
- *Challenge R4:* Identify thresholds or abrupt or irreversible changes
  - R3.1. Estimate impacts of ongoing climate change on exploited species and the ecosystem they depend upon
  - R3.2. Develop predictive models to assess ecosystem change [cross-cutting] [WG3-R1] [WG2]

- *Challenge R6*: Functional connectivity (in all cardinal directions) [move to Priority II ?]
- *Challenge R5*: Develop recovery strategy plans for overexploited species, considering the ecological role and current and future status of the ecosystem (which may affect their realized recovery abundance)
  - R4.1. Determine the effects of past removal of whales on food web structure and functioning, and estimate the effect of their incipient recovery
  - R4.2. Determine the effects of past overfishing (i.e., icefish and Nototheniid species) on food web structure and functioning, and estimate the effect of their potential recovery
- *Challenge R6*: Understand the role of myctophidae for consumers, producers and as an extractable resource
- *Challenge R7*: Understand the role of Mackerel icefish for consumers, producers and as an extractable resource

*Priorities specific to Antarctic krill*: Krill is a key species in - drive the functional biodiversity of - and is the target species of the largest fishery in tonnage caught in the Southern Ocean. Up to now, we have almost no knowledge on krill's resilience to climate change, which is a prerequisite to make reliable predictions of krill population shifts under different climate change scenarios in the future (according to IPCC predictions). The following process studies on krill are needed to generate appropriate data, embedded in individual and ecosystem models to understand population shifts of krill that is important for krill fishery management decisions.

- *Challenge R8*: Improve knowledge on Antarctic krill's resilience to climate change.
  - R8.1. To assess the resilience of krill to climate change we have to understand first how basic life function traits (reproduction, lipid accumulation, growth etc.) are controlled by geophysical cycles (photoperiod -, tide - and lunar cycle), which will not shift in a changing environment. It is established that krill has an endogenous clock but our molecular understanding how this clock mediate physiological functions and behaviour via geophysical cycle is far from clear
- *Challenge R9*: Get a mechanistic understanding of seasonal krill flux in relation to currents, bottom topography and endogenous control via geophysical forcing.
  - R9.1. Relate process orientated studies to long-term seasonal data from the field such as obtained from gliders
- *Challenge R10*: Develop an integrated, spatially explicit, stock-recruitment population model for Antarctic krill
  - R10.1. Unravel the control on recruitment success
  - R10.2. Investigate if only a small part of the population is responsible for replenishing the krill stock (as long-term data on krill sex and ontogenetic stage distribution assume).

*Logistical and technical challenges (funding, infrastructure, data accessibility, etc.)*

- *Challenge L1*: Obtaining and securing long-term funding for collecting key variables.
  - L1.1. Cross-national funding opportunities
  - L1.1b. Ensure long-term funding of existing programs and develop [EU-programs] for organismic studies in the Southern Ocean
  - L1.2. Access costs for logistics to conduct research

- *Challenge L2: Securing ship-time for conducting surveys, including ships of opportunity such as fishing and tourism industry vessels.*
    - L2.2. Need to increase temporal coverage to seasons other than summer.
  - *Challenge L3: Improve international collaboration on logistics, such as platform-sharing*
    - L3.1. Improve alternatives/availability of platforms for deployment and retrieving of sensors, dunes, mooring, gliders, etc.
  - *Challenge L4: Develop methods and techniques for remote collection of data and near-real time data delivery.*
  - *Challenge L5: Develop data-sharing protocols that foster cooperation between different stakeholders, and official (government) and non-official (universities) scientists.*
    - L5.1. Data accessibility outside respective management organisations
  - *Challenge L6: Priorities specific to Antarctic krill*
    - L6.1. Develop a network of Antarctic stations to implement process studies on krill in Antarctica
    - L6.2. Develop programs to get funding for field work at Antarctic Stations
    - L6.3. Develop an infrastructure to perform scientific work on krill fishing vessels
- Uptake challenges (effective communication between stakeholders, engaging the public)*
- *Challenge U1: Achieve an open, nurturing discussions between different stakeholders, within an interdisciplinary and inter-cultural environment [securing gender, racial and economic inclusion]*
  - *Challenge U2: Engage constructively and iteratively with policy-makers at all stages of the research, with a focus on the existing and likely future threats to target ecosystems*
  - *Challenge U3: Disentangle science from management.*
  - *Challenge U4: Need to collide existing information and identify data gaps, including the incorporation of new experts into the discussion*
  - *Challenge U5: Develop Decision Support Tools (DSTs). Key challenges for their implementation include the logistics of operating and maintaining the continuous delivery of information [Technical or Communication challenge?]*
  - *Challenge U6: Improve collaboration with RFMO and national fisheries managers (EEZ) adjacent to CCAMLR area.*
  - *Challenge U7: Engage business operators in the collection of long time series of ecosystem monitoring data. These should be utilised to their maximum and expanded with greater spatial coverage, engaging operators in using mobile, comparative, and complimentary measurement platforms.*
  - *Challenge U8: Priorities specific to Antarctic krill*
    - U8.1. Coordinate communication between scientist working on collecting long-term data via gliders and scientists focusing on process-oriented studies
    - U8.2. Effective communication between scientist and fishery regarding data collection (to close knowledge gaps)

