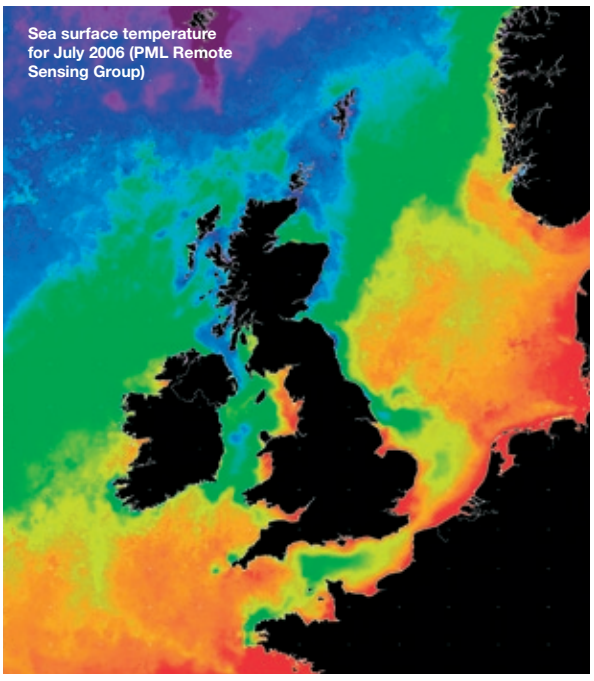
MCCIP Marine Climate Change Impacts Partnership

Marine climate change impacts

Annual Report Card 2006

We are observing large changes in our marine environment that are driven in part by climate change. This report card represents our first step in bringing together evidence from across the UK science community to help YOU understand and act upon the issues.



Sea surface temperature for July 2006 (PML Remote Sensing Group)

"I'm no longer sceptical. Now I do not have any doubt at all. I think climate change is the major challenge facing the world."

David Attenborough

www.mccip.org.uk/arc

Introduction

We are observing large changes in our marine environment that are driven in part by climate change and that are predicted to continue into the future. Mitigating and adapting to these changes will present significant challenges for decision makers. Providing sound scientific advice is an integral part of this process and is the primary goal of the Marine Climate Change Impacts Partnership (MCCIP) and this, its first Annual Report Card (ARC). The UK has set out a vision for "clean, safe, healthy, productive and biologically diverse oceans and seas", yet as recently as 2005, the Defra publication *Charting Progress* was unable to assess the potential impacts of climate change on the UK's marine environment. MCCIP has come together to inform key decision makers about these issues.

Leading scientists from around the UK have contributed reports on the science of marine climate change. Their full assessments are available online (www.mccip.org.uk/arc) and are summarised here in the ARC, which has been peer reviewed by an expert panel. Each of the scientists also rated their level of certainty in the statements of what is happening now and what could happen in the future by qualitatively assessing both the amount and consistency of the available information. This is presented as high, medium or low confidence.

The ARC begins with a summary of climate changes in the marine environment, setting the context for the subsequent assessments of impacts on our vision for an ecosystem that is healthy and biologically diverse; clean and safe; and (commercially) productive. These impacts could be good or bad, but that judgement needs further debate, and what is presented here should inform it.

For a glossary of technical terms, the full reports and information on the confidence assessment, please see the online ARC: www.mccip.org.uk/arc

Climate change in the marine environment

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN	CONFIDENCE
Temperature (air and sea) NOCS, FRS, Met Office, UKCIP	• Sea surface temperature (SST) and air temperature over the sea within the mid-latitude North Atlantic and UK coastal waters have been rising by 0.2 – 0.6ºC per decade over the past 30 years. • Warming is greatest within the English Channel and North Sea where temperatures have risen faster than land temperature. • Warming is also evident in waters of the upper 1500 m of the North Atlantic.	• Climate change models anticipate that SST will continue to rise in all waters around the UK coast, with stronger warming in the south-east (~0.15 – 0.4ºC per decade in the southern North Sea) than the north-west (~0.05 – 0.2ºC per decade at Rockall).	HIGH
Ocean salinity NOCS, FRS, UKCIP, Cefas	• An increasing trend in surface salinity since 1995 around the North Atlantic is less evident in the UK shelf-seas. • Deep waters of the North Atlantic have freshened over the past 40 years.	• Difficult to predict, but changes in precipitation, evaporation, ocean circulation and ice melt have the potential to impact upon salinity.	LOW
Storms and waves NOCS, Met Office, ERI	• There has been a greater incidence of severe winds and increasing wave heights (by about 2% per year) in western and northern UK territorial waters over the past 50 years.	• Different modelling approaches project different scales of change but indicate that wind strength and wave heights will increase.	HIGH (present) LOW (future)
Large-scale oceanic processes NOCS	• The Atlantic Meridional Overturning Circulation (MOC) helps to maintain relatively mild temperatures in north-west Europe. Some observations suggest that the MOC has reduced in strength by up to 30% since the early 1990s. However, other studies disagree with this interpretation.	• Most climate models anticipate some reduction in strength of the MOC due to increased freshwater influence in high latitudes, but continue to show overall future warming of the UK climate. • An abrupt MOC shutdown leading to rapid cooling remains a high-impact, low-probability event. Our level of understanding is hampered by both model and observation limitations.	LOW

