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Impacts of Sea-Level Rise, Ocean Acidification, and Warming

Module 4: Climate Change and Ocean Health

Duration: 1 Hour

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Interaction of Ocean-Climate

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- Ocean changes associated with a 2°C warming of global surface temperature carries high risks of impacts and should not be exceeded.

Global ocean, including enclosed seas acts as a climate integrator:

- Absorbs 93% of the earth's additional heat
- Captures 28% of anthropogenic CO_2 emissions
- Accumulates all water resulting from melting glaciers

Increasing ocean temperature and sea level leading to ocean acidification

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

The United Nations Framework Convention on Climate Change (UNFCCC)

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- Aiming to stabilise atmospheric greenhouse gas concentrations by preventing dangerous human interference with the climate system

> ***Within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner***

- As ocean acts as the frontline protecting costal areas, it is crucial to the livelihood and food security.

Goal

The increase in average global surface temperature must be less than 2°C over the preindustrial average

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

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RCP 8.5

- A high carbon emission trajectory, leading to significantly warmer oceans, lower pH, and great sea-level rise by 2100
- I.E. Sea Surface Temperature (SST) is projected to increase by 2.73 ± 0.72°C, and surface pH by -0.33 ± 0.003 units. The volume of ocean water corrosive to calcium carbonate shells (Ωa < 1) expands from 76% to 91%

RCP 2.6

- The Copenhagen Accord's goal of keeping global temperature increase below 2°C. It projects a less severe impact on the ocean.
- For example, SST increasing by 0.71 ± 0.45°C and surface pH by -0.07 ± 0.001 units by 2100. The volume of corrosive water expands to only 83%

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

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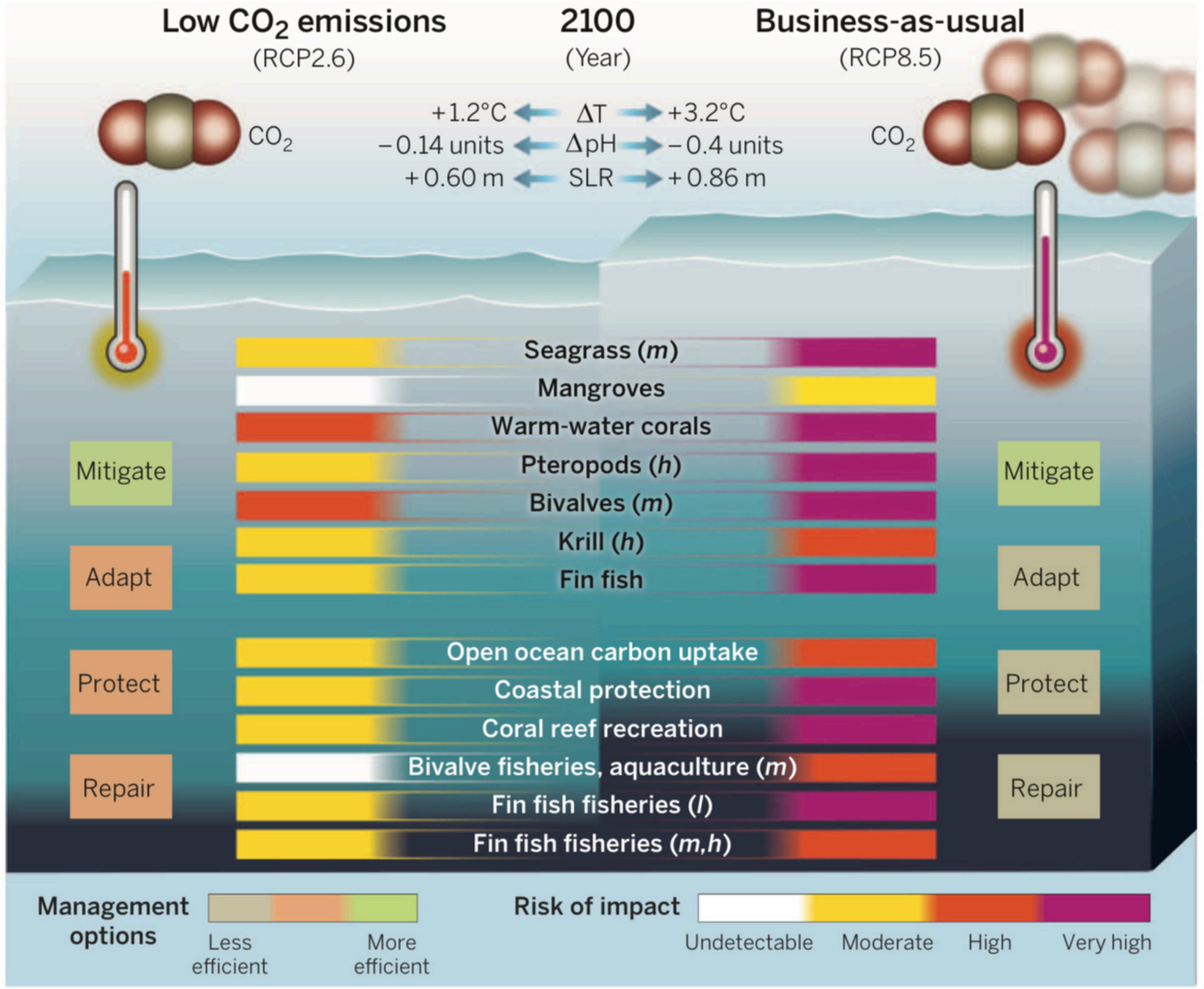

