CLIMATE CHANGE REPORT CARDS

THE MARINE CLIMATE CHANGE IMPACTS PARTNERSHIP EXPERIENCE AND ARCTIC POSSIBILITIES

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The Need

To ensure politicians and their advisers take decisions in a timely fashion based on accurate, simple, timely information provided without bias.

It was not to provide advice on what to do.

The Solution

MCCIP KEY TOPICS

MARINE CLIMATE CHANGE
Temperature (air and sea)
Storms and waves
Sea level
Ocean acidification
Atlantic Heat Conveyor
Salinity
Shelf sea stratification
Coastal erosion
Air – sea exchange of CO_2
Air –sea exchange of heat and water

HEALTHY AND BIOLOGICALLY DIVERSE
Plankton
Fish
Seabirds
Waterbirds
Marine mammals
Non-native species
Coastal habitats
Intertidal habitats
Shallow and shelf sublittoral habitats
Deep sea habitats

CLEAN AND SAFE
Coastal flooding
Nutrient enrichment
Harmful algal blooms
Pollution
Human health

PRODUCTIVE
Shipping
Tourism
Built structures
Fisheries
Aquaculture

	WHAT IS ALREADY HAPPENING	WHAT COULD HAPPEN
Temperature (Air and Sea) *Marine Scotland; NOC; Cefas; IMGL; MOHC; PML; SAMS*	**High Confidence** ↔ • Marine air and sea surface temperatures have risen over the north-east Atlantic and UK waters in the last 25 years. • The largest increase in air temperature has been over the southern North Sea at a rate of around 0.6° C per decade. • The largest increases in sea surface temperature have occurred in the eastern English Channel and the southern North Sea at a rate of between 0.6 and 0.8° C per decade. • **Although temperatures are generally increasing, inter-annual variability is high. 2008 UK coastal sea surface temperatures were lower than the 2003–2007 mean.**	**Medium Confidence** ↓ • **Models project that temperatures will continue to rise in UK and north-eastern Atlantic waters up until at least the 2080s. However, in the next 10 years, natural oceanic and atmospheric variability make it difficult to predict whether temperatures will go up or down.**
Seabirds *JNCC; CEH*	**Medium Confidence** ↔ • **Between 2000 and 2008, the total number of seabirds breeding in the UK decreased by approximately 9%. Breeding success also declined. Climate change is partly responsible.** • **Major changes in plankton abundance in the North Sea have contributed to the reduction in quality and abundance of prey species such as sandeels.** • **The greatest reductions in breeding success of species most sensitive to food shortages, such as Arctic skua, black-legged kittiwake and shag are seen in the Northern North Sea and Scottish Continental Shelf.**	**Low Confidence** ↔ • **Models predict that by 2100, UK climate will no longer be suitable for great skua and Arctic skua. The same models predict that the geographic range of black guillemot, common gull and Arctic tern will shrink so that only Shetland and the most northerly tips of mainland Scotland will hold breeding colonies.** • Any increased storminess would reduce the amount of safe breeding habitat for shoreline-nesting species (e.g. terns) and create unfavourable foraging conditions at sea, which may lead to starvation of adults and chicks of some species.

Regional Snapshots of Marine Climate Change Impacts

What Is Already Happening

This map shows some of the changes in each regional sea. It is noticeable that it is in the south that many of the changes are being observed.

Region 1 – Northern North Sea

- Squid are becoming more abundant off north-east Scotland creating new opportunities for fisheries.
- Since 2000 breeding success of seabirds such as Arctic skua, black-legged kittiwake, and shag has declined due to decreased food availability linked to climate change.

Region 2 – Southern North Sea

- The warm water intertidal topshell, *Gibbula umbilicalis* is now established on rocky shores.
- The largest rate of warming in UK sea-surface temperature (1984–2008, ~0.7 °C/decade).
- The largest rate of warming in UK marine air temperature (1984–2008, 0.6 °C/decade).
- Some evidence that warmer conditions have been coincident with increased numbers of the warm-water bivalve *Abra alba*.
- Red seaweed *Caulacanthus ustulatus*, introduced from Asia, now present in Kent.