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN	CONFIDENCE
Sea level Hadley Centre, UKCIP	• Global average sea level has risen during the 20th century by between 1 and 2 mm per year. Satellite measurements suggest the rise was around 3 mm per year for the period between 1993 and 2003.	• During the 21st century it is likely that global average sea level will rise by between 9 and 88 cm, relative to 1990, but will not be uniform around the world. • The anticipated range of relative sea-level rise by the 2080s (relative to the 1961 – 1990 mean) is 20 to 80 cm in south-west England and 0 to 60 cm in Scotland.	MEDIUM
Acidification PML	• Ocean acidity has been relatively stable for over 20 million years. • The ocean is becoming more acidic as increasing atmospheric carbon dioxide (CO_2) is absorbed at the sea surface. Models suggest that surface pH has decreased by 0.1 pH unit since pre-industrial times.	• Model projections suggest that the change in average pH in UK waters this century will exceed its current range of variation. • The full impacts of acidification remain largely unknown but organisms such as corals, some plankton, shellfish and sea urchins are expected to become less able to produce calcareous parts, such as shells, by the middle of this century.	HIGH (for pH change)
Shelf-sea stratification Cefas	• Stratification is the term used when the sea becomes layered due to changes in temperature and salinity with depth.The seasonal cycle of stratification in shelf-seas is subject to significant interannual variability in timing and strength. • Modelling suggests that, over the last 40 years, the timing of peak stratification in the Irish Sea has become later by about 20 days.	• Possible changes in timing and strength of stratification. • Changes to rainfall seasonality and extreme events may impact stratification in areas of freshwater influence, such as estuaries.	LOW
Seabed (nearshore and offshore) Cefas	• Unknown. At present there are no changes definitely attributable to climate change.	• Changed sediment conditions at some coastal environments, such as partially enclosed lagoons and bar-built estuaries, may occur. • Sediment supply may be altered if climate change results in the modification, construction or removal of sea-defences.	LOW

Climate change: impacts on our vision for a healthy and biologically diverse marine ecosystem

The variety and distribution of marine species are being altered by climate change, although it is not the only factor. Cold-water species of plankton, fish and intertidal invertebrates are retreating northwards around the UK and the ranges of southern species are expanding. Fishing pressure remains the principal cause of changes in the abundance of most fish species, but climate has probably also played a role in some cases. For example, the decline of prey species (particularly sandeels) has resulted in low breeding success of black-legged kittiwakes and other seabirds.

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN	CONFIDENCE
Plankton SAHFOS	• A 1000 km northward shift of warmer-water plankton, with a similar retreat of colder-water plankton, has been observed in the north-east Atlantic over the past 40 years as the seas around the UK have become warmer. • There is a correlation between plankton shifts and changes in various fish stocks.	• Continued increase in sea temperature and ocean acidification may exert a major influence on plankton variability, with implications for primary production and climate control.	MEDIUM
Fish MBA	• Abundances of some warm-water fish species (e.g. tuna, stingrays, triggerfish) have increased in southern UK waters during recent warming periods (1950s, 1980s – 2002), while declines were apparent during cooling episodes (1920s, 1960 – 1970s). Observations of rare fish migrants to UK waters cannot be directly attributed to climate change. • Cold-water species have retracted north in some regions (e.g. North Sea) but not in others.	• Continuing temperature rises are likely to further change fish distributions.	LOW
Marine mammals SMRU	• There is little useful information on the effects of climate change on marine mammals.	• There appear to be no special circumstances that suggest marine mammals around the UK should be severely affected. • Sea-level rise may affect current haul-out sites for seals, but the rate of change and creation of new sites may allow their populations to adapt. • As top predators in the food chain, marine mammals may be impacted by changes affecting the food chain that supports them.	LOW
Seabirds JNCC, CEH	• Poor breeding success, reduced survival and population declines of black-legged kittiwakes in recent years have been strongly linked to climate change, in particular to warmer winters and changes to their fish prey populations (e.g. sandeels). Evidence suggests other species may have been similarly affected.	• Further declines in some seabird populations are expected. • Anticipated sea-level rise may reduce available breeding habitat for shoreline-nesting species (e.g. terns). • Potential increased storminess could detrimentally affect cliff-nesting colonies of seabirds.	MEDIUM
Non-native species Cambridge University, SAHFOS	• New marine life is arriving into our waters both by migration and by human introduction. • The number of different non-native species is increasing in marine habitats and some are causing major ecological changes. • Distributions of non-native species are currently limited by water temperature. • Warmer UK waters over the last three decades are facilitating the establishment of some of these species.	• Future temperature increases could enable a wider range of species to invade and become established.	MEDIUM