Changes in ocean physics and chemistry and impacts on organisms and ecosystem services according to stringent (RCP2.6) and high business-as-usual (RCP8.5) CO2 emissions scenarios.

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

Sea Level Changes

Global mean sea level, known as **GMSL** is gradually rising and accelerating approximately 6-9 m with the tendency of melting glacier and ice sheets in the Greenland and Antarctic ice sheets.

- Caused by thermal expansion, melting of glaciers and ice sheets and land water storage changes ⟶ Following with Representative Concentration Pathway (RCP)
- GMSL will rise between 0.43 m (0.29–0.59 m, likely range; RCP2.6) and 0.84 m (0.61–1.10 m, likely range; RCP8.5) by 2100

Non-climate anthropogenic drivers

- Demographic and Resettlement trends
- Anthropogenic subsidence

Increasing low-lying coastal communities' exposure and vulnerability to SLR and extreme sea level (ESL) events

(Source: Summary for Policymakers, 2022)

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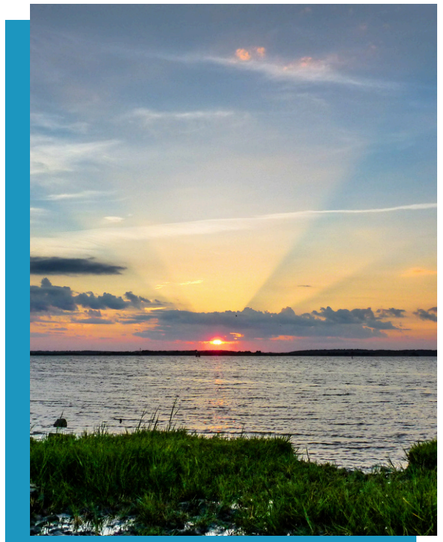
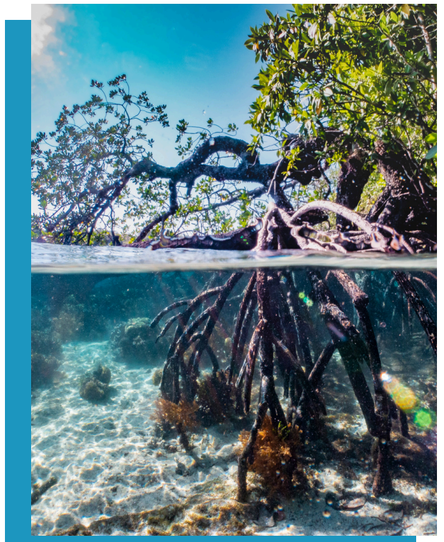
Coastal Ecosystem

I.E. Salt marshes, mangroves, vegetated dunes and sandy beaches, can build vertically and expand laterally in response to SLR, providing important services that include coastal protection and habitat for diverse biota.

- A consequence of human actions, coastal ecosystems progressively lose their ability to adapt to climate-induced changes and provide ecosystem services,





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Increased Warmer Ocean

Recent studies strongly show that many species, including various invertebrates, commercially important fish species and marine mammals are undergoing phenological and geographical shifts due to a key consequence of ocean warming.

- **Species' range shifts**, usually following a shift in isotherms or temperature extremes, is a key consequence of ocean warming.
- Causing potentially permanent changes to ecosystems, including local extinctions, while simultaneously producing novel assemblages.

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

Ocean Warming's Effect

Experimental studies suggest that some species may adapt to warming projected under RCP8.5

- Biogeographical shifts restrict adaptive potential and the small number of species

Marine life Habitat shifts to cooler water or in depth level, will significantly impact Fisheries with alterations in fishing practices and adaptation of fishing methods.

Warming causes mass mortality of warm-water corals through bleaching as well as through biotic diseases, resulting in declines in **coral abundance and biodiversity**.

