

Evolution and Biodiversity in the Antarctic: the Response of Life to Change (EBA)

Final Implementation plan

The structure of this programme will be based around a series of five major unifying key questions that are addressed across the realms of terrestrial, limnetic and marine environments. These will form the Work Packages of the programme, which will operate along the lines of a matrix of the key questions vs selected environments.

The EBA programme will bring together a wide range of disciplines to tackle a series of well-focused questions. These disciplines include plate tectonics, climatology, glaciology, geophysics, oceanography, paleontology, molecular biology, taxonomy, biogeography, autecology, cellular and organismal-level ecophysiology, and community ecology.

The programme will run a series of workshops. There will be three types: a) thematical, fostering cross-disciplinary interaction, including joint workshops with the other SCAR programmes, particularly ACE and AGCS; b) interaction with non-polar experts in evolutionary biology; c) integrative, for the Antarctic community. The workshop timetable will be defined at the EBA workshop during the SCAR Biology Symposium in Curitiba in 2005.

Additional to the workshops will be national and international field programmes. Such programs will be wide ranging, including subantarctic islands, inland to the most remote nunataks as well as northward to the Magallanes, and stretching across the Southern Ocean down to the deep ocean as well as the shelves. This wide range will need significant support from COMNAP and national programs.

Scope

- To understand the evolution and diversity of life in the Antarctic.
- To determine how these have influenced the properties and dynamics of present Antarctic ecosystems and the Southern Ocean system.
- To make predictions on how organisms and communities are responding and will respond to current and future environmental change.
- To identify EBA science outcomes that are relevant to conservation policy and to communicate this science to the SCAR Antarctic Treaty System via the SCAR ATS Committee.

Work packages:

1. Evolutionary history of Antarctic organisms

Key scientific areas to be investigated will include:

1. Vicariance and Radiations: When did the key radiations of Antarctic taxa take place? (key groups will be focused upon)
2. Impact of glaciation: on land (habitat modification/loss and timing and extent of isolation); at sea (evolutionary links between continental shelf and slope or deep-sea species).
3. Phylogeography: geographical structure and relationships in the Antarctic biome.
4. Evolutionary history of Antarctic micro-organisms (both prokaryotic and eukaryotic).

2. Evolutionary adaptation to the Antarctic environment

Key scientific areas to be investigated will include:

1. Adaptations and their integration into life history pattern in Antarctic organisms

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The life history pattern of an organism integrates the proximate adaptations (genomic, biochemical, cellular, physiological, structural and behavioural) in response to the biophysical environment. As such, life history patterns enable successful reproduction and survival in response to the variability or stability of both the biological (eg competition, predation) and physical (eg temperature, water availability pressure, etc) environments.

3. Patterns of gene flow within, into and out of the Antarctic, and consequences for population dynamics: isolation as a driving force

Key scientific areas to be investigated will include:

1. Population structure and dynamics in the context of evolutionary biology.
2. Natural and anthropogenic dispersal processes: immigration and emigration of organisms; intra-Antarctic dispersal; the role of advective/transport processes in gene flow and population structure.
3. Genetic structure of populations: differences among and between Antarctic and non-Antarctic populations
4. The extent to which populations of Antarctic organisms exist as metapopulations.

4. Patterns and diversity of organisms, ecosystems and habitats in the Antarctic, and controlling processes.

Key scientific areas to be investigated will include:

1. Biodiversity: to what extent is the diversity of the Antarctic biota underestimated (both standard & cryptic species)?
2. Spatial and temporal variations in diversity: variation of diversity at different spatial scales within the Antarctic and within defined time frames.
3. Response to latitudinal and environmental gradients: local, regional and global.
4. Unknown areas: patterns of diversity and biotic composition of unexplored but important areas (e.g. deep sea, inland nunataks, isolated islands, subglacial lakes).

5. Impact of past, current and predicted future environmental change on biodiversity, and the consequences for Antarctic marine, terrestrial and limnetic ecosystem function

Key scientific areas to be investigated will include:

1. Interactions between introduced and indigenous species in selected environments under climate change.
2. Effect of abiotic change on biota
3. Modelling interactions between environmental change and organism responses in order to predict biotic change.
4. Impact of biological feedback on climate

Links:

EBA will establish links with other international programmes concerned with global physical change and the biological response. Of particular importance are bipolar connections. Furthermore will we forge avenues to align EBA outcomes with conservation policy in particular and to advise policy makers in general.

Timeline

2005: Planning phase including

- a) Planning meeting in Cambridge in March to draft Implementation Plan.
- b) SCAR Biology Symposium "Evolution and Biodiversity in the Antarctic", Curitiba, Brazil.