Region 3 – Eastern English Channel

- Net erosion of saltmarshes in recent decades.
- Red seaweed *Caulacanthus ustulatus*, introduced from Asia, now present in Kent.
- The warm water red tuft alga, *Chondracanthus acicularis*, increased coverage in lower shores.

Region 4 – Western English Channel, Celtic Sea and South-West Approaches

- Increased incidences of disease outbreaks in the pink sea fan *Eunicella verrucosa* linked to increased temperatures.
- Warm water kelp *Saccorhiza polyschides* showing massive increases in abundance and cold water *Alaria esculenta* decreasing in abundance.
- Red seaweed *Caulacanthus ustulatus*, introduced from Asia, now present in Devon and Cornwall.
- Large observed populations of warm-water copepod *Calanus helgolandicus*.
- Coldwater alga *Pelvetia canaliculata* declined in estuaries.
- New fisheries have developed for warm water species. Observed seabass stock biomass has quadrupled since 1985.
- The warm water red tuft alga, *Chondracanthus acicularis*, increased coverage in lower shores.
- Net erosion of saltmarshes in recent decades.

Region 5 – Irish Sea and North Channel

- Northern limit of honeycomb worm *Sabellaria alveolata* extending.

Region 6 – Minches and Western Scotland

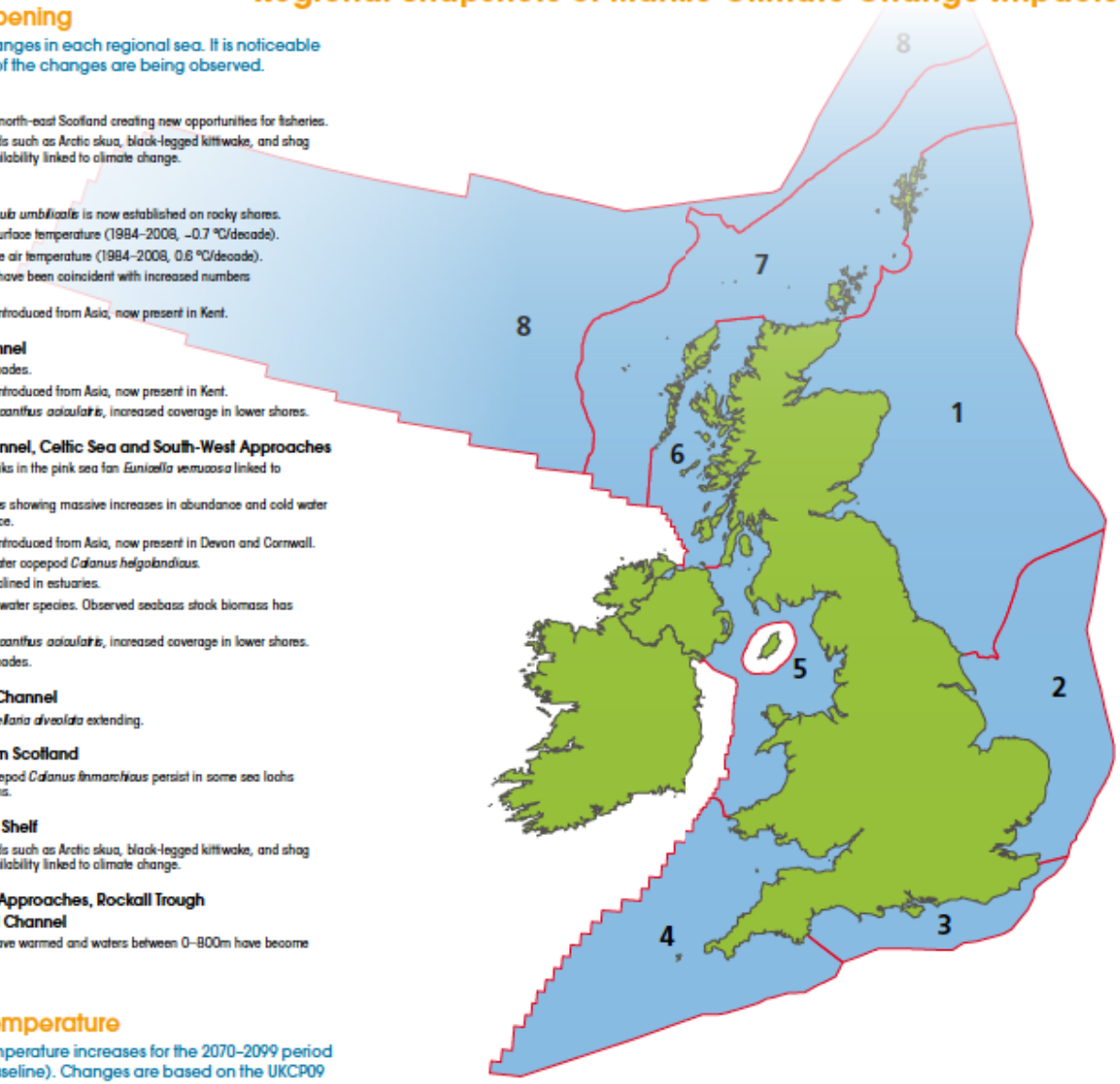
- Relict populations of the cold-water copepod *Calanus finmarchicus* persist in some sea lochs but are vulnerable to changing conditions.

