Attachment B.

List of science knowledge and information needs identified in the CEP 5-Year Work Plan, CEP Climate Change Response Work Programme, CEP Final Reports and other CEP Manuals.

Colours indicate science needs identified within the relevant issues of the Climate Changes Response Work Programme (CCRWP): Issue 1: Non-native species (yellow); Issue 2: Terrestrial and freshwater environments (green); Issue 3: Marine near-shore environments (blue); Issue 4: Species at risk (grey); Issue 5: Built environment (purple); and Issue 6: Emerging issues (red).

| CEP work plan priority | Science needs identified by the CEP | Source |
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| 1. Introduction of non-native species | *Species transfer to Antarctica:* | |
| Identify terrestrial and marine regions and habitats at risk of non-native species introductions | 5-YWP, NNS Manual (Annex), CCRWP (Issue 1), CEP IX (para. 129) |
| Identify pathways for the introduction of marine and terrestrial non-native species (including risks associated with wastewater discharge) | 5-YWP, NNS Manual (Annex), CCRWP (Issue 1) |
| Generate a list, with suitable descriptions, of potential non-native species based on the experience of the sub-Antarctic Islands (or other relevant environments) and the biological characteristics and adaptability of the “effective” colonisers | CCRWP (Issue 1) |
| Identify pathways for introduction of non-native species without any direct human intervention | 5-YWP, CEP XVIII (para. 226) |
| *Species transfer within Antarctica:* | |
| Identify native marine and terrestrial species at risk of relocation and vectors and pathways for intra-continental transfer | 5-YWP, NNS Manual (Annex), CCRWP (Issue 1) |
| Synthesise knowledge of Antarctic biodiversity, biogeography and bioregionalisation and undertake baseline studies to establish which native species are present | 5-YWP, NNS Manual (Annex), CEP XIII (para. 331), CEP XII (para. 232), CEP IX (para. 129) |
| Identify marine and terrestrial habitats/bioregions at highest risk from species redistribution and biological homogenization within Antarctica | CCRWP (Issue 1) |
| *Microorganisms, disease and wastewater:* | |
| Investigate risks and impacts of non-native species (including microorganisms) associated with wastewater discharge on native Antarctic species and habitats | CCRWP (Issue 1) |
| Assess risks and pathways for introduction of microorganisms that might impact on existing microbial communities | 5-YWP, NNS Manual (Annex), CEP IX (para. 129) |
| Improve understanding of the effects of climate change on the distribution and impacts of disease organisms on native plants and animals | CCRWP (Issue 1) |
| *Monitoring and response:* | |
| Monitor for non-native species in the terrestrial and marine environments (including microbial activity near sewage treatment plant discharges) | 5-YWP, NNS Manual (Annex), CEP XV (para. 244) |
| Identify techniques to rapidly respond to non-native species introductions | 5-YWP, NNS Manual (Annex) |
| 1. Tourism and NGO activities | Consistent and dedicated monitoring of tourism impacts | 5-YWP, CEP X (para. 304) |
| Monitor visitor sites covered by Site Guidelines | 5-YWP, CEP IX (para. 108) |
| 1. Climate change implications for the environment | Improve understanding of current and future change to the terrestrial (including aquatic) biotic and abiotic environment due to climate change | 5-YWP, CCRWP (Issue 2) |
| Undertake long-term monitoring of change to the terrestrial (including aquatic) biotic and abiotic environment due to climate change | 5-YWP, CCRWP (Issue 2), CEP XI (para. 304) |
| Continue to develop biogeographic tools to provide a sound basis for informing Antarctic area protection and management at regional and continental scales in light of climate change, including identifying the need to set aside reference areas for future research and identifying areas resilient to climate change.  Identify and prioritise Antarctic biogeographic regions most vulnerable to climate change | 5-YWP, CCRWP (Issue 2), CEP XVII (para. 61) |
| Develop future spatial climate change predictions on the timescale of decades. Identify and prioritise Antarctic biogeographic regions most vulnerable to climate change. | CCRWP (Issue 2) |
| Improve understanding of the effects of climate change (e.g. changing sea ice extent and duration, snow cover, ground moisture, microclimate, changing melt flows and consequences to lake systems) on habitat status, trends, vulnerability and distribution. | 5-YWP, CCRWP (Issue 2) |
