INDICATOR #17

Impacts of human activities on benthic habitat

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Cold-water coral reefs, coral gardens, and sponge aggregations provide a habitat for a variety of fish and invertebrates and thus represent biodiversity hotspots in the Arctic seas [1–3]. These habitats are vulnerable to fisheries and other human activities such as oil and gas exploration [4, 5] and are as such examples of Vulnerable Marine Ecosystems (VMEs). Impact or damage may lower the local biodiversity and diminish the possibility for many species to find shelter and feeding grounds. Because corals and sponges grow very slowly [3, 6], the recovery of these habitats may take from decades to centuries, and in some cases, may not recover at all. Political awareness about this issue is reflected in The United Nations General Assembly Resolution 61/105 towards long-term sustainable use of deep-sea fisheries resources and prevention of significant adverse impacts on vulnerable marine ecosystems.

Population/ecosystem status and trends

Cold-water coral reefs

Reef-building corals are characterized by a calcareous skeleton and are called stony corals. A reef is formed when dead coral skeletons accumulate over thousands of years. *Lophelia pertusa* is a reef-building species (Figure 17.1A) and is common in the waters around the south coast of Iceland, the Faroe Islands, and Norway north to about 71 °N [3].

Coral gardens

Coral gardens are important ecosystems in the Aleutian Islands and the eastern Bering Sea. These gardens are often structurally complex environments dominated by gorgonians (sea fans), stylasterid corals (lace corals), sponges, and other sedentary animals. Gorgonians have a largely upright, plant like growth form (Figure 17.1A) and a skeleton of a horny organic material. They reach their highest diversity in the Arctic in the Aleutian Islands. To date, 101 coral species have been indentified of which 50 could be endemic to the region [5]. The Bering Sea has dense aggregations of soft corals and sea pens on the shelf and slope, respectively. This region is relatively poor in stony corals, which occur as solitary cups and do not form true reefs as *Lophelia* does in the Norwegian and Barents Seas. The diversity of non-reef building corals, including *Octocorallia* and *Scleractinia*, is also high in these seas. In Norway, a total of 40 species are documented, of which the gorgonians are the most conspicuous [7].

Sponge grounds

Sponge grounds refer to areas where large sponges are strikingly common, i.e., those areas where more than 90% of the biomass in a trawl haul, excluding benthic fish, is sponges (Figure 17.1D). There have been so few studies on these types of environments that it is still necessary to define sponge grounds by the percentage biomass in trawl hauls. They have been found in the waters of East Greenland, Iceland, the Faroe Islands, northern Norway, the Barents Sea, Svalbard, and the Aleutian Islands [3, 5, 8].

Stressors and protection

Most of the Arctic Ocean, notably the deep basins, ridge systems and parts of the continental shelf, is largely unexplored and not impacted by human activities due to the limitations imposed by the annual ice-cover. These activities are thus limited to seasonally ice-free areas such as some shelf seas (e.g., Chukchi Sea, Bering Sea, and Barents Sea) that sustain important commercial fisheries and offshore regions where oil and gas exploration takes place. The on-going decrease in the ice-cover around the Arctic means that previously pristine areas are becoming accessible to fisheries and an expanding oil and gas industry.

Bottom trawling has the greatest potential to disturb benthic habitats. Because it involves towing a trawl, or fishing net, along the sea floor, it has a detrimental effect on the VMEs [1, 4]. Bottom trawls are widely used in the Bering Sea, around the Aleutian Islands, and in the Barents Sea.

Few studies have evaluated the impacts of trawl disturbance on Arctic benthic ecosystems. Preliminary estimates, however, show that 30–50 % of the reefs in the Norwegian Exclusive Economic Zone (EEZ) have been impacted or damaged by bottom trawling [4] (Figure 17.1B–C). Reefs damaged by trawling have been documented also in the Faroe Islands and Iceland. All three countries have closed some coral areas against trawling.

In the Aleutian Islands corals and sponges are common by-catch [9] and one study showed that about 40% of the surveyed sea floor was disturbed by trawling [1]. In 2006, the Aleutian Islands Coral Habitat Conservation Area was established prohibiting bottom trawling in a 950,000 km^2 area around the island chain and closed six coral gardens to all bottom tending fishing gear [5].

There is little quantitative information on the impact of trawling on sponge communities in the Arctic (Figure 17.1E–F). However, studies from other areas indicate that lumpy, non-flexible species are the most vulnerable. Trawling not only causes physical damage to the organisms but also turns over the substrate and causes re-suspension of sediments [10]. This is crucial because the water immediately above the seabed contains a naturally high concentration of particles with dead organic matter that sponges, as well as corals, feed upon. Re-suspension of sediments due to trawling causes organic matter to mix with mineral particles from the sediments. The result is lower food quality for suspension feeders and a high concentration of mineral particles in suspension that can clog up the filtering mechanism of sponges.

Drilling for oil and gas can impact VMEs through anchoring operations and discharge of drill mud and cuttings to the seafloor. During production, additional impacts may result from the discharge of produced water if it is not injected back into the geological structures. Handling of pipelines and cables may directly interfere with benthic communities, as can anchor operations by the vessels.

For most of the Arctic, there is no quantitative information on the impact of human activities on VMEs making it difficult to evaluate trends. In several countries, however, (e.g., Iceland, Norway, and the US) restrictions on trawling have been imposed on coral reefs and coral gardens through the establishment of coral Marine Protected Areas (MPAs). It is expected that human impacts have ceased within the MPAs, and in Norway satellite tracking shows that the restrictions are respected. In areas with no such protection it is likely that human activities still have a negative impact on corals. There are no restrictions specificly aimed at sponges in the Arctic. The lack of information about distribution makes it very difficult to evaluate trends, but large sponges are easily caught as by-catch in trawls and thus there may be an ongoing negative trend.