Region 7 – Scottish Continental Shelf

- Since 2000 breeding success of seabirds such as Arctic skua, black-legged kittiwake, and shag has declined due to decreased food availability linked to climate change.

Region 8 – Atlantic North-West Approaches, Rockall Trough and Faroe-Shetland Channel

- Since 1970 waters between 0–600m have warmed and waters between 0–800m have become more saline.



What Could Happen

Based on UKCP09 projections these are some possible consequences of climate change in each regional sea.

Region 1 – Northern North Sea

- 7–54cm sea-level rise projected in Edinburgh between 1990 and 2095 under a medium greenhouse gas emission scenario.

Region 2 – Southern North Sea

- 21–68cm sea-level rise projected in London between 1990 and 2095 under a medium greenhouse gas emission scenario.
- Built structures will be impacted by projected changes in winter significant wave height more so than in most other regions.

Region 3 – Eastern English Channel

- Sea-level rise and storm surge changes are likely to be most severe leading to further decreases in saltmarsh extent.

Region 4 – Western English Channel, Celtic Sea and South-West Approaches

- Increased tendency for stratification could lead to offshore blooms including *Karenia mikimotoi* which has been associated with fish kills and benthic mortalities in coastal waters.
- 21–68cm sea-level rise projected in Cardiff between 1990 and 2095 under a medium greenhouse gas emission scenario.

Region 5 – Irish Sea and North Channel

- Built structures will be impacted by projected changes in winter significant wave height more so than in most other regions.
- 7–55cm sea-level rise projected in Belfast between 1990 and 2095 under a medium greenhouse gas emission scenario.

Region 6 – Minches and Western Scotland

- Increased tendency for stratification could lead to offshore blooms including *Karenia mikimotoi* which has been associated with fish kills and benthic mortalities in coastal waters.

