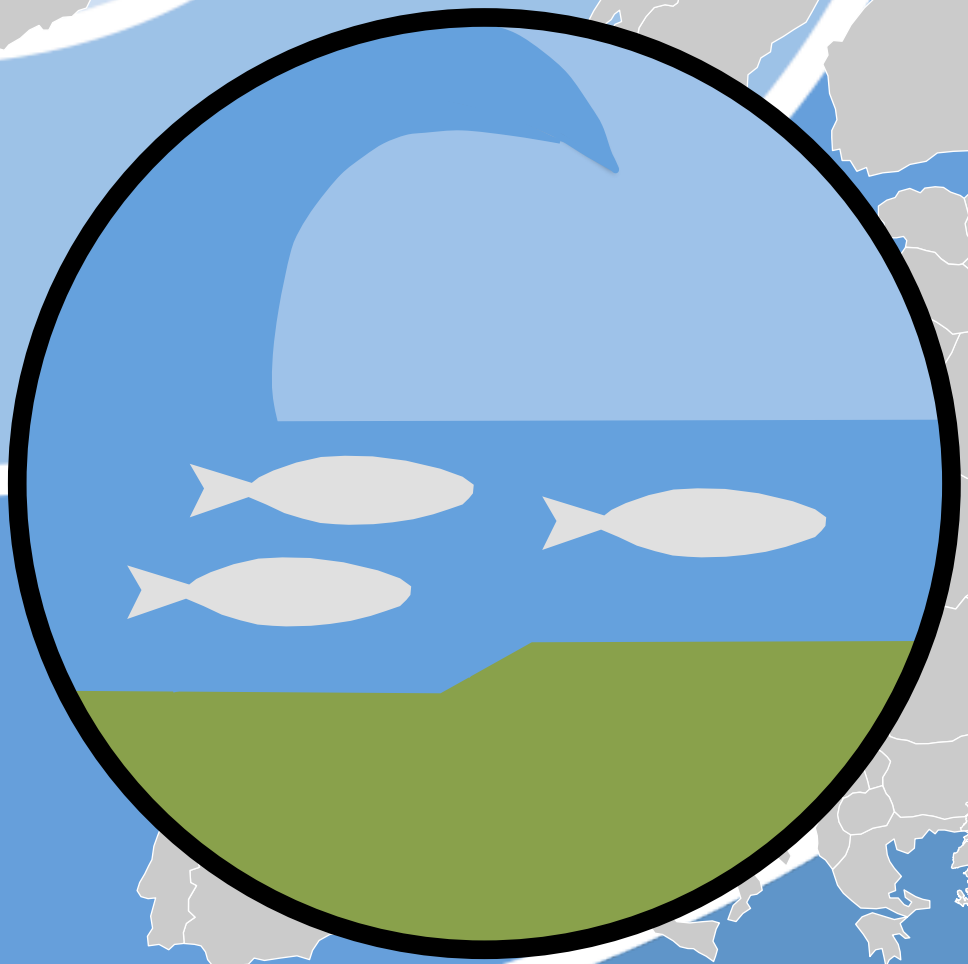
Europe's biodiversity in a changing climate

Part 2: Marine biodiversity



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Biodiversity

Marine ecosystems

The main story

Physical changes

Warmer water

- The average temperature of the upper layers of the ocean has increased by 0.6°C over the past 100 years.
- In polar oceans, temperatures and acidities are changing at more than twice the global average.
- All European seas have warmed considerably since 1870, and the warming has been particularly rapid since the late 1970s. The multi-decadal rate of sea surface temperature rise during the satellite era (since 1979) has been between 0.21 °C per decade in the North Atlantic and 0.40 °C per decade in the Baltic Sea.

Acidification

The oceans have absorbed approximately 50% of the carbon dioxide (CO_2) re-leased to the atmosphere since the beginning of the industrial revolution. When carbon dioxide is absorbed by the oceans it reacts with seawater to form carbonic acid.