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

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Ocean Acidification

- CO_2 plays an essential role to dramatically affect to Greenhouse Gases and cause Ocean Acidification, related to how it gradually harms to aquatic life
  - Organisms producing calcium carbonate **shells** and **skeletons** experience the strongest negative impacts
- It involves an increase in the partial pressure of carbon dioxide (pCO_2) and dissolved inorganic carbon, while decreasing pH and the saturation of seawater

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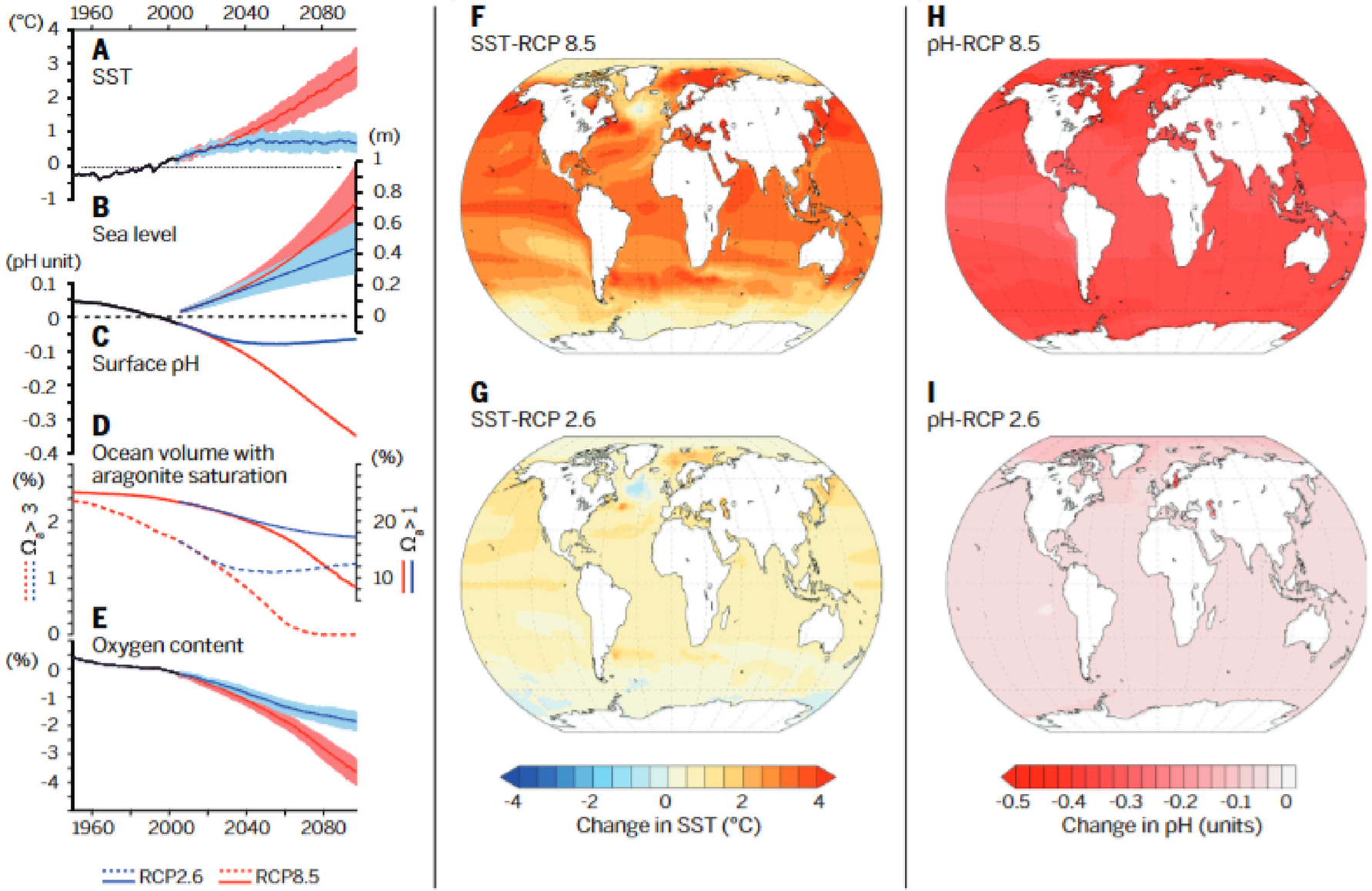

Fig. 1. Environmental changes over the industrial period and the 21st century for a business-as-usual scenario and a stringent emissions scenario consistent with the UNFCCC target of increase in global surface temperature by 2°C. (A to E)

