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Ecological History of the Wadden Sea: 2000 Years of Human-induced Change in a Unique Coastal Ecosystem

About 7000 years ago, retreating glaciers and subsequent sea level rise created a unique coastal ecosystem in the southern North Sea. Since then the Wadden Sea has been the largest intertidal system in the world, and is discussed to be designated as a UNESCO site of natural world heritage. However, the Wadden Sea is also a fundamentally altered ecosystem due to a long history of human intervention with their coastal environment. A vision of "What was natural in the Wadden Sea" is completely lost in the living memory today.

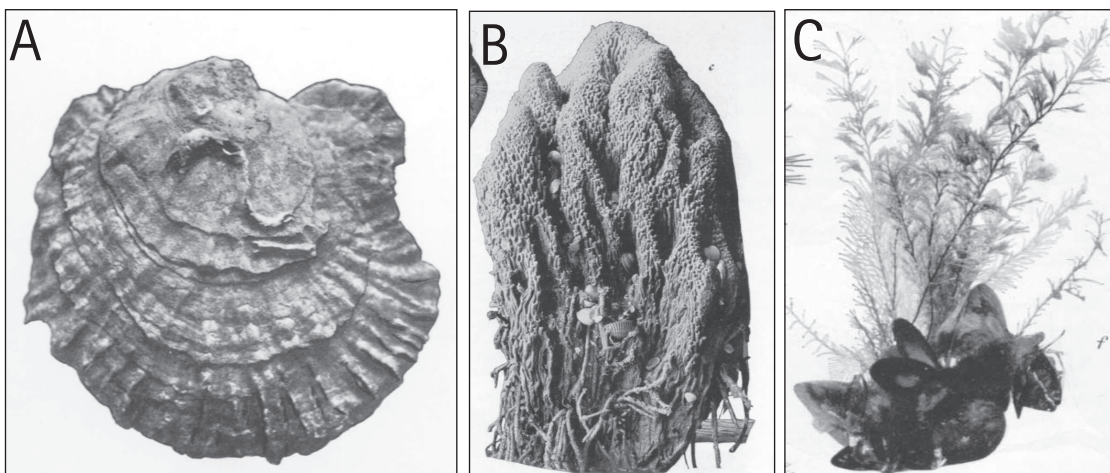
During a multi-disciplinary workshop held from 23 to 25 January 2004 at the Wadden Sea Research Station of the Alfred-Wegener Institute for Polar and Marine Research in List / Sylt, Germany, archaeologists, historians, and ecologists explored the ecological history of the Wadden Sea. Our goals were (1) to create a vision of a pristine Wadden Sea ecosystem before large-scale human interference, (2) to construct a comprehensive overview on the history of ecological change in the Wadden Sea, (3) to analyze the consequences of multiple human impacts on food-web and ecosystem structure, and (4) to learn from the past in order to inspire public imagination today, and guide conservation and restoration measures in the future.

The workshop was organized into two parts. On the first day, invited participants gave a series

of 10 presentations on selected overview topics. This day was open to a wide audience of students, scientists, conservationists, managers and media, and was attended by 40 guests from Denmark, The Netherlands, Canada and Germany. On the second and third day, a group of 16 invited scientists, students, conservationists, and managers met as a working group to focus on open questions and problems regarding the ecological history of the Wadden Sea. Major topics were the reconstruction of the Wadden Sea ecosystem, the timeline of ecological changes, causes and consequences of changes, and the implications to conservation and management.

At least over the past 2000 years, humans were a major driver of change in the Wadden Sea through resource exploitation, habitat alteration, and pollution. Coastal people hunted and fished especially large predators such as whales, large groundfish, diadromous fish, waterfowl and seabirds. Especially since the Middle Ages, many species were extirpated or severely reduced over time and listed on the Red List of endangered species today. About 1000 years ago, people started dyke building and draining for land reclamation. The former amphibious and diverse landscape was transformed into monotonous agricultural fields. As a consequence, a mosaic of marine, brackish, freshwater, and wetland habitats was lost. On the

Figure 1: Former habitat-building species in the Wadden Sea that are lost today. (A) European oysters (*Ostrea edulis*) once provided extensive banks and an important commercial fishery since the Middle Ages until its collapse in the early 1900s. (B) The 'sandcoral' (*Sabellaria spinulosa*), a polychaete worm, formed reef structures which were destroyed by the bottom fishery. Only a few relicts still exist today. (C) The sea moss (*Sertularia cupressina*), a hydrozoan (here attached to the blue mussel *Mytilus edulis*), formed meadows on the seafloor and was harvested in the 20th century for decoration purposes. Photos from Hagmeier and Kändler 1927.



seafloor, complex habitat structures such as oyster banks, *Sabellaria* (a polychaete worm, also called 'sandcoral') reefs, and mussel beds were destroyed directly or indirectly by the fishery, and eelgrass meadows were reduced by disease and eutrophication. Together, overexploitation and habitat loss were the major drivers for extinction and population declines in the Wadden Sea fauna and flora in the past. The loss of large predators and habitat-building species has altered food web and ecosystem structure and functioning, as well as the goods and services for humanity. For example, of about 20 commercial fisheries that existed in the 19th century, only 3 are left today.

This grim picture of the ecological history of the Wadden Sea is contrasted by some positive trends during the last decades. Conservation efforts, especially reduced exploitation and increased habitat protection, enabled many waterfowl and seabirds as well as seals to partly recover. It is these success stories that should guide future conservation efforts. Wetland and brackish water restoration, reduced pollution, seafloor protection, and no-take zones are valuable and feasible management options. Enhancing the ecological diversity and integrity will increase the quality of the Wadden Sea land- and seascape and with that the options for coastal people and economies.

The contents and results of the workshop will be accessible to a wide readership in a Special Volume of the journal *Helgoland Marine Research* to be published in the beginning of 2005. This volume will feature a series of scientific papers from multiple disciplines reviewing human activities and impacts on marine resources over time. Contributions will cover a wide range of interrelated topics, ranging from human settlement and

cultural change, habitat transformation, marine exploitation in Medieval Europe and in recent centuries, and the history of eutrophication, to changes in species occurrence and abundance from deep time to the present. A Synthesis paper will reflect the working group discussions.

The workshop was part of the *History of Marine Animal Populations* (HMAP, <http://www.hmap.cmrs.dk>) program and one key element of the HMAP North Sea group. HMAP aims at bringing together marine history, archaeology, paleontology, and ecology to enhance our understanding of changes in the biodiversity, distribution and abundance of marine life in the world's oceans. HMAP is an element of the *Census of Marine Life* (<http://www.coreocean.org/>), a decade-long global research effort asking: 'What was, what is and what will be in the oceans?'. Funding by the Alfred Sloan Foundation in New York, the Alfred-Wegener Institute, and the Maritime History and Marine Environmental Research School (MARINERS, http://www.fishnet.dk/networks/mariners/mariners_da.htm) in Denmark is gratefully acknowledged.

Reference:

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