Identify tangible actions that would be able to address these challenges. Delineate the scope of suggested actions (leading organisation, involved stakeholders, funding, timeline, implementation).

#### Action I.1

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               | Develop coordinated, multinational, funding programs                        |
| <b>Related challenge</b>            | ALL   |
| <b>Short description</b>            |   |
| <b>Key stakeholders to consider</b> | National Funding Agencies, EU Agencies, International Cooperation Agencies, |
| <b>Timeline</b>                     | 2022-2023   |
| <b>Potential resources</b>          |   |
| <b>Other comments</b>               |   |

#### Action II.2

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               | WS to develop responsive sampling strategy for Antarctic krill   |
| <b>Related challenge</b>            | R1.2, R8, R9, L1, L2, L3, L5, U7, U8   |
| <b>Short description</b>            | Initial Workshop to assemble existing capacities, identify relevant indicators, knowledge, and technological gaps, and set the decade's roadmap. |
| <b>Key stakeholders to consider</b> | National Programs with current research on krill, SKAG, CCAMLR, ARK, IAATO   |
| <b>Timeline</b>                     | 2022   |
| <b>Potential resources</b>          |  |
| <b>Other comments</b>               |  |

#### Action II.3

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               | WS to develop <i>in situ</i> experimental krill research  |
| <b>Related challenge</b>            | R7, L1, L5, U8  |
| <b>Short description</b>            | Initial Workshop to assemble existing capacities, identify relevant indicators, knowledge, and technological gaps, and set the decade's roadmap |
| <b>Key stakeholders to consider</b> | CCAMLR members states who have the infrastructure for experimental krill work, fishery, krill scientists  |
| <b>Timeline</b>                     | One year (2022)   |

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|----------------------------|--|
| <b>Potential resources</b> |  |
| <b>Other comments</b>      |  |

#### Action II.4

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               | Data Limited Fisheries Working Group  |
| <b>Related challenge</b>            | R1, R2, R3, L4, U5  |
| <b>Short description</b>            | There is considerable experience in data limited fisheries science and management that resides outside the typical CCAMLR arena. None of the other key science bodies in the Southern Ocean (SCAR, SOOS, ICED etc) focus on fisheries management. <u>A dedicated Working Group of fisheries scientists to be established to provide advice into existing management bodies would provide an inlet for external science and integration across geographic boundaries (i.e. between RFMO and CCAMLR).</u> |
| <b>Key stakeholders to consider</b> | Initial outreach through RFMO and national fisheries research organisations to collate key individuals / groups.  |
| <b>Timeline</b>                     | Should be started in line with Action #1, to ensure functional connectivity is incorporated into data limited fisheries science.  |
| <b>Potential resources</b>          | Regional funding (ERC / NSF scale)  |
| <b>Other comments</b>               |   |

#### Action II.5

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               | Myctophidae fisheries research Working Group  |
| <b>Related challenge</b>            | R6, U5, (III)U3   |
| <b>Short description</b>            | Coarse biomass estimates of Myctophidae in the SO are an order of magnitude greater than for Antarctic krill, yet very little is known about their basic role within the foodweb. Fisheries techniques under development to harvest myctophids are likely to be trawl-based, and once the economic hurdles to extraction are overcome, there will likely be calls to develop exploratory fisheries for them. Mapping the functional role of myctophids to the rest of the foodweb, as well as understanding their movement and distribution in time and space (seasonality, hotspots, etc) will be a prerequisite to such exploratory fisheries being approved. <u>Developing a WG to synthesise and direct myctophid fisheries-related research in the SO</u> would provide a focal point for responsible management authorities in the SO (CCAMLR, EEZ national managers, etc). |
| <b>Key stakeholders to consider</b> | RFMO, nation-states with trawl fisheries, SCAR, CCAMLR.   |

|                            |   |
|----------------------------|---|
| <b>Timeline</b>            | Should be started in line with Action #1, to ensure a key marine biomass and potential resource is fully considered in developing sustainable management options. |
| <b>Potential resources</b> | Regional funding (ERC / NSF scale)  |
| <b>Other comments</b>      |   |