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN	CONFIDENCE
Intertidal species MBA, MECN	• Southern, warm-water species on rocky shores in the UK have increased in abundance and range with rising temperatures (e.g. purple acorn barnacle has extended its range by 170 km since the mid 1980s), whilst northern, cold-water species (e.g. common tortoiseshell limpet) have decreased in abundance.	• Continued extension and retraction of ranges with rising temperatures of southern and northern species respectively. • Some new species will become established whilst others will disappear from our shores.	MEDIUM
Seabed ecology University of Liverpool, MECN	• Climate processes such as sea temperature and waves can directly influence the abundance and species composition of seabed communities. • Localised effects through fishing impacts, habitat modification and contaminants are also important and make it difficult to assess the influence of climate change.	• Unknown.	LOW

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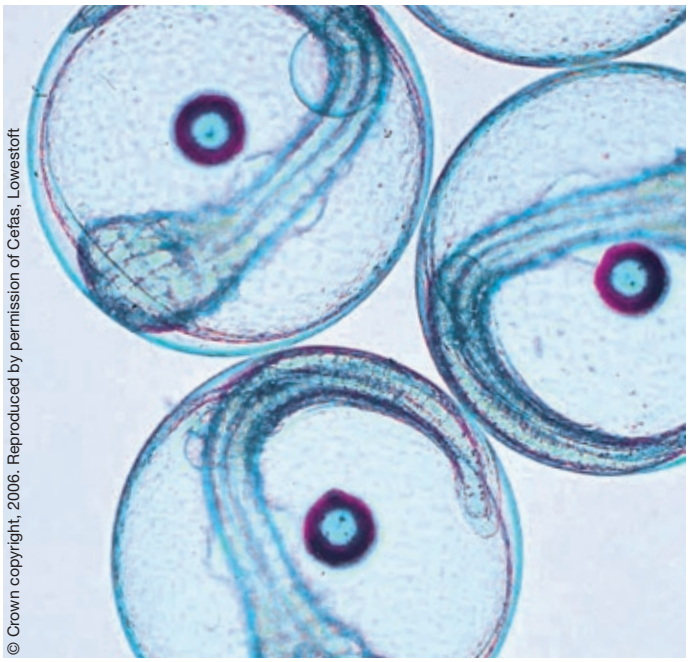

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Climate change: impacts on our vision for clean and safe seas

Future changes in the intensity and frequency of extreme events may alter the pattern of inputs of chemicals, nutrients and pathogens to the marine environment and increase the risk of coastal flooding. Other climate changes may impact upon the fate of chemicals, nutrients and pathogens; change exposure of humans to pathogen risk; and alter the distribution and susceptibility of marine species. This area remains largely unstudied because current monitoring programmes are not specifically designed to evaluate climate change impacts, as they are largely focussed on the status and trends of inputs and concentrations of contaminants in the environment.

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN	CONFIDENCE
Coastal flooding Hadley Centre, Defra	• No clear trend in extreme water levels has been observed, other than those associated with a rise in relative mean sea level.	• Future extreme flood events may become more common due to local relative sea-level rise and increased storminess. • Flood events with a 50-year return period might increase in height by more than 1 m during the 21st century at some locations.	LOW
Nutrient enrichment NOCS, Cefas	• Unknown. Nutrient availability is an important component of marine ecosystems but long-term nutrient observations are currently inadequate for identifying climate change impacts on nutrient enrichment.	• The input of nutrients from the shore, the natural process of removing them and how nutrients circulate through the water column are all likely to be affected by climate change. • More episodic river flows might cause short-term high-concentration pulses of nutrients to nearshore environments.	LOW
Harmful Algal Blooms (HABs) SAHFOS	• HABs have increased in some areas of the north-east Atlantic over the past 50 years, as the seas around the UK have become warmer, especially since the mid-1980s. • There is regional variability within this trend and some places, such as the east coast of Britain, have experienced reduced incidences of HABs.	• Potential increase in HABs associated with heavy rainfall and with high river discharges. • Reduced mixing of the water column (increased stratification) would favour many HAB-causing species.	MEDIUM
Pollution Cefas	• Unknown. Pollutant monitoring is currently inadequate for identifying climate change impacts.	• Climate change may influence the release of pollutants currently locked in seabed sediments. • Terrestrial inputs of storm water containing untreated sewage and other pollutants may increase.	LOW

Climate change: impacts on our vision for commercially productive seas

Present understanding of climate change impacts on commercial marine activities is limited, but the future seems certain to present both major challenges and some new opportunities. It appears likely that declines in the populations of commercial cold-water fish will continue although warm-water species could provide new opportunities for both fisheries and aquaculture. Reductions in polar ice cover may increase the Arctic shipping season but elsewhere changes to storminess and waves could impinge on shipping loads and place ports, aquaculture sites and other marine structures at risk. Ports and other coastal structures may also be at increased risk from sea-level rise and coastal flooding. Conditions for tourism in our coastal zone are becoming increasingly favourable but significant effort is required to exploit available opportunities and manage associated environmental pressures.