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

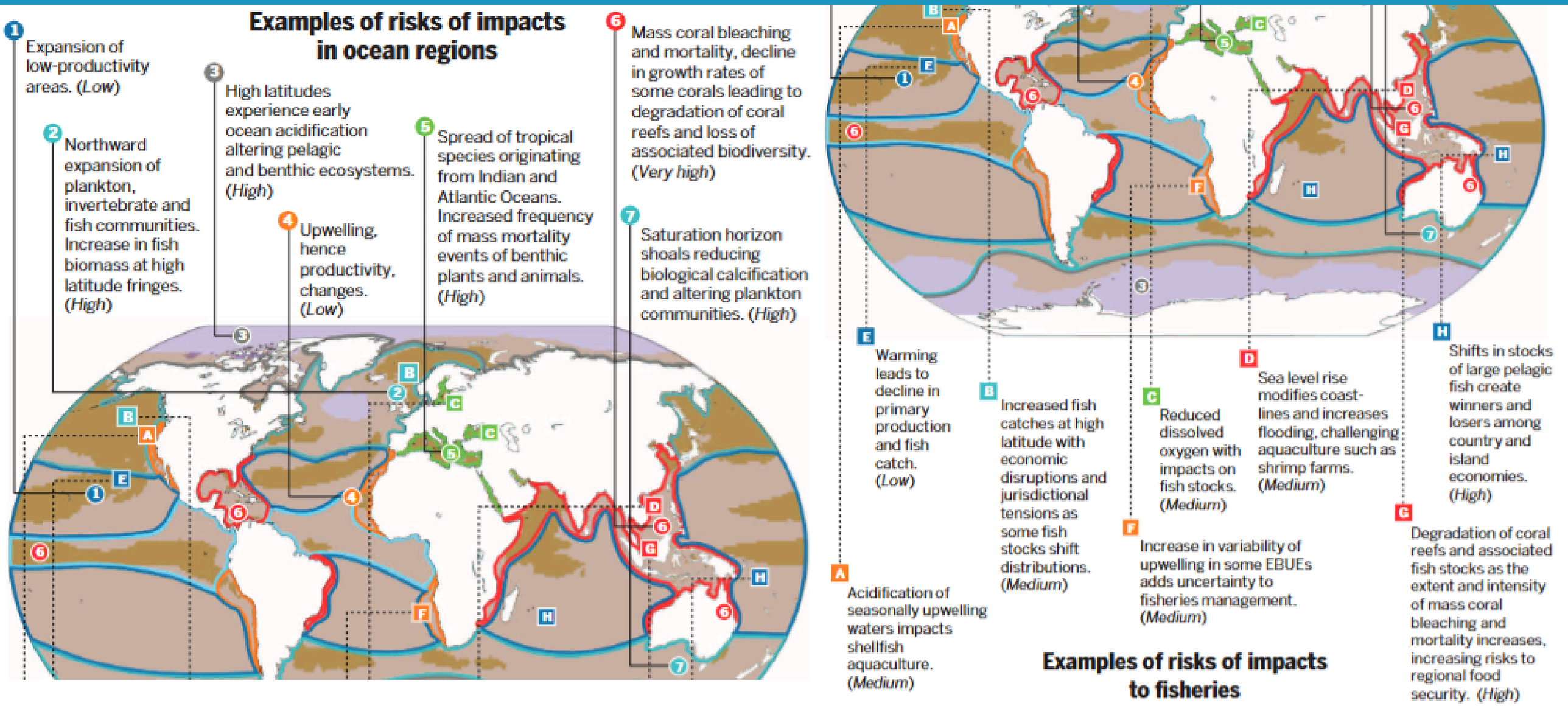

Fig. 3. Regional changes in the physical system and associated risks for natural and humanmanaged systems.

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

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Organism Producing Calcium carbonate shells and skeletons

- Under RCP 8.5 including reduced calcification, reduced rates of repair, and weakened calcified structures
- Recent field observations show **a decrease in coccolith thickness and dissolution of live pteropod shells** in the California Current System and Southern Ocean

Decreases in net calcification have been observed in coral reefs during the period 1975–2008, causing some coral reefs to shift toward net erosion.

(Source: Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios, 2015)

ACTIVITY: Climate Impact Web

1. Divide into 6-8 Groups
1. Choosing a marine ecosystem
2. Mapping out how temperature, pH, and Sea Level affect it
3. Sharing in Canva Slide

I.E. Coral Reef and Seagrass

★ SUMMARY

- The three major climate change stressors on marine and coastal environments: **Sea-Level Rise, Ocean warming, and acidification** as the results of the absorption of Carbon Dioxide gas that produced by Anthropogenic emissions.
- It fosters the outcomes such as increased flooding, coral bleaching, and threats to shellfish.
- There are two Representative Concentration Pathway, known as **RCP**, that forecast the near future in 2100 by;
    1. **RCP 8.5** highlights a high carbon emission trajectory with dramatically increased temperature in ocean, leading to ocean warmer, lower pH, and vast sea-level rise
    2. **RCP 2.6** stresses on the Copenhagen Accord's goal of keeping the mean global temperature increase below 2°C

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THANK YOU

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