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- c) International workshop on EBA where work package sub-committees will be appointed and specific milestones detailed.
- d) IPY advanced planning, database construction and integration
- e) Circulation of questionnaire about planned and anticipated research activities that will contribute to the aims of EBA in order to collect feedback from potential participants.

• **2006:** SCAR Open Science Meeting, Hobart. EBA begins. Workshops

Elephant seals in a changing environment

CAML: processes underlying colonisation and dispersal in Antarctic marine fauna. Includes systematics, molecular biology, endemism, bioevolution...

CAML/SCAR-MarBIN: populating the Antarctic marine biodiversity database and visualisation of data products. Includes seafloor topography, sampling intensity, CTD data, predator tracks...

- **2007:** Workshops: World View of Evolution. Miraflores, Spain.
- **2008:** SCAR Open Science Meeting, St. Petersburg. Evolutionary Biology-Biodiversity Joint Session.
- **2009:** SCAR Biology Symposium, possibly in Japan or Korea. Major EBA session and third workshop (integrative) one. Also mid-program review.
- **2010:** EBA-IPY activities: will be the SCAR Open Science Meeting where we will devote to IPY results.
- **2011:** last field season.
- **2012:** SCAR Open Science Meeting.
- **2013:** SCAR Biology Symposium – wrapup of results and last year of program.

Methodology

The EBA programme is wide-ranging and multidisciplinary. The RiSCC programme has developed a manual of methods and workshops will assist in standardising methods as appropriate. In many disciplines, methods are developing rapidly, so it is not feasible or productive to list specific methodologies in detail. However, a few general points are worth emphasising.

1. The programme will use state-of-the-art enabling technologies in molecular biology, genomics/proteomics, ecophysiology, microbiology, taxonomy and organismal biology, all of which are established and proven at the highest level in various national groups contributing to the EBA community.
2. The programme will liaise with the relevant physical, geological and historical disciplines to ensure regular interaction and use of the most recent data and insights in interpreting the biological results.
3. The programme will necessarily involve fieldwork and laboratory work, both in the Antarctic and in home institutions. In particular, the study of latitudinal gradients requires extensive international collaboration (as was achieved for the recent Victoria Land Transect study, which involved international collaboration, the IBMANT collaboration between European and Latin American countries on evolutionary connections between the Antarctic and South America, and ICEFISH 2004, a sub-Antarctic cruise with scientists from eight countries).
4. Exploration of some areas will require new technologies, for example, samplers for low densities of propagules in the atmosphere and sub-glacial lakes; benthic landers or remotely operated vehicles for the deep sea; autonomous underwater vehicles for work

beneath ice shelves; and remote-controlled small aircraft for spectral sensing of terrestrial and limnetic environments.

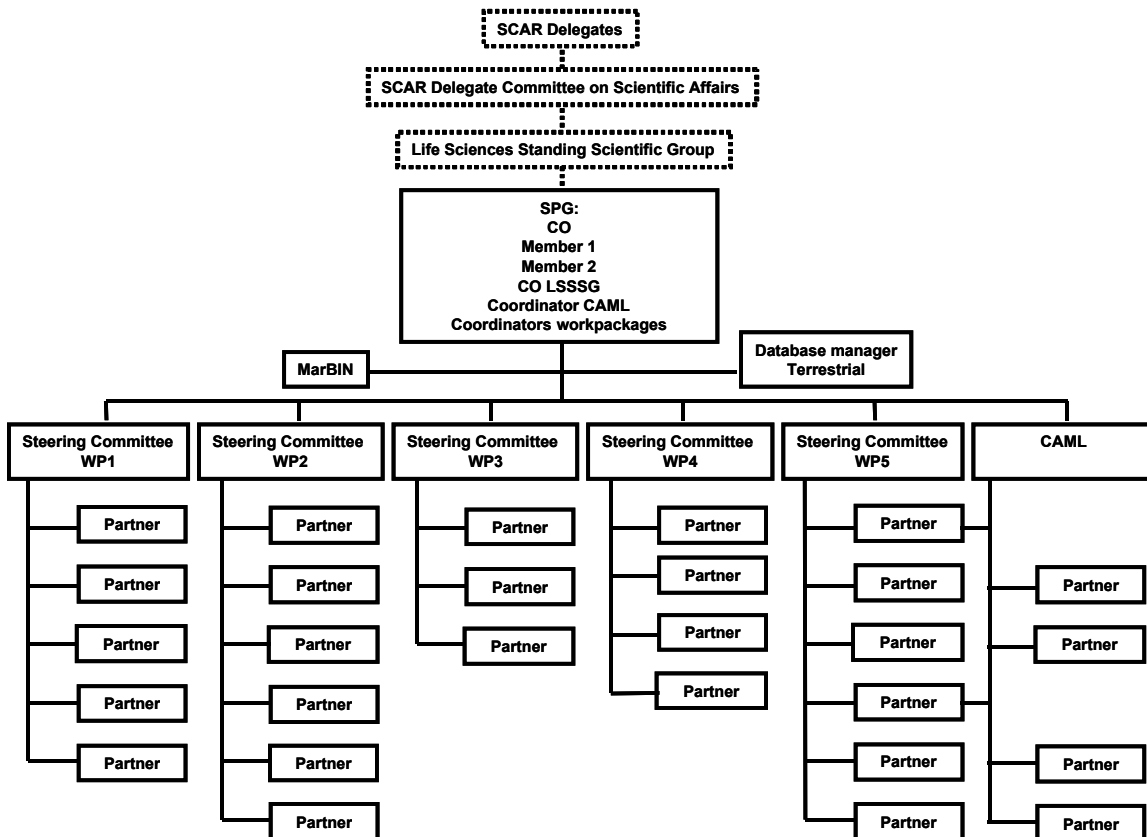
5. Importance will be attached to spatial and temporal scales in studies of gene flow, population dynamics, disturbance ecology and biological diversity.