| Understand and predict changes to the near-shore marine environment, and the impacts on species and habitats of that change | 5-YWP, CCRWP (Issue 3) |
| Long-term monitoring of change to the near-shore marine biotic and abiotic environment due to climate change | CCRWP (Issue 3), CEP XI (para. 304) |
| Determine marine areas vulnerable to increasing human activities (excluding fishing activities) where impacts may be exacerbated as a consequence of climate change | CCRWP (Issue 3) |
| Assessment on impact of ocean acidification to marine biota and ecosystems | 5-YWP, CCRWP (Issue 3), CEP XIV (para. 37) |
| Enhance understanding of Antarctic biogeography and how species distribution is likely to change with climate change | **CCRWP (Issue 4)** |
| Assess the conservation status of key Antarctic species. Understand population status, trends, vulnerability and distribution. | **5-YWP, CCRWP (Issue 4)** |
| Understand the effect of climate change on species potentially at risk, including critical thresholds yielding irreversible impacts | **CCRWP (Issue 4)** |
| Develop remote sensing methodologies to determine the status of key Antarctic species | **CCRWP (Issue 4)** |
| Determine the relationships and interactions between species (food webs, habitat transformation, etc.) to determine the impacts of climate change on communities and ecosystems | **CCRWP (Issue 4)** |
| Develop future spatial climate change predictions on the timescale of decades | **CCRWP (Issue 5)** |
| Identify risk presented to Antarctic infrastructure by storms, sea level change, melting of permanent ice/flooding, permafrost melt, etc. | **CCRWP (Issue 5)** |
| Research practical solutions to address climate change-related impacts on infrastructure | **CCRWP (Issue 5)** |
| Assess the impact of plastic pollution on natural systems in light of climate change | **CCRWP (Issue 6)** |
| Determine the origins and natural and anthropogenic transport routes of plastic pollution in the Antarctica marine and terrestrial environments | **CCRWP (Issue 6)** |
| Southern Ocean observations and modelling to understand climate change | 5-YWP, CEP XVIII (para. 95) |
| Monitor emperor penguin colonies, including using remote sensing and complementary techniques, to identify trends in populations and potential climate change refugia | 5-YWP, CEP XX (para. 222), CEP XVI (para. 176) |
| 1. Processing new and revised protected / managed area management plans | Monitoring to assess the status of values at ASPA 107 Emperor Island | 5-YWP, CEP XIX (para. 136) |
| Use remote sensing techniques to monitor changes in vegetation within ASPAs | 5-YWP, CEP XVII (para. 226), CEP XV (paras. 213 and 240) |
|  | Long-term monitoring of biological values in ASPAs | 5-YWP, CEP XV (para. 192) |
| 2. Repair or remediation of environmental damage | Research to inform the establishment of appropriate environmental quality targets for the repair or remediation of environmental damage in Antarctica | 5-YWP, Clean-Up Manual (Section 3), CEP XVII (para. 48) |
| Techniques to prevent mobilisation of contaminants such as melt water diversion and containment barriers | 5-YWP, Clean-Up Manual (Section 3) |
| Techniques for in-situ and ex-situ remediation of sites contaminated by fuel spills or other hazardous substances | 5-YWP, Clean-Up Manual (Section 3) |
| How will climate change affect mobilization and exposure of species/ecosystems to contaminants? | **CCRWP (Issue 5)** |
| What is the susceptibility of microbial and macroscopic species in the Antarctic terrestrial environment to contaminants, including under warmer and wetter environmental conditions? | **CCRWP (Issue 5)** |
| What is the susceptibility of near shore marine species to contaminants? | **CCRWP (Issue 5)** |
| 2. Monitoring and state of the environment reporting | Undertake long-term monitoring of change to the terrestrial (including aquatic) biotic and abiotic environment due to climate change | 5-YWP, CCRWP (Issue 2) |
| Identify areas vulnerable to increasing human footprint as a consequence of climate change | **CCRWP (Issue 6)** |
| Long-term monitoring of change to the near-shore marine biotic and abiotic environment due to climate change | 5-YWP, CCRWP (Issue 3) |
| Support and undertake collaborative long term monitoring of change (e.g. SOOS, ANTOS) and seek regular state of knowledge reports from such programmes | CCRWP (Issues 2 and 3) |