*Action II.6*

...

**Describe already-existing activities and stakeholders who are presently working towards resolving these challenges.**

|                             |  |
|-----------------------------|--|
| <b>Name of Action</b>       | Science-Industry Forum                       |
| <b>Related challenge</b>    | R1.1, R1.2, L2, L5.3, U1, U7, U8.2           |
| <b>Short description</b>    | Communication between scientists and fishery |
| <b>Leading organisation</b> | SKAG, ARK, CCAMLR                            |
| <b>Key stakeholders</b>     | CCAMLR members, scientist, fishery           |
| <b>Timeline</b>             | One year (start)                             |
| <b>Resources</b>            |  |
| <b>Other comments</b>       |  |

**Rank suggested actions in order of priority while taking into account feasibility and timeline. The highest ranking actions will be included in the Southern Ocean Action Plan and will most likely require additional notes.**

|                          |                      |
|--------------------------|----------------------|
| <b>Order of priority</b> | Action number & name |
| <b>1</b>                 | ex: Action 2         |
| <b>2</b>                 |                      |
| <b>3</b>                 |                      |
| <b>...</b>               |                      |

- III. Ensure science-based and effective spatial planning process, including MPAs, with consideration of sustainable fisheries management and tourism development

*Research challenges (purely scientific)*

- *Challenge R1:* Assess the success of existing Southern Ocean Marine Protected Areas in meeting their conservation objectives, including as scientific references areas, and determine additional requirements for the achievement of regional conservation and research objectives
- *Challenge R2:* Develop a framework for an effective Southern Ocean spatial planning, including new MPAs, considering effects on ecosystem processes and resource extraction, historical changes and future projections on species distribution, and climate-driven change.
- *Challenge R3:* Develop informed strategies for management adaptation and conservation priorities at different time-scales
- R3b. Identify mechanisms to harmonise Southern Ocean conservation priorities [across ATS, CCAMLR, IWC, ...]
- *Challenge R4:* Develop a framework to assess responsible and sustainable marine transport and tourism industries, in harmony with the spatial planning of the Southern Ocean
  - R4.1. Investigate how transport and other marine activities can be developed to avoid disturbing current and future functions of marine protected areas
  - R4.2. Identify what social (eg., ) and environmental risks cruise ships and infrastructure development pose
  - R4.3. Determine the scope for consistent and dedicated monitoring of tourism impacts, particularly at highly visited sites

*Logistical and technical challenges (funding, infrastructure, data accessibility, etc.)*

- *Challenge L1:* Obtaining and securing long-term funding for collecting key variables.
  - L1.1. Cross-national funding opportunities
  - L1.1b. Ensure long-term funding of existing programs and develop for organismic studies in the Southern Ocean
  - L1.2. Access costs for logistics to conduct research
- *Challenge L2:* Securing ship-time for conducting surveys, including ships of opportunity such as fishing and tourism industry vessels.
- *Challenge L3:* Develop methods and techniques for remote collection of data and near-real time data delivery.
- *Challenge L4:* Develop data-sharing protocols that foster cooperation between different stakeholders, and official (government) and non-official (universities) scientists.
  - L4.1. Data accessibility outside respective management organisations

*Uptake challenges (effective communication between stakeholders, engaging the public)*

- *Challenge U1:* Engage constructively and iteratively with policy-makers at all stages of the research

- *Challenge U2*: Disentangle science from management.
- *Challenge U3*: Develop Decision Support Tools (DSTs).
- *Challenge U4*: Ensure new research/findings are included to define adopted MPA boundaries (with boundaries modified if required - e.g. new important foraging areas included)

**Identify tangible actions that would be able to address these challenges. Delineate the scope of suggested actions (leading organisation, involved stakeholders, funding, timeline, implementation).**