Region 7 – Scottish Continental Shelf

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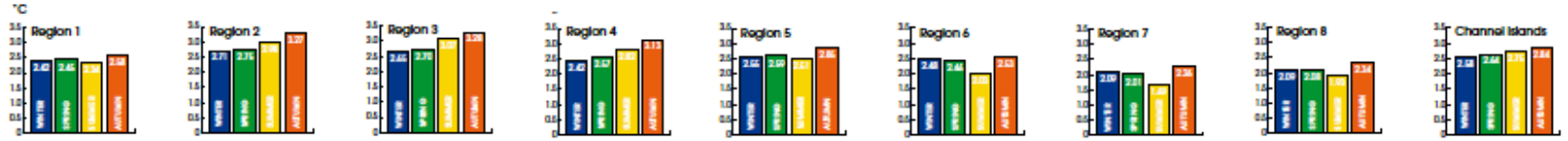
Region 8 – Atlantic North-West Approaches, Rockall Trough and Faroe-Shetland Channel

- Surface layers are likely to be stratified for a longer period during year by the end of the century.
- Increased tendency for stratification could lead to offshore blooms including *Karenia mikimotoi* which has been associated with fish kills and benthic mortalities in coastal waters.

Future Sea Surface Temperature

Seasonal mean sea surface temperature increases for the 2070–2099 period (compared with a 1960–1990 baseline). Changes are based on the UKCP09 model projections under a medium greenhouse gas emissions scenario.

Data courtesy of Met Office Hadley Centre.



Variations on a theme – Special Topics

2009

www.mccip.org.uk/elr

MCCIP Marine Climate Change Impacts Partnership

Marine climate change impacts

Exploring ecosystem linkages

Understanding the links between climate change impacts on the oceans is a critical priority for our future wellbeing. By taking a new 'bigger picture' approach, we can start to show how the interconnected nature of the marine ecosystem magnifies the many discrete impacts of climate change, documented in the MCCIP Annual Report Cards.

To support this new approach, we asked five groups of leading scientific experts on issues such as ocean acidification, Arctic sea-ice loss, seabirds and food webs, non-native species, and coastal economies to give us their views.

CO_2 and ocean acidification

In the last 200 years, ocean acidity has increased by 30% and at a rate much faster than anytime in the last 65 million years. This has serious implications for marine ecosystems and climate regulation.

Arctic sea ice

In the last decade there has been a 35% decrease in summer sea ice extent and a 15% reduction in winter sea ice, leading to changes in habitats and ecosystems.

A view from above

Climate change has already caused changes in plankton, fish distribution and species composition in the seas around the UK. Declines in some seabird populations such as black-legged kittiwakes, terns and skuas may continue as a result.

Non-native species

Most introductions of non-native species have arrived via human intervention, intentional or otherwise. The likelihood that they will establish and flourish in the UK marine environment could be greater due to climate change.

Coastal economies and people

Many of our coastal communities will face both challenges (e.g. increased flood and erosion risks, declining traditional fisheries) and opportunities (e.g. new tourism patterns, new fisheries) through climate change.

PHOTOS from top: Natural History Museum, iStockphoto.com/westphalia, Lorna Gill/SNH, Paul Newland/MarLIN, Davey Benson.

2012

www.mccip.org.uk/ffa

MCCIP Marine Climate Change Impacts Partnership

Marine climate change impacts

Fish, Fisheries & Aquaculture

Understanding how climate change will have an impact on fish and shellfish around the UK and Ireland is fundamental to managing activities in our seas.

MCCIP therefore commissioned three groups of scientists to consider how climate change is affecting marine fish, fisheries and aquaculture and what the social and economic consequences could be.

DISTRIBUTIONS

There are clear changes in the depth and latitudinal distributions, and migration and spawning behaviours of fish, many of which can be related to warming sea temperatures.

MANAGEMENT

Cultivated shellfish and finfish are susceptible to climate change, although finfish farming technologies offer good potential for adaptation.

Controlled or closed fishing areas (a type of protected area) that can be adapted in response to climate change have the potential to help protect commercial and vulnerable fish stocks.

SOCIO ECONOMICS

Marine recreational fishing is an important socio-economic activity that could be positively affected by climate change because of the increasing abundance of species that are of interest to anglers.