Ecological consequences

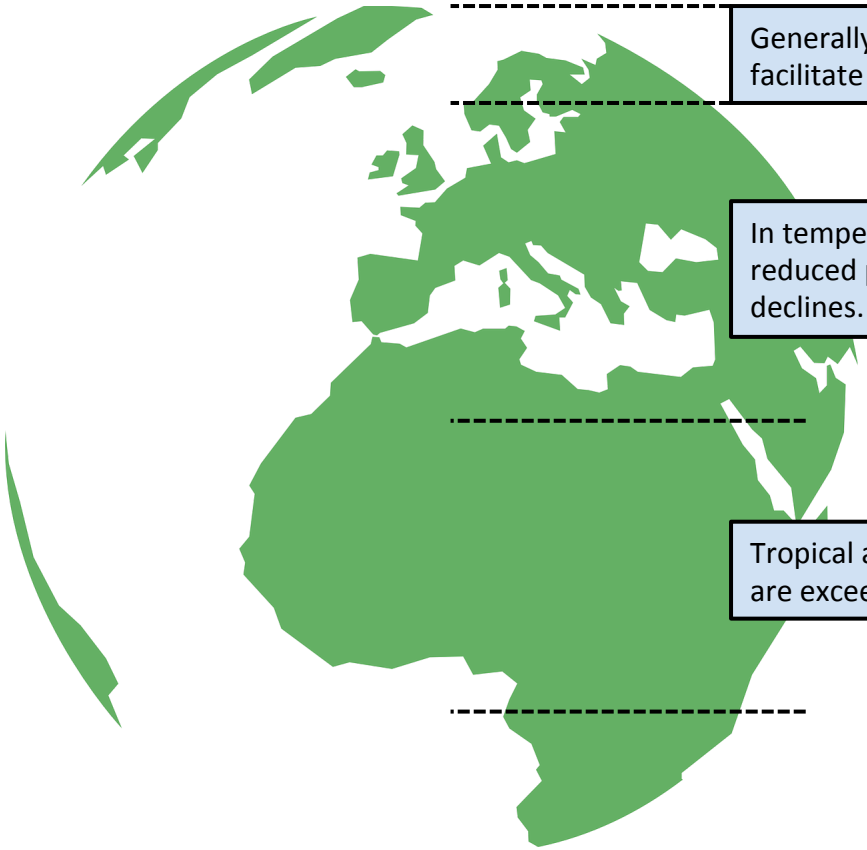
- The warming of the upper layers of the ocean drives greater stratification of the water column, reducing mixing in some parts of the ocean and consequently affecting nutrient availability, primary production and oxygen concentrations.
- The annual primary production of the world's oceans has decreased by at least 6% since the early 1980s. Poleward displacements of phyto- and zooplankton have occurred by hundreds of km's per decade.
- Habitat-forming species such as corals, sea grass, mangroves, salt marsh grasses, and oysters are endangered. Collectively, these organisms form the habitat for thousands of other species.
- A rising number of "exotic" marine species are expanding their ranges from lower to higher latitudes, often with large-scale impacts on ecosystems at the destination.
- The uneven distribution of heating of the world's oceans also strongly influences the behavior of ocean currents, which play critical roles in the dynamics, local climates, and biology of the ocean.

Acidification gradually will make it more difficult for marine organisms to build calcium carbonate shells and skeletons. Impacts of ocean acidification on biological processes are therefore expected, but their exact nature remains largely unknown.

Vulnerabilities and opportunities - global impacts

Main message

Projections indicate: Global ocean animal biomass consistently declines with climate change from the year 1970 to 2100, on average with 5% for every 1 °C of global warming. Projected decline by 2100 is 5 to 17% by 2100.



Generally, warming waters and enhanced primary production are expected to facilitate species expansions and biomass increases in polar regions.

In temperate regions, warming is expected to change species composition, and reduced primary production due to enhanced stratification will result in biomass declines.

