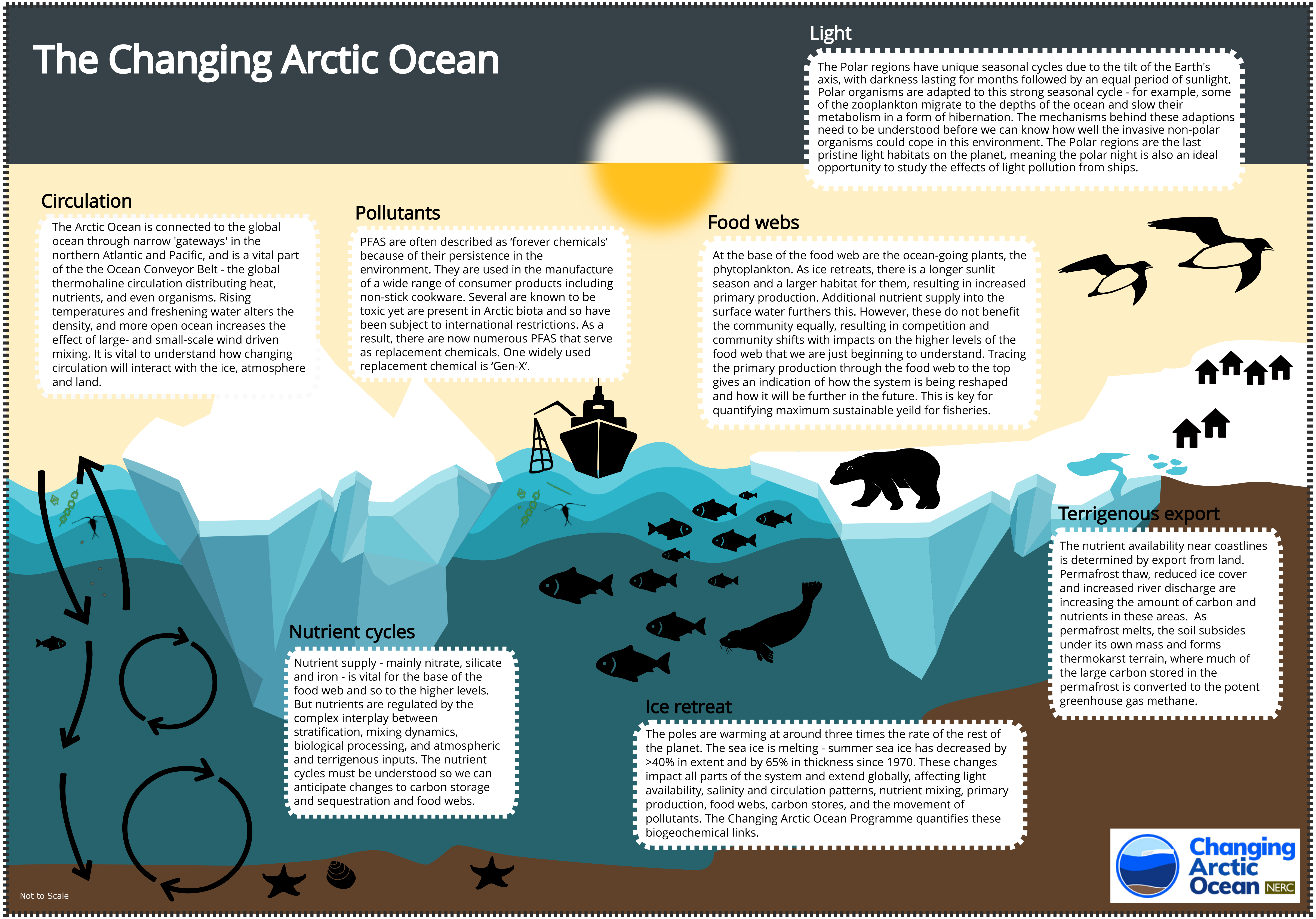
The Changing Arctic Ocean



Light

The Polar regions have unique seasonal cycles due to the tilt of the Earth's axis, with darkness lasting for months followed by an equal period of sunlight. Polar organisms are adapted to this strong seasonal cycle - for example, some of the zooplankton migrate to the depths of the ocean and slow their metabolism in a form of hibernation. The mechanisms behind these adaptions need to be understood before we can know how well the invasive non-polar organisms could cope in this environment. The Polar regions are the last pristine light habitats on the planet, meaning the polar night is also an ideal opportunity to study the effects of light pollution from ships.

Circulation

The Arctic Ocean is connected to the global ocean through narrow 'gateways' in the northern Atlantic and Pacific, and is a vital part of the the Ocean Conveyor Belt - the global thermohaline circulation distributing heat, nutrients, and even organisms. Rising temperatures and freshening water alters the density, and more open ocean increases the effect of large- and small-scale wind driven mixing. It is vital to understand how changing circulation will interact with the ice, atmosphere and land.

Pollutants

PFAS are often described as 'forever chemicals' because of their persistence in the environment. They are used in the manufacture of a wide range of consumer products including non-stick cookware. Several are known to be toxic yet are present in Arctic biota and so have been subject to international restrictions. As a result, there are now numerous PFAS that serve as replacement chemicals. One widely used replacement chemical is 'Gen-X'.

Food webs

At the base of the food web are the ocean-going plants, the phytoplankton. As ice retreats, there is a longer sunlit season and a larger habitat for them, resulting in increased primary production. Additional nutrient supply into the surface water furthers this. However, these do not benefit the community equally, resulting in competition and community shifts with impacts on the higher levels of the food web that we are just beginning to understand. Tracing the primary production through the food web to the top gives an indication of how the system is being reshaped and how it will be further in the future. This is key for quantifying maximum sustainable yeild for fisheries.

Terrigenous export

The nutrient availability near coastlines is determined by export from land. Permafrost thaw, reduced ice cover and increased river discharge are increasing the amount of carbon and nutrients in these areas. As permafrost melts, the soil subsides under its own mass and forms thermokarst terrain, where much of the large carbon stored in the permafrost is converted to the potent greenhouse gas methane.

Nutrient cycles

Nutrient supply - mainly nitrate, silicate and iron - is vital for the base of the food web and so to the higher levels. But nutrients are regulated by the complex interplay between stratification, mixing dynamics, biological processing, and atmospheric and terrigenous inputs. The nutrient cycles must be understood so we can anticipate changes to carbon storage and sequestration and food webs.

Ice retreat

The poles are warming at around three times the rate of the rest of the planet. The sea ice is melting - summer sea ice has decreased by >40% in extent and by 65% in thickness since 1970. These changes impact all parts of the system and extend globally, affecting light availability, salinity and circulation patterns, nutrient mixing, primary production, food webs, carbon stores, and the movement of pollutants. The Changing Arctic Ocean Programme quantifies these biogeochemical links.

Changing Arctic Ocean NERC