Relationship with IPY

The International Polar Year activities will fall within the timing of the EBA programme. EBA and IPY activities were conceived in parallel. The EBA Science Plan clearly shows that it will make a significant contribution to IPY activities by undertaking a focused initiative elucidating the evolutionary response of organisms, populations and communities to environmental change. EBA will leave a legacy of evolutionary and biodiversity information which is the hallmark of IPY.

Programme management and governance

The EBA programme will be managed by a Scientific Programme Group. This group will comprise coordinators of individual work packages and Census of Antarctic Marine Life (CAML). The SPG will work by electronic mail but will also meet once a year. An important aspect will be liaison with other scientific disciplines. This will be achieved by a series of multidisciplinary workshops focussed on specific topics. Six steering groups will be formed to support each of the objectives as well as CAML. EBA will construct a website to present the Science Plan and to communicate with its members and the general public. EBA will also schedule workshops to monitor the progress of the programme. EBA will work closely with JCADM with regard to data management, with marine data being integrated into MarBIN and terrestrial data into the RiSCC Biodiversity database, as well as into relevant data centres and databases.



Other Planned workshops:

Dispersal
ICEFISH 2006
Phylogeography/ population genetics
The Molecular approach to Antarctic Biological Science: Strategies and techniques
Joint SALE/ EBA workshop
Connectivity between marine and terrestrial ecosystems

Milestones

- **2005:** Implementation of EBA: International workshop where work package sub-committees will be appointed and specific milestones detailed: "Evolution and Biodiversity in the Antarctic", 9th SCAR Biology Symposium, Curitiba, Brazil.
- **2006:** EBA begins. Workshop "Factors Driving Evolution in the Antarctic": 2nd SCAR Open Science Conference, Hobart.
- **2007:** Workshop "World View of Evolution": Miraflores, Spain.
- **2008:** Evolutionary Biology-Biodiversity Joint Session: 3rd SCAR Open Science Conference, St. Petersburg.
- **2009:** Major EBA session, integrative workshop, mid-programme review and initiation of ideas for next LSSSG Programme: 10th SCAR Biology Symposium.
- **2010:** EBA-IPY activities: 4th SCAR Open Science Meeting.
- **2012:** 5th SCAR Open Science Meeting.
- **2013:** Synthesis of results, completion of EBA programme and preparation for start of next LSSSG Programme: 11th SCAR Biology Symposium.

Deliverables

The main output from the EBA programme will be a significant step forward in our understanding of the Antarctic biota and its evolution. There will also be important contributions to fundamental understanding in a number of disciplines.

Specific output will include the following:

- Primary literature publications and books
- Conference proceedings and publications from workshops
- Programme reports
- Website
- Input to databases
- Advisory reports to ATCM and others (e.g., CEP, CCAMLR, COMNAP)
- Input to, and feedback from, international programmes
- Synergies with other SCAR programmes (e.g., ACE, AGCS, SALE)
- Trained PhD graduates and post-doctoral research fellows
- Capacity development of students from developing Antarctic nations
- Outreach via National Programmes and in coordination with proposed SCAR Outreach Committee

National and International Involvement

It is anticipated that the majority of the SCAR nations will participate in this programme, that it will act as a major route for capacity building in new SCAR members and those with a comparatively reduced logistic and financial resource base, and that it will contribute to a wide variety of international programmes. Input from individual researchers and research groups will be solicited through a questionnaire. Researchers will be expected to register their anticipated contribution to the Programme through the EBA website.