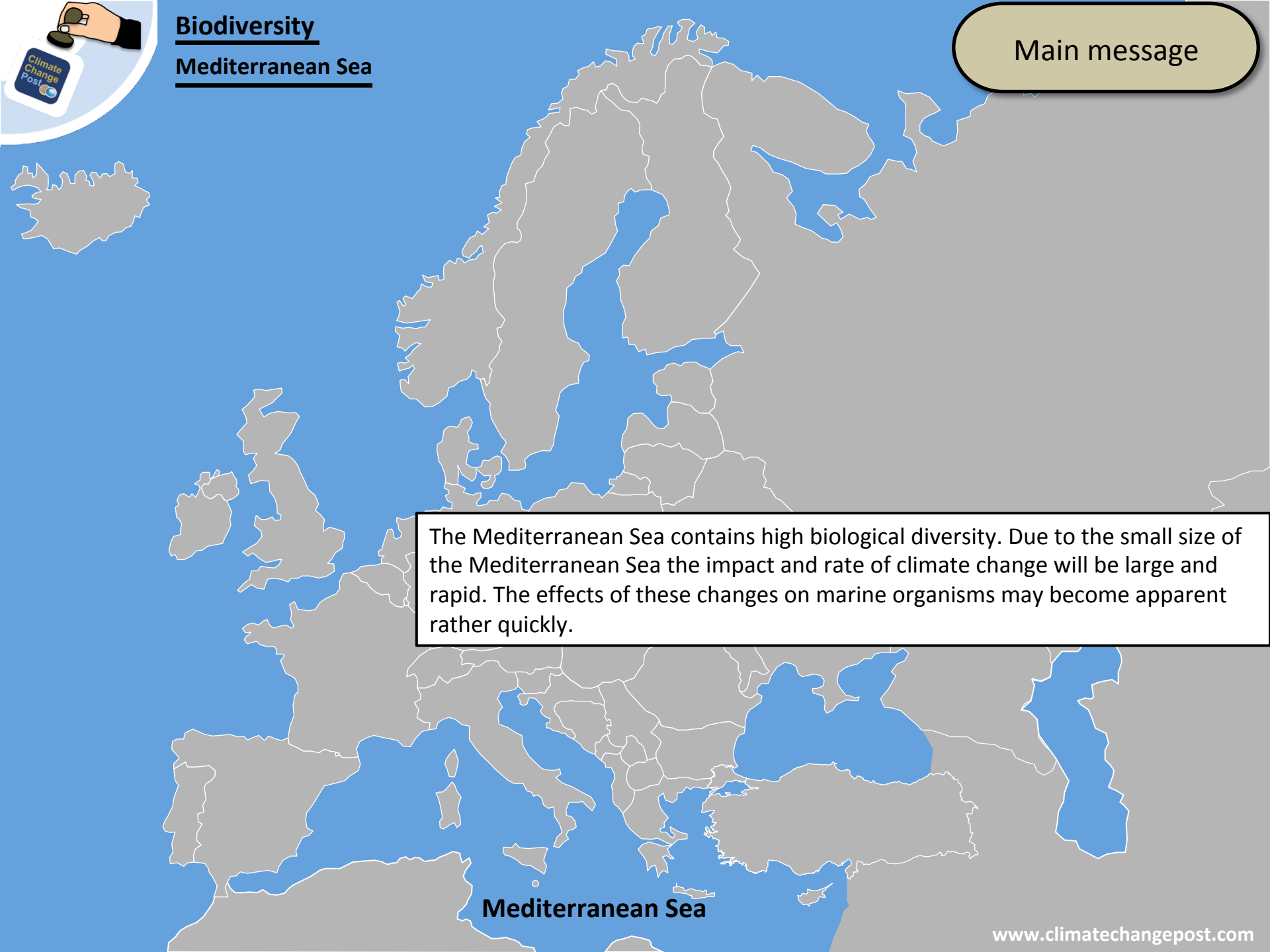
Tropical areas may experience pronounced species losses as thermal thresholds are exceeded.