#### *Action IV.1*

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               |  |
| <b>Related challenge</b>            | R1, L1, L2, L3, L4, U1   |
| <b>Short description</b>            | Develop a Working Group to coordinate efforts conducted at all existing MPAs in the SO |
| <b>Key stakeholders to consider</b> | CCAMLR, National Programs responsible for local MPAs,                                  |
| <b>Timeline</b>                     | Ongoing  |
| <b>Potential resources</b>          | Governmental   |
| <b>Other comments</b>               |  |

#### *Action IV.2*

|                                     |  |
|-------------------------------------|--|
| <b>Name of Action</b>               |  |
| <b>Related challenge</b>            | R2, L1, U1, U2, U3, U4   |
| <b>Short description</b>            | Develop a framework for regional planning. This challenge will feed form results of priorities I and II. |
| <b>Key stakeholders to consider</b> | CCAMLR,  |
| <b>Timeline</b>                     |  |
| <b>Potential resources</b>          |  |
| <b>Other comments</b>               |  |

#### *Action IV.3*

|                                     |                            |
|-------------------------------------|----------------------------|
| <b>Name of Action</b>               |                            |
| <b>Related challenge</b>            | R4, U1, U3                 |
| <b>Short description</b>            |                            |
| <b>Key stakeholders to consider</b> | IAATO, ATS, UNCLOS, CCAMLR |

|                            |  |
|----------------------------|--|
| <b>Timeline</b>            |  |
| <b>Potential resources</b> |  |
| <b>Other comments</b>      |  |

Describe already-existing activities and stakeholders who are presently working towards resolving these challenges.

|                             |   |
|-----------------------------|---|
| <b>Name of Action</b>       | Due South   |
| <b>Related challenge</b>    | L2 – Coordination across multiple national-run programs and incorporate vessels of opportunity from various industries that operate in the southern ocean |
| <b>Short description</b>    | SOOS initiative to forecast cruises and surveys.  |
| <b>Leading organisation</b> |   |
| <b>Key stakeholders</b>     |   |
| <b>Timeline</b>             |   |
| <b>Resources</b>            |   |
| <b>Other comments</b>       |   |

Rank suggested actions in order of priority while taking into account feasibility and timeline. The highest ranking actions will be included in the Southern Ocean Action Plan and will most likely require additional notes.

|                          |                      |
|--------------------------|----------------------|
| <b>Order of priority</b> | Action number & name |
| <b>1</b>                 | ex: Action 2         |
| <b>2</b>                 |                      |
| <b>3</b>                 |                      |
| <b>...</b>               |                      |

IV. Ensure a sustainably harvested and productive Southern Ocean by working towards a stronger interface between science, industry and policy

*Research challenges (purely scientific)*

- *Challenge R1:* Determine how the complexity and uncertainty in our understanding of the functioning of these ecosystems should be reflected in the preparation and delivery of management advice
- *Challenge R2:* Assess the need for sustainable resource utilization in light of changing environments and expanding human needs
  - *R2.1.* Agree the level of food security that can come from the Southern Ocean, taking into account ecosystem processes and future effect of climate change.
- *Challenge R3:* Determine how the Southern Ocean can contribute to blue growth and a low carbon energy transition
- *Challenge R4:* Investigate what ways research and policy can effectively tackle the whole extraction cycle, from exploration to the final stage of closure of operations, and related remediation and reclamation activities
- *Challenge R5:* Identify the institutional, political and practical obstacles to adopting and implementing ecosystem-based management on a larger scale [review]
- *Challenge R6:* Assess how external pressures and changes in the geopolitical configurations of power affect Antarctic governance and science
- *Challenge R7:* Knowledge enabling Antarctic operators to be leading contributors in developing a responsible strategy for, achieving economic gains with sustainable solutions and inclusive benefit from a green economy
- *Challenge R8:* Understand the science behind stock assessments of active fisheries, particularly 'research' fisheries in data poor areas, how the science can be improved (toothfish, icefish, krill - inclusion of climate change models? feedback management?), [Action?][webinars, Lectures for public] [WS for more savvy public], look at ongoing actions<sup>1</sup>
- *R8.b.*and what the management response should be if a fishery is found to be depleted or unsustainable. [Action?]