WIDER IMPLICATIONS

Shifting distributions of fish have led to a series of international disagreements and will continue to have implications for fisheries management across international boundaries.

2015

www.mccip.org.uk/mbl

MCCIP Marine Climate Change Impacts Partnership

Marine climate change impacts

Implications for the implementation of marine biodiversity legislation

This Report Card looks at climate change and marine biodiversity legislation, with a focus on the legislation used to establish various types of marine protected areas.

Key headlines

Climate change is rarely explicitly considered in marine biodiversity legislation, but mechanisms generally exist that could enable climate change issues to be addressed.

The potential impacts of climate change on marine protected areas include features being gained to or lost from sites and, in certain cases, the entire network.

Flexibility is required in responding to climate change impacts on marine protected areas so options such as designating new sites, abandoning old sites and revising management measures may all need to be considered.

With over 1,250 designated features in the UK marine protected area network, identifying where and how these habitats and species are likely to be affected by climate change will be a critical step in managing marine protected areas.

At the current stage of development for the Marine Strategy Framework Directive, further practical consideration of how climate change could affect targets for the achievement of Good Environmental Status is required.

The Process

- Commission topic experts to provide up-to-date briefing addressing specific questions and provide confidence assessments
- Peer review the briefing
- Revise the briefing in light of peer review comments
- Report card working group summarize and simplify key messages from briefing documents
- Check with experts that simplified key messages are accurate
- Publish report card and full briefing documents

The Feedback

- The report cards are used by a wide range of people including advisers and politicians to inform thinking and policy decisions
- The full briefing papers and cards are well cited in peer review literature
- The process is well respected and experts are fully engaged and willing to continue to contribute
- Special topic reports are requested by advisers and politicians

Marine Climate Change in Australia

Impacts and Adaptation Responses 2012 REPORT CARD

This report card summarises our current knowledge of marine climate change impacts for Australia, highlighting key knowledge gaps and adaptation responses

Australia's oceans generate considerable economic wealth through fisheries, aquaculture, tourism and mining. Marine ecosystems provide irreplaceable services including coastal defence, oxygen production, nutrient recycling and climate regulation. Unless we adapt and mitigate, climate change will threaten our economic prosperity and social well-being.

Key findings:

- Climate change is already happening: Widespread physical changes include rapid warming of the southeast and increasing flow of the East Australia Current. Increasing biological impacts include reduced calcification in Southern Ocean plankton and Great Barrier Reef corals from both warming and acidification
- Scientists, managers and resource users are working to design adaptation strategies that reduce the vulnerability of marine species, systems and industries to climate change
- We are observing and monitoring key physical and biological variables in the ocean, which is critical to evaluating effective adaptation strategies.
- Preparation for climate change also involves changes in management or policy arrangements that currently limit adaptation responses.

www.oceanclimatechange.org.au

Commonwealth Marine Economies Programme

Funded by UK Government

Caribbean Marine Climate Change Report Card 2017

What you need to know about the impact of climate change on the critical state of coasts and seas in Caribbean Small Island Developing States (SIDS), and what needs to be done.

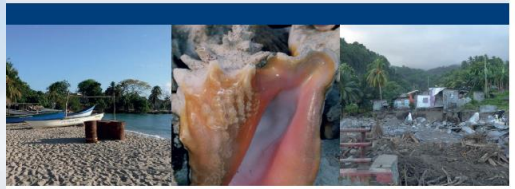
Key messages:

Caribbean states are particularly vulnerable to climate change which presents a significant risk to the region's people.

Climate change can have significant negative impacts on the quality of life of Caribbean peoples, if an integrated approach to dealing with its social impacts is not taken.

Much more needs to be done to reduce other human pressures on island systems to make states more resilient to climate change.

The seas, reefs and coasts on which all Caribbean people depend are under threat from coral bleaching, ocean acidification, rising sea temperature, and storms. There needs to be a greater effort to protect these resources.