Source: Lotze et al. (2019)

Biodiversity

Mediterranean Sea

Main message



The Mediterranean Sea contains high biological diversity. Due to the small size of the Mediterranean Sea the impact and rate of climate change will be large and rapid. The effects of these changes on marine organisms may become apparent rather quickly.

Biodiversity

Mediterranean Sea

Pressures

Warmer water

One of the effects on Mediterranean ecosystems is that fish and benthic species from the warm waters of the southernmost parts of the Mediterranean are extending their distribution range to the north. Because coldwater species living in the northern and colder areas of the western Mediterranean basin cannot move farther north, they may dramatically decrease in number or even be at risk of extinction. Endemic species may be replaced gradually by exotic species.

Acidification

Acidification will probably drastically alter marine ecosystems in the Mediterranean and cause a decline of marine biodiversity.

Salinization

The Mediterranean Sea shows a gradual salinization of the water, especially in the intermediate and deep layers (more than 150 m deep), that seems to be related to the general decrease in rainfall and increase in evaporation in the Mediterranean area, and to the decrease in river flow to the sea due to the construction of dams and reservoirs.

Sea level rise

In general, the smaller the tidal range, the greater the susceptibility of marine wetlands to sea level rise. The Mediterranean and Baltic coastal wetlands, which have low tidal ranges, are therefore considered to be more vulnerable than wetlands in the Atlantic and North Sea.

Additional pressures

Climate change is an additional pressure on top of many already experienced by fish stocks, such as fishing, loss of habitat, pollution and disturbance from introduced species. In addition, anthropogenic pressures are found in water management on land, which affects river discharges and habitat loss, and degradation of waters and substrate necessary for fish spawning, feeding and growth.

Mediterranean Sea

Biodiversity

Mediterranean Sea

Local impacts

The combined action of anthropic effects and climate change negatively affects the entire ecosystem. In the Eastern Liguria sea, for example, events of mass mortality regarding a large number of marine invertebrates have already affected a broad geographic area, from the Tuscan archipelago to the Southern France coast, causing on the whole losses higher than 50% in terms of density and biomass of several benthic species.

One of the main problems may be migration of marine species through the Suez Canal, mainly from the Red Sea and Indo Pacific regions into the Mediterranean. It is also expected that a significant number of invasive species will be imported in ballast water.

The eastern Mediterranean is an essentially land-locked basin with nutrient-poor surface waters ("marine desert"). In the past two decades rapid increases of the sea surface temperature have been observed, dominated by changes in summer. The warming of surface and deep waters will result in salinization and water mass stabilization. The marine biodiversity can be affected, e.g. through reduced nutrient delivery to surface waters.