*Logistical and technical challenges (funding, infrastructure, data accessibility, etc.)*

- *Challenge L1:* Securing the long-term commitment from funding agencies to carry on the SO Decade Action Plan.
- *Challenge L2:* Obtaining funding for conducting seminars and related activities.

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<sup>1</sup> Example: <https://www.oceandecade.org/resource/166/Announcement-of-the-results-of-the-first-endorsed-Decade-Actions-following-Call-for-Decade-Actions-No-012020>

*Uptake challenges (effective communication between stakeholders, engaging the public)*

- *Challenge U1:* Understanding the decision-making process for managing resources, from basic science to policy making.
- *Challenge U2:* Provide relevant and timely scientific advice to decision-makers for sustainable management of the Southern Ocean under a changing climate
- *Challenge U3:* Achieve an open, nurturing discussions between different stakeholders, within an interdisciplinary and inter-cultural environment [securing gender, racial and economic inclusion]
- *Challenge U4:* Develop strong multidisciplinary work, involving physical, biology, social scientist, economists, industry and policy-makers.

**Identify tangible actions that would be able to address these challenges. Delineate the scope of suggested actions (leading organisation, involved stakeholders, funding, timeline, implementation).**

*Action III.1*

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               | Science-management education  |
| <b>Related challenge</b>            | R1, L1, U1  |
| <b>Short description</b>            | The key management organisation in the SO (CCAMLR) is becoming paralysed, with scientists increasingly discussing management options as opposed to providing the scientific knowledge to managers. At the same time, delegate Members are inserting individuals with no scientific credentials into scientific working groups in order to promote management discussions. Given that managers must incorporate other (sometimes competing) interests into their decision-making process (social, economic, political etc), a process of continual education of the role of scientists in the provision of advice to managers would seem useful. |
| <b>Key stakeholders to consider</b> | National-level scientific and management agencies involved in Southern Ocean resource management.   |
| <b>Timeline</b>                     | Ongoing   |
| <b>Potential resources</b>          | Governmental  |
| <b>Other comments</b>               |   |

*Action III.2*

|                          |   |
|--------------------------|---|
| <b>Name of Action</b>    |   |
| <b>Related challenge</b> | R2, R3 U2, U3, U4   |
| <b>Short description</b> | Round of discussions on the significance of the SO for global budget, climate change resilience, resource productivity, and capacity to contribute to the global blue economy |

|                                     |   |
|-------------------------------------|---|
| <b>Key stakeholders to consider</b> | National-level scientific and management agencies involved in Southern Ocean resource management. |
| <b>Timeline</b>                     | Ongoing   |
| <b>Potential resources</b>          | Governmental  |
| <b>Other comments</b>               |   |

*Action III.3*

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               |   |
| <b>Related challenge</b>            | R4, R5, R6  |
| <b>Short description</b>            |   |
| <b>Key stakeholders to consider</b> | National-level scientific and management agencies involved in Southern Ocean resource management. |
| <b>Timeline</b>                     | Ongoing   |
| <b>Potential resources</b>          | Governmental  |
| <b>Other comments</b>               |   |

*Action III.4*

|                                     |   |
|-------------------------------------|---|
| <b>Name of Action</b>               |   |
| <b>Related challenge</b>            | R7  |
| <b>Short description</b>            |   |
| <b>Key stakeholders to consider</b> | National-level scientific and management agencies involved in Southern Ocean resource management. |
| <b>Timeline</b>                     | Ongoing   |
| <b>Potential resources</b>          | Governmental  |
| <b>Other comments</b>               |   |

**Describe already-existing activities and stakeholders who are presently working towards resolving these challenges.**

|                          |  |
|--------------------------|--|
| <b>Name of Action</b>    |  |
| <b>Related challenge</b> |  |
| <b>Short description</b> |  |

|                             |  |
|-----------------------------|--|
| <b>Leading organisation</b> |  |
| <b>Key stakeholders</b>     |  |
| <b>Timeline</b>             |  |
| <b>Resources</b>            |  |
| <b>Other comments</b>       |  |

Rank suggested actions in order of priority while taking into account feasibility and timeline. The highest ranking actions will be included in the Southern Ocean Action Plan and will most likely require additional notes.

| <b>Order of priority</b> | <b>Action number &amp; name</b> |
|--------------------------|---------------------------------|
| <b>1</b>                 | ex: Action 2                    |
| <b>2</b>                 |                                 |
| <b>3</b>                 |                                 |
| <b>...</b>               |                                 |