IPCC WGII findings on the polar regions:

Ecosystem impacts of ocean warming and acidification

HANS PÖRTNER, CLA WGII CH. 6, OCEAN SYSTEMS, TS, SPM, SYR

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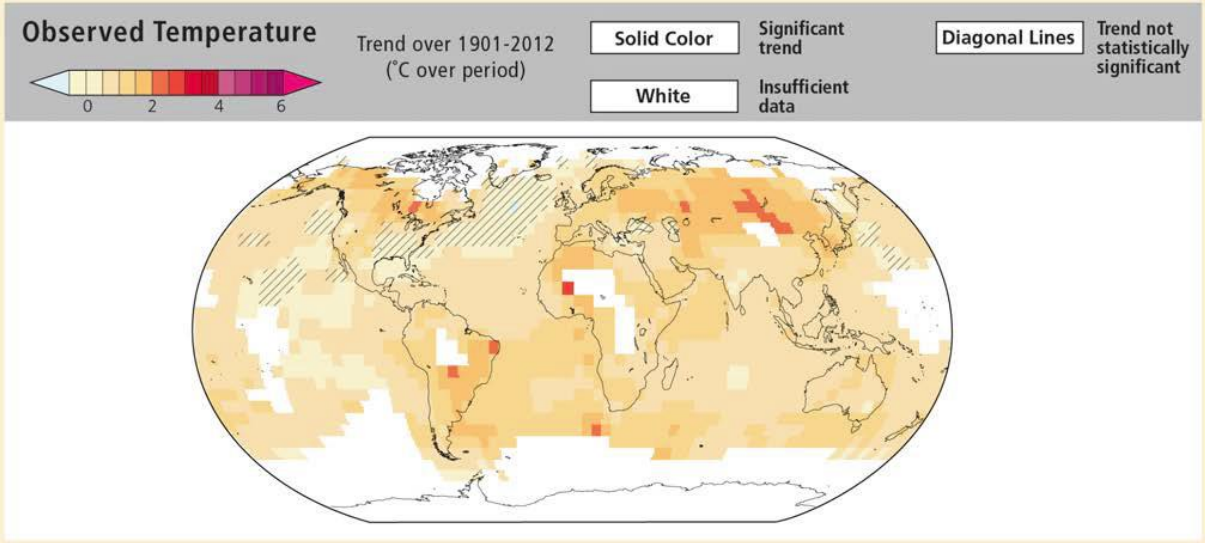