Mediterranean Sea

Biodiversity

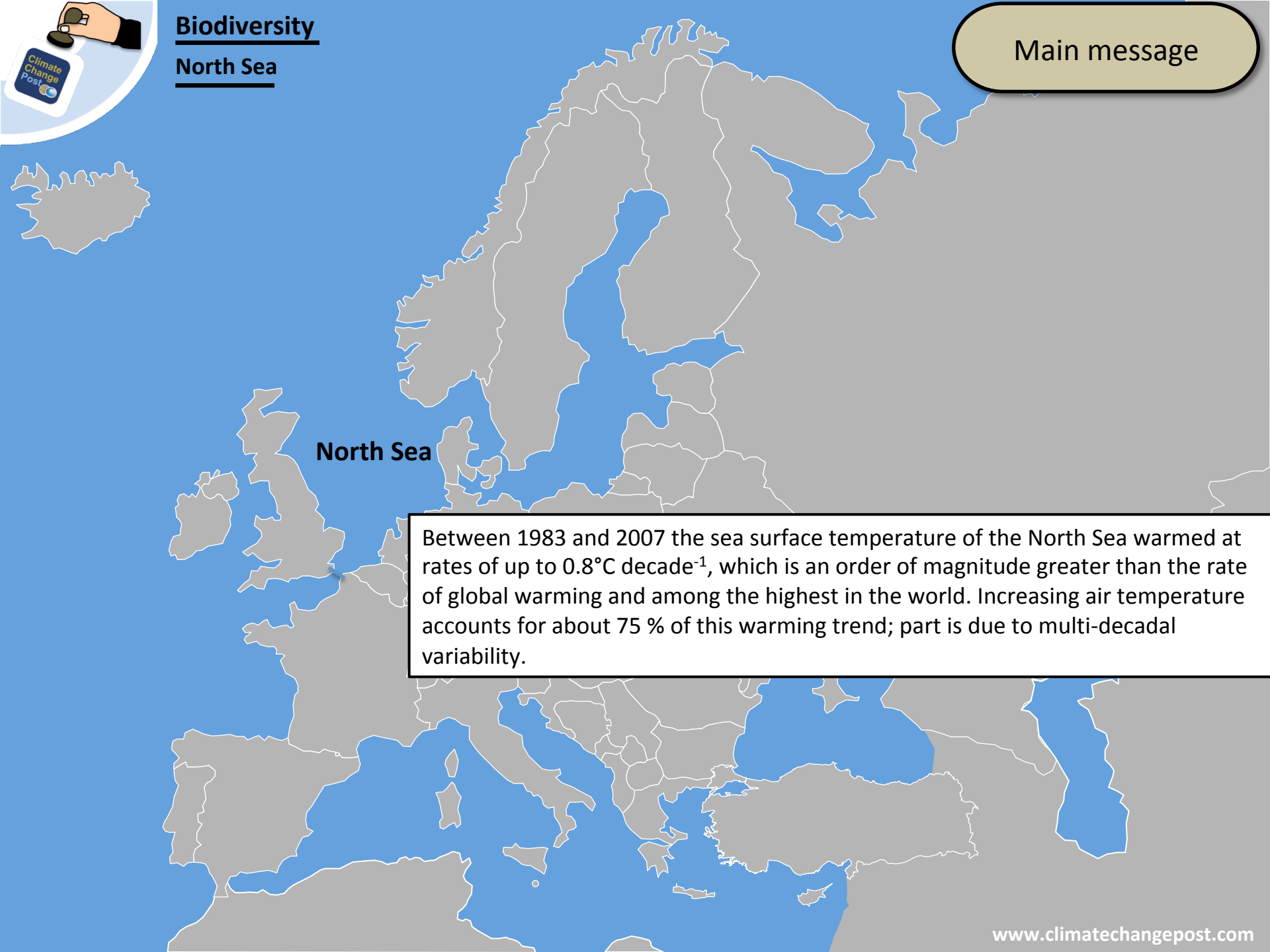
Atlantic Ocean

Local impacts

Biodiversity

North Sea

Main message



Between 1983 and 2007 the sea surface temperature of the North Sea warmed at rates of up to 0.8°C decade^{-1}, which is an order of magnitude greater than the rate of global warming and among the highest in the world. Increasing air temperature accounts for about 75 % of this warming trend; part is due to multi-decadal variability.

Biodiversity

North Sea

Pressures

Warmer water

Plankton in the Greater North Sea have shown a northerly movement of about 250 km per decade over the past 40 years which appears to have accelerated since 2000. Plankton communities are changing from cold to warm water species.

The peak of the spring bloom has advanced. However, the peak density of zooplankton feeding on phytoplankton occurs later in the season, when the availability of phytoplankton as a food source has already dropped. The peak in the plankton bloom is also no longer synchronized with the larval stage of fish and, therefore, fewer fish reach maturity. This means that a limited amount of food is available for the higher levels in the food chain.

North Sea

Warmer water

In the 1960s porpoises were rare along the Dutch coast. Since the 1980s they have been increasingly sighted. It is highly likely that this is due to a geographical shift in their distribution and not to an increase in the local population. The shift may be related to a shift in its prey in the northern North Sea, as a result of which the porpoise has moved further south looking for food.

