



Brain-be 2.0

Belgian Research Action through Interdisciplinary Networks

POLICY BRIEF

Policy Brief n° [***]

Conservation management of polar ecosystems: using genomic approaches to study connectivity across spatial and functional scales - COPE

Context and question(s) of research

Many animals and plants in Antarctica have special adaptations to survive the cold, which also makes them vulnerable to climate change. As temperatures rise and ice sheets melt, it is crucial to protect the unique biodiversity. One measure to do so is by creating Marine Protected Areas (MPAs), which help safeguard important ocean habitats. Scientists have proposed nine MPAs in the Southern Ocean (SO), but so far, only two have been established. The COPE project studies the population genetics of Antarctic *Trematomus* fishes and *Charcotia* amphipods to improve MPA planning and identify areas that require special protection. *Trematomus* fish belong to the notothenioids (ice fishes) and occupy pelagic and benthic habitats. They are prey for top predators such as penguins, seabirds and whales. *Charcotia* benthic amphipods (Lysianassidae, Crustacea) are endemic to the SO and an important part of the Antarctic food web. They link different trophic levels as prey for fish and marine mammals and as scavengers recycling nutrients in the food web.

The broad research questions addressed by the COPE project are: Is there hidden species diversity among Antarctic species? How much connected are populations across the Southern Ocean? Do species show local genetic adaptations? How do movements and reproductive traits influence connectivity? What environmental factors shape the distribution? Above mentioned *Charcotia* amphipods and *Trematomus* fish are the target species of the project to answer these questions.

Main findings

We made several key contributions to the field. We identified additional cryptic diversity in both target taxa, improving estimates of endemic diversity in Antarctic marine ecosystems. Ecological niche reconstructions in amphipod sister species revealed significant inter- and intraspecific differences, highlighting their trophic flexibility.

Our most novel findings include genetic population differentiation and structuring in two amphipod and six *Trematomus* species across various geographic scales in the Southern Ocean. Genome-wide data revealed diverse patterns, even among closely related species. We found no population structure in three *Trematomus* species within the Eastern Weddell Sea, while two other *Trematomus* species and the amphipod *Charcotia obesa* exhibited geographic isolation.

Additionally, we detected population differentiation at small scales, such as along the Western Antarctic Peninsula and within the Eastern Weddell Sea. Patterns of adaptive genetic variation suggest chromosomal rearrangements may play a key role in *Trematomus* adaptation. Notably, we observed unexpected genetic connectivity between the Filchner Trough and the western Weddell Sea, potentially influenced by ocean currents.

Research on *Trematomus* fish and *Charcotia* amphipods offers important insights that can strengthen current Marine Protected Area (MPA) proposals and refine conservation strategies.

Application of *Trematomus* results: Our findings on the population connectivity and structure of *Trematomus* fish are particularly relevant to the Weddell Sea MPA (WSMPA) Phase 1 proposal, led by Germany. This proposal defines three management zones: the General Protection Zone (GPZ), the Special Protection Zone (SPZ), and the Fisheries Research Zone (FRZ), aiming to safeguard biodiversity, protect marine ecosystems, and provide climate change refugia. Genetic analysis revealed a significant break in *Trematomus eulepidotus* and *T. loennbergii/lepidorhinus* populations across the Filchner Trough (Weddell Sea), as well as a genetic link between the Trough and parts of the Weddell Sea. These findings support the inclusion of this region within the SPZ, aligning with WSMPA's key conservation objectives. Similar connectivity patterns observed in other Antarctic species, such as *Pleuragramma antarctica* (Antarctic silverfish), highlight the ecological importance of the Filchner Trough and its role in maintaining Southern Ocean biodiversity.

Application of *Charcotia* results: Research on the benthic amphipod *Charcotia obesa*, is highly relevant to the Domain 1 Marine Protected Area (D1MPA) proposal around the West Antarctic Peninsula, led by Argentina. The D1MPA consists of two management zones: the General Protection Zone (GPZ), covering 60% of the area, and the Krill Fishery Zone (KFZ). Primary goals include safeguarding critical fish habitats, krill nurseries, feeding grounds for apex predators like penguins, seals, and whales, and protecting diverse benthic and pelagic ecosystems, including high-productivity regions like polynyas. COPE findings reveal minor local population structure in *Charcotia obesa* within the WAP. The patterns suggest the presence of environmental or biological barriers shaping genetic diversity. Similar population structures have been observed in Antarctic bivalves, reinforcing the idea that small-scale genetic variation is common in the region. Protecting all three benthic bioregions within the D1MPA—Antarctic Peninsula, South Orkney Islands, and Atlantic Basin—is crucial to conserving the full genetic diversity of benthic species, ensuring their long-term resilience and adaptability.

Conclusion and recommendations

The COPE research provides a strong scientific basis for developing Marine Protected Areas (MPAs) in the Southern Ocean. The COPE results support current proposals, such as the WSMPA and D1MPA, by identifying key areas that need protection. The *Trematomus* findings are especially relevant for the WSMPA, and we plan to submit them to CCAMLR's EMM working group. Representative dr. Anton Van de Putte and dr. Marie Verheye will present the COPE results at the EMM meeting in Norway (July 7–18) either in 2025 or 2026. We recommend incorporating the findings into MPA proposals to strengthen marine conservation and suggest continued research to refine management strategies. While COPE initial results on amphipods are valuable, additional samples from different bioregions are required to enhance their impact. Aligning COPE research with CCAMLR's goals ensures that conservation efforts are guided by the best available science, supporting sustainable marine protection.

Read more

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is an international body comprising 27 countries, including Belgium. The Commission is responsible for the conservation of marine life and environmental integrity in the Southern Ocean. As part of its work, CCAMLR relies on scientific input to guide policy decisions, particularly with respect to the establishment and management of Marine Protected Areas (MPAs).

Scientific advice is provided to the Commission via the CCAMLR Scientific Committee and its working groups including EMM (Ecosystem monitoring and Management). Papers can be submitted to these working groups and the Scientific Committee. Once these findings are reviewed, the working groups may offer recommendations to the Scientific Committee. Following this, scientists can also submit more general working papers to the Scientific Committee of CCAMLR, which meets just before the Commission itself. These papers are intended to provide broader recommendations that can guide the Commission's decisions.

Information

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