

Marked changes in megafauna composition of the North Sea require multidisciplinary collaborations: an historical overview

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The North Sea is a shallow and highly productive sea in which **long-term ecosystem changes** may ultimately be related to changes in climate or nutrients, but the long-term dynamics are influenced by anthropogenic impacts and internal factors such as competition and predation. Its fishing grounds have been exploited for centuries, resulting in stock depletions, a modified species composition, and shifts towards reduced life-expectancies of most commercial fish species. **Seabirds and marine mammals** have been affected, often in unexpected ways. Atlantic whale stocks are slowly recovering from historical overexploitation and sightings within the North Sea have become more frequent as a result. The species composition and overall abundance of dolphins and porpoises have fluctuated over decadal time scales, seemingly in response to climatic variations or variations in prey availability.

Seabirds and marine mammals are charismatic marine species that many people are concerned about. These concerns range from conservation priorities on one end to suggestions to reduce stocks by culling to protect commercial fisheries. Many species at higher trophic levels are characterised by relatively long lifespans, long generation times, complex social structures, and extensive ranges. As top-predators, these species have a structuring role in the ecosystem, which means that understanding their **population dynamics** is indispensable for ecosystem studies. Historical census work conducted by a variety of research institutes around the North Sea since the mid-1980s forms the baseline of our current understanding of the **spatial distribution, habitat requirements** and **species interactions** of seabirds and marine mammals (often under the umbrella of the 'European Seabirds at Sea Database Co-ordinating Group').

Marine ecosystems are sensitive to (natural) fluctuations, but it is far from clear exactly how climate change, human exploitation or environmental modifications interact and affect the functioning, **trophic dynamics** and **biodiversity** within the North Sea. Over the most recent decades, partly as a result of European policy, fishing intensity has declined or has shifted geographically, several forms of marine pollution have decreased while others have emerged. Unfortunately, synoptic surveys of the North Sea have not been continued as a result of which recent data are largely lacking and large parts of the North Sea are currently understudied. Within the context of this historical work, we urgently need a refreshment of **distribution data**, a new series of experiments to assess the impact and importance of current levels of discards provisioning on marine birds, and more attention to ecological interactions between marine mammals, seabirds and their (fish, crustacean, benthic) prey. Proposals for multi-disciplinary collaborations will be put forward.

Keywords: charismatic megafauna; ecosystem changes; species interactions; historical distribution data; trophic dynamics; future collaborations