Warmer water

While overfishing in the North Sea is directly affecting fish populations in general, the rising temperature is probably at least in part responsible for the poor state of the cod population. Fewer larvae are surviving than in the past. This decrease in cod numbers has been attributed to both changes in the plankton and the direct effect of the water temperature on the physiology of the cod.

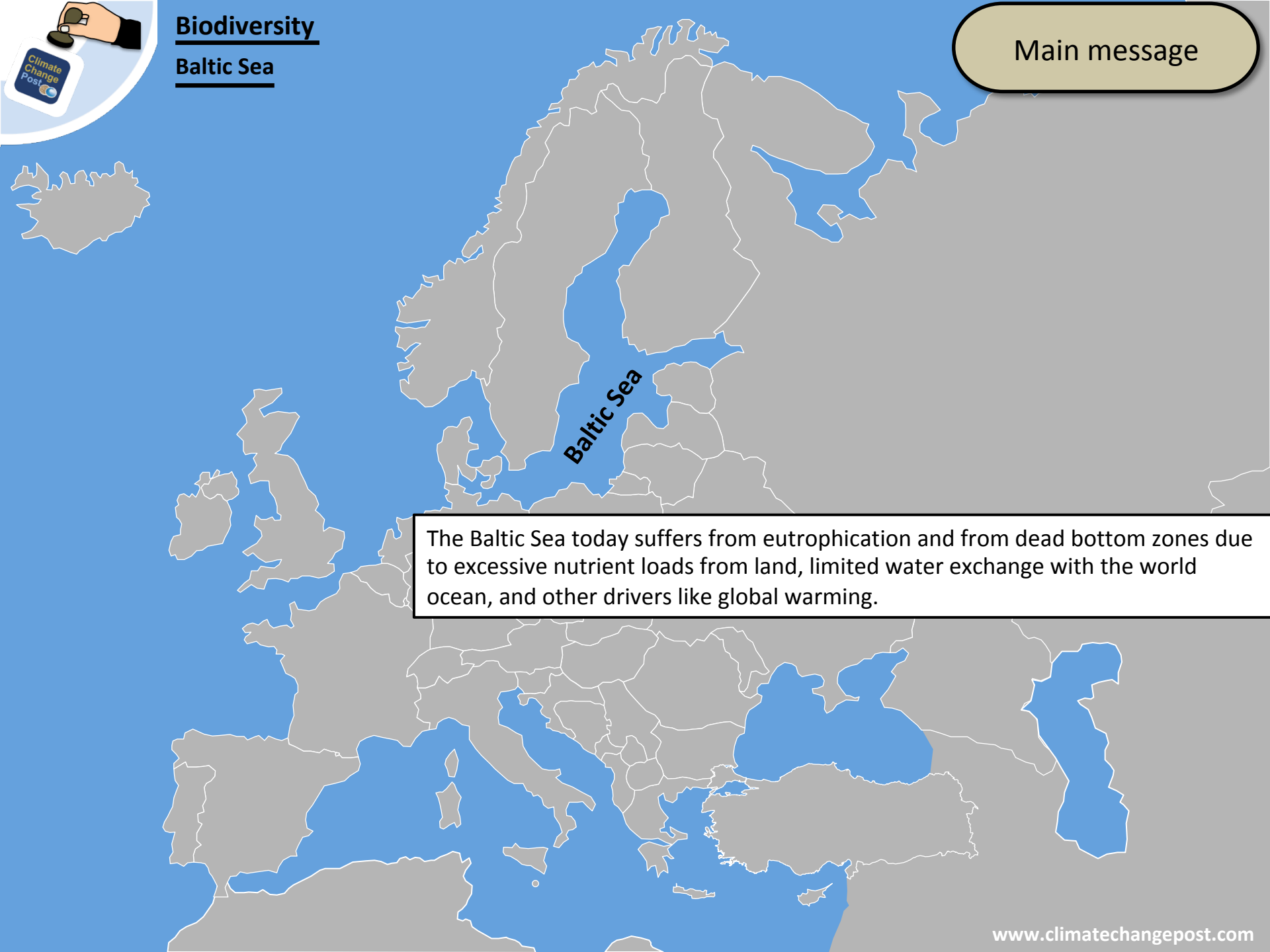
Warmer water

Along with a strong decline in the number of cold water species such as cod, the number of warm water fish species such as sardines and anchovy is being observed. Gradually, the number of species will rise and biodiversity will increase.

Biodiversity

Baltic Sea

Main message

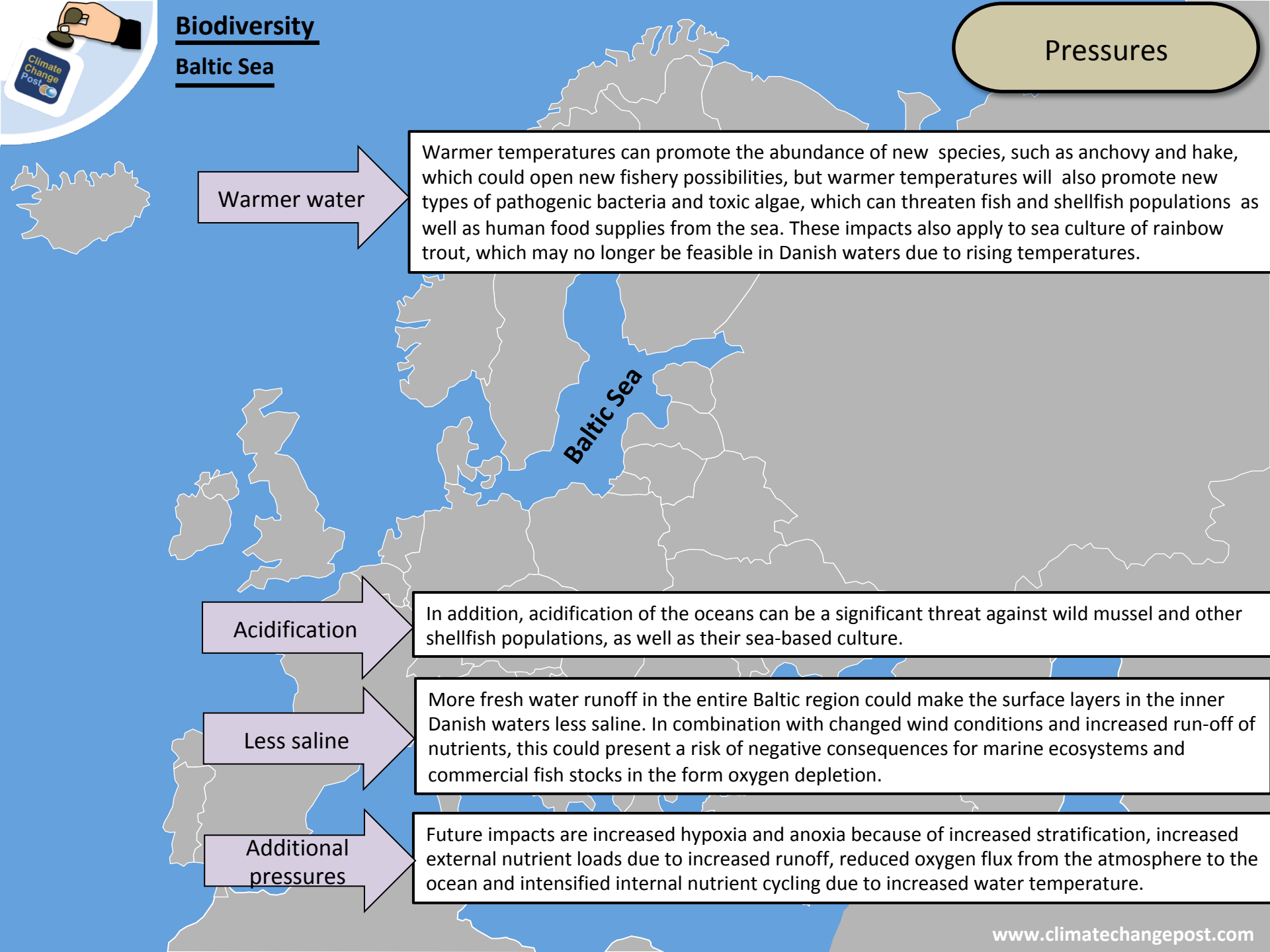


The Baltic Sea today suffers from eutrophication and from dead bottom zones due to excessive nutrient loads from land, limited water exchange with the world ocean, and other drivers like global warming.

Biodiversity

Baltic Sea

Pressures



Warmer water

Warmer temperatures can promote the abundance of new species, such as anchovy and hake, which could open new fishery possibilities, but warmer temperatures will also promote new types of pathogenic bacteria and toxic algae, which can threaten fish and shellfish populations as well as human food supplies from the sea. These impacts also apply to sea culture of rainbow trout, which may no longer be feasible in Danish waters due to rising temperatures.

Acidification

In addition, acidification of the oceans can be a significant threat against wild mussel and other shellfish populations, as well as their sea-based culture.

Less saline

More fresh water runoff in the entire Baltic region could make the surface layers in the inner Danish waters less saline. In combination with changed wind conditions and increased run-off of nutrients, this could present a risk of negative consequences for marine ecosystems and commercial fish stocks in the form oxygen depletion.

Additional pressures

Future impacts are increased hypoxia and anoxia because of increased stratification, increased external nutrient loads due to increased runoff, reduced oxygen flux from the atmosphere to the ocean and intensified internal nutrient cycling due to increased water temperature.

Biodiversity

Estuarine ecosystems and intertidal areas

Local impacts

Changes in sea level may result in significant losses of lagoon and estuarine habitat. Many of the salt marsh systems in **Ireland** provide over-wintering feeding grounds for many species of migratory birds. The loss of these habitats could present major problems for species numbers and diversity. Estuaries may also be affected by decreased runoff, which may reduce flushing. This would allow increased penetration of predators and pathogens of shellfish into estuarial zones.

The **Wadden Sea**, along the coast of the Netherlands, Germany and Denmark, is a wetland of international importance.

- The reproductive capacity of shellfish will decrease in the near future when seawater gets warmer. As a result, shellfish-eating birds, such as Red Knots, oystercatchers and eider ducks, will find less food.
- For the Dutch Wadden Sea a 20% increase in the number of species is predicted at a 2°C increase of water temperature, and an increase up to 30% when temperature rises up to 4°C.
- Sedimentation in the Wadden Sea might no longer keep pace with sea level rise, and sandbanks and salt marshes will become submerged. It is estimated that this critical boundary is between 3 and 6 mm per year. If sandbanks and salt marshes disappear, then many of the plants and animals that are dependent on these (such as shellfish-eating birds) will also disappear.

The **Ebro River Delta**, 200 km south of Barcelona, is one of the most important wetland areas in the Mediterranean region. The area comprises freshwater, brackish and saline lagoons, salt marshes and coastal sandy areas.
Subsidence of the delta coupled with sea level rise could be a major threat: saline water wedging would be enhanced, and decreased freshwater and solid discharge and increased nutrient concentration would lead to chemical pollution, increased eutrophication, water salinity and temperature increase. Climate change driven decreasing flows in the Ebro River will have a further detrimental effect on the ecological status of the lower part of the watershed.

The **Doñana wetlands** in southern Spain provide the most important wintering site for waterfowl in Europe. Its marshes are threatened by eutrophication due to pollution and reduced flow of incoming streams, promoting toxic cyanobacterial blooms, and dominance by invasive floating plants that create anoxic conditions in the water. In addition, groundwater extraction has major effects.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