CRFM mc3 UWI

Extreme events

What is already happening?

Since the 1990s, there has been an increase in both the number and strength of storms and hurricanes in the North Atlantic. These changes have important consequences for society, given the damage and destruction that hurricanes inflict on lives and infrastructure, as well as the damage done to natural sea defences such as corals and mangroves.

Changing patterns of rainfall are having serious impacts. Prolonged droughts are leading to serious water availability issues for local populations and tourists. Some of the most extreme flooding events in recent years have not been associated with hurricane events; rather, they have been caused by extreme rainfall events.

Sea level in the region has risen by around 20 cm over the past 100 years, increasing the risk of flooding.

What could happen?

While the overall frequency of Atlantic storms may decrease in the future, the strongest category 4 and 5 storms may increase by 80% in frequency over this century, with higher winds and rainfall rates associated with these storms.

Global mean sea level is projected to rise by a further 26-82 cm (10-32 inches) over the coming century, but higher increases exceeding a metre are possible. In the northern Caribbean, sea level rise could be 25% higher than the global average due to other physical factors affecting land elevation.

This projected rise in sea level and severe storms is likely to increase the risk of storm surge events for Caribbean states, which will further exacerbate risks to biodiversity, settlements and infrastructure across Caribbean states.

What could an Arctic marine climate change impacts fact sheet look like?

Two aspects I will cover

1) What it could look like - the concept

2) What process is needed to produce it

The Concept – basic v thematic

- Cover - key points
- Introduction - purpose, standard confidence, why all this matters and why rapid translation of science into knowledge is needed, proven approach, body of evidence on which to draw in the Arctic
- The facts - what is happening and what may happen in the future on climate change impacts - on the system, on biodiversity, on ecosystem services, on humans
- Regional impact hot spots perspective based around a polar view double page spread map to show the challenges of impacts in context of wider Arctic environment change
- Pace of change - seen and anticipated for the Arctic - scale and magnitude - set against history with inset graphs and short case studies and also against pace elsewhere in the world
- Impact research priorities to plan for the future in the face of climate change - What we need to now consolidate or fill gaps on and how to enhance connectivity and resilience for adaptation
- Further information

The facts: impacts on the Arctic ocean system

- Temperature (air, sea-surface, deeper water layers)
- Ice extent (summer/September ice, ice quality)
- pH changes (surface waters, deeper water layers)
- Salinity (changes in salinity, with information on main areas of changes such as glacier fronts/estuaries)
- Currents (changes in the overall current patterns)
- Shore-thaw and erosion (changes in shoreline)
- Changes in inland permafrost (input of nutrients, heavy metals, etc from land increases?)

The facts: impacts on marine biodiversity

- Impact on ecosystems (changes in ecosystem structures) and habitats (areal loss, changes in habitat distribution)

- Impact on “key species groups/species”:
  - mammals,
  - birds,
  - fish,
  - invertebrates,
  - marine macrophytes
  - and on the distribution and abundance of these

Which ecosystems, habitats and species are sensitive to climate change impact (vulnerability and resilience for these)

How projected changes shift ecologically important features (e.g. ice edges changing in space and time)?

The facts: impacts on ecosystem services

- What are the most important ecosystem services that will likely be impacted?
- Changing foodwebs, changing food quantities and qualities

The facts: impacts on humans

- Socio-economic impact on coastal indigenous communities
- Opening of new maritime traffic routes multiplying the amount of shipping through Arctic.
- Increased development of offshore petroleum and gas industry /offshore constructions and energy infrastructure (oil rigs, cables, pipeline)
- Development of fisheries in new areas previously covered by ice or otherwise not utilised.
- Arctic tourism…

The facts: impacts on marine biodiversity

The process

- Agree the topics to be covered
- Identify the experts to provide the backing papers
- Produce the backing papers and carry out peer review
- Produce fact sheet content and review with authors
- Translate into different languages
- Design and publication