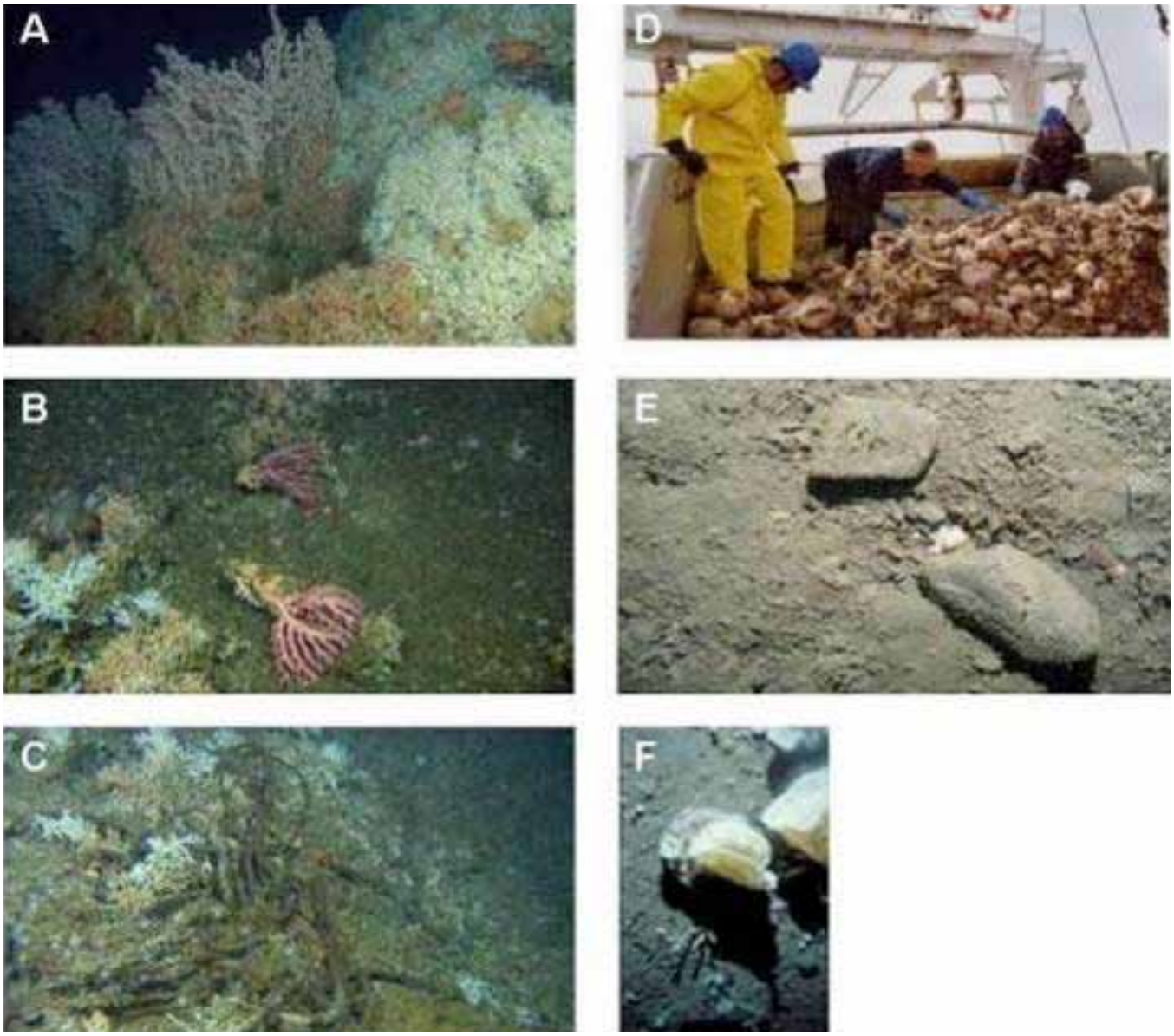

Figure 17.1: (A) Typical *Lophelia pertusa* reef at 160 m depth in Lopphavet, Finnmark county, northern Norway. Other species on the photo are the gorgonian coral *Paragorgia arborea* ("bushes" upper left), redfish *Sebastes* sp. and *Mycale* sponges (lower left and right). **(B)** Korallen, the northernmost coral reef in the world at about 71 °N. Smashed *Lophelia* skeletons and slain down gorgonian corals (red). **(C)** A dumped or lost wire at Korallen. **(D)** Agassiz trawl sample from a sponge ground off Iceland. Demonstrates how sponges are prone to be caught in large numbers by bottom trawls. **(E)** Axinellid sponges found in Langanes fisheries closure north of Iceland. The field was closed in 1993 and the photo is from 2005. **(F)** Typical bottom from a trawled area close to the Langanes closure in Iceland. Large sponges are rare in the trawled area.

Concerns for the future

Large areas of the Arctic are not mapped and the full distribution and condition of the VMEs are not assessed. Thus, there is an urgent need to map and evaluate the condition of the hitherto defined VMEs and to use new knowledge to define additional VMEs if necessary.

Increasing sea temperature will most likely induce changes in the distribution of species and the structure of benthic communities. Ocean acidification and changes in salinity are additional stressors with as yet unpredictable consequences. When ice melts, new and pristine areas may become more accessible to fishing, oil and gas exploration, and seafloor mining. Maritime transport is expected to increase considerably, which will add to the pollution load of the region. Finally, the distribution of fish stocks is expected to change and with it the location of fishing, perhaps bringing more fishing activity into VMEs [11].