| Determine marine areas vulnerable to increasing human activities (excluding fishing activities) where impacts may be exacerbated as a consequence of climate change | CCRWP (Issue 3) |
| Develop remote sensing methodologies to determine the status of key Antarctic species | **CCRWP (Issue 4)** |
| Monitor bird populations to inform future management actions | 5-YWP, CEP XVIII (para. 244), Resolution 5 (2015) |
| Use remote sensing techniques to monitor changes in vegetation within ASPAs and more widely | 5-YWP, CEP XVII (para. 226) |
| Monitor emperor penguin colonies, using remote sensing and complementary techniques, to identify potential climate change refugia | 5-YWP, CEP XVI (para. 176) |
| Long-term monitoring of biological values in ASPAs | 5-YWP, CEP XV (para. 192) |
| Long-term monitoring to verify or detect environmental impacts associated with human activities | 5-YWP, CEP XII (para. 50) |
| Long-term monitoring and sustained observations of environmental change | 5-YWP, CEP XI (para. 304) |
| Consistent and dedicated monitoring of tourism impacts | 5-YWP, CEP X (para. 304) |
| Systematic and regular monitoring of visitor sites covered by Site Guidelines | 5-YWP, CEP IX (para. 108) |
| Long-term monitoring of biological indicators at sites visited by tourists | 5-YWP, CEP IX (para. 119) |
| 2. Site specific guidelines for tourist-visited sites | Long-term monitoring to assess the status and recovery of vegetation at Barrientos Island. | 5-YWP, CEP XIX (para. 181), CEP XV (para. 147) |
| Systematic and regular monitoring of visitor sites covered by Site Guidelines | 5-YWP, CEP IX (para. 108) |
| 2. Overview of the protected areas system | Continue to develop biogeographic tools to provide a sound basis for informing Antarctic area protection and management at regional and continental scales in light of climate change, including identifying the need to set aside reference areas for future research and identifying areas resilient to climate change | 5-YWP, CCRWP (Issue 2) |
| Use remote sensing techniques to monitor changes in vegetation within ASPAs and more widely, to inform the further development of the Antarctic protected areas system | 5-YWP, CEP XVII (para. 226) |
| 2. Designation and management of Historic Sites and Monuments | Assess the risk of climate change to HSMs and ASPAs designated to protect heritage values | **CCRWP (Issue 5)** |
| Assess climate change impacts on rates of degradation of historic infrastructure (e.g. microbial degradation of timber and organic artefacts) | **CCRWP (Issue 5)** |
| Characterise how implemented solutions to climate change impacts at historic sites may alter perceptions of their historic value | **CCRWP (Issue 5)** |
| Determine how climate change will affect artefacts left *in situ*, or those still to be unearthed (i.e. in a warmer and wetter environment) | **CCRWP (Issue 5)** |
| 2. Biodiversity knowledge | Research on of the environmental impacts of remotely piloted aircraft systems (RPAS), particularly on wildlife responses including:   * a range of species including flying seabirds and seals. * both behavioural and physiological responses. * demographic effects, including breeding numbers and breeding success. * ambient environmental conditions, for example, wind and noise. * the effects of RPAS of different sizes and specifications. * the contribution of RPAS noise to wildlife disturbance. * comparisons with control sites and human disturbance. * habituation effects. | 5-YWP, CEP XX (paras. 211-212), CEP XIX (para. 98), CEP XVIII (para. 129) |
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|  | Collection and submission of further spatially explicit biodiversity data | 5-YWP, CEP XV (para. 186), CEP XIII (para. 273), CEP XII (para. 232) |
| Research on the impacts of underwater noise on Antarctic marine mammals | 5-YWP, CEP XV (para. 192) |
| Synthesis of available knowledge on the biogeography, bioregionalisation and endemism within Antarctica | 5-YWP, CEP XIII (para. 331) |
| Site-specific, timing-specific and species-specific studies to understand the impacts arising from interactions between human activities and wildlife and support evidence-based guidelines to avoid disturbance | 5-YWP, CEP XI (para. 109) CEP XVIII (paras. 129, 240, 241) |
| Inventory of Mr Erebus ice caves and microbial communities | 5-YWP, CEP XV (para. 178) |
| Regular population counts and research to understand the status and trends in the southern giant petrel population | **5-YWP, CEP XII (para. 217), CEP XI (para. 283). CCRWP (Issue 4)** |