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN	CONFIDENCE
Shipping MCCIP	• Unknown. No studies currently available.	• Major risks to ports from flooding and physical damage associated with sea-level rise and storminess. • Future changes in wind speed and storminess could lead to reduced loads, route changes and restrictions for some ships. • Continued decline of Arctic sea-ice could open up new shipping routes and increase the Arctic navigation season from Europe to Asia from 20 – 30 to 90 – 100 days per year within the next century.	LOW
Tourism CRU, MCCIP	• Climate change is increasing the frequency of months when conditions are more comfortable for tourists in north-west Europe than in the Mediterranean.	• The north-west European coast will be subject to enhanced pressure from tourism (e.g. through a longer holiday season). • Sea-level rise, increased storminess and changes in rainfall patterns may have an influence on infrastructure and desirability of holiday locations.	MEDIUM
Built structures Cefas	• Unknown, but allowances for annual rates of sea-level rise are accounted for in the planning of coastal structures.	• Future risks to offshore structures from changes in the frequency, intensity and direction of wave heights are unknown.	LOW (for waves)
Fisheries Cefas	• Warm-water commercial species such as sea bass, red mullet and tuna are becoming more commonplace in our seas. • Cold-water species, such as cod, have declined, with a possible link suggested between warmer sea temperatures and reduced populations of fish at the southern limit of their distribution range. (Fishing remains the main pressure on commercial fish stocks.)	• Continued decline in abundance and northward retreat in distribution of commercial cold-water species. • Changes to ocean circulation might affect movement of young fish from spawning grounds to nursery areas. • New species might become available for commercial exploitation. • Climate change impacts on primary productivity will affect fisheries, but they are not yet well understood.	MEDIUM
Aquaculture FRS	• Unknown. No studies currently available.	• Rising water temperatures could increase growth rates for some species, but may cause thermal stress for cold-water species and intertidal shellfish. • New species may be cultivated. • Temperature change will affect diseases of farmed species and thermal stress is likely to increase disease susceptibility. • Storm damage to farms may increase escapes and result in fewer suitable areas. • Occurrence of harmful algal and jellyfish blooms may change, leading to fish kills and closure of shellfish harvesting areas.	LOW

ARC Online and more information...

Each section of the report card has to be very brief – if you are interested, a more detailed report from each contributing scientist is accessible through our online ARC at **www.mccip.org.uk/arc**

What is MCCIP?

MCCIP is a partnership between scientists, government, its agencies and NGOs. The principal aim is to develop a long-term multi-disciplinary approach to understanding and communicating the implications of climate change in our seas.

Sponsoring partners are:
Countryside Council for Wales, Defra, Dept. of the Environment Northern Ireland, Environment Agency, Natural England, RSPB, Scottish Environment Protection Agency, Scottish Executive, Scottish Natural Heritage, States of Guernsey, States of Jersey, Welsh Assembly Government, WWF. (More partners welcomed.)

Future Developments for MCCIP

- Newsletter
- Workshops and seminars
- Links with industry
- Response centre for marine climate change enquiries
- Exploration of applications of future UKCIP marine climate change scenarios

Quality Assured Science

The MCCIP Steering Group (SG) consists of the sponsoring partners together with scientific experts from SAHFOS, CRU, MECN, FRS, Natural Environment Research Council 'RAPID' programme and Cefas.

The SG commissioned the contributing scientists and appointed an 'Expert Advisory Panel' who reviewed the quality of the science in the ARC.

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Further details on the work of MCCIP or on becoming a sponsor can be found on our website (www.mccip.org.uk). If you have any further enquiries please contact us at office@mccip.org.uk

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Your feedback

This is the first Annual Report Card. We will publish this annually to keep you up to date with new developments in the science and the rapidly changing marine environment.

Future publications will chart the progress of the themes explored here and look in greater detail at regional changes and the linkage between people and the marine environment. We will also report on new findings and improvements in our understanding of the science (increasing certainty), and will highlight any major knowledge gaps.

We would be grateful for your feedback on this and other aspects of MCCIP work to ensure that we are meeting YOUR needs. Please email: feedback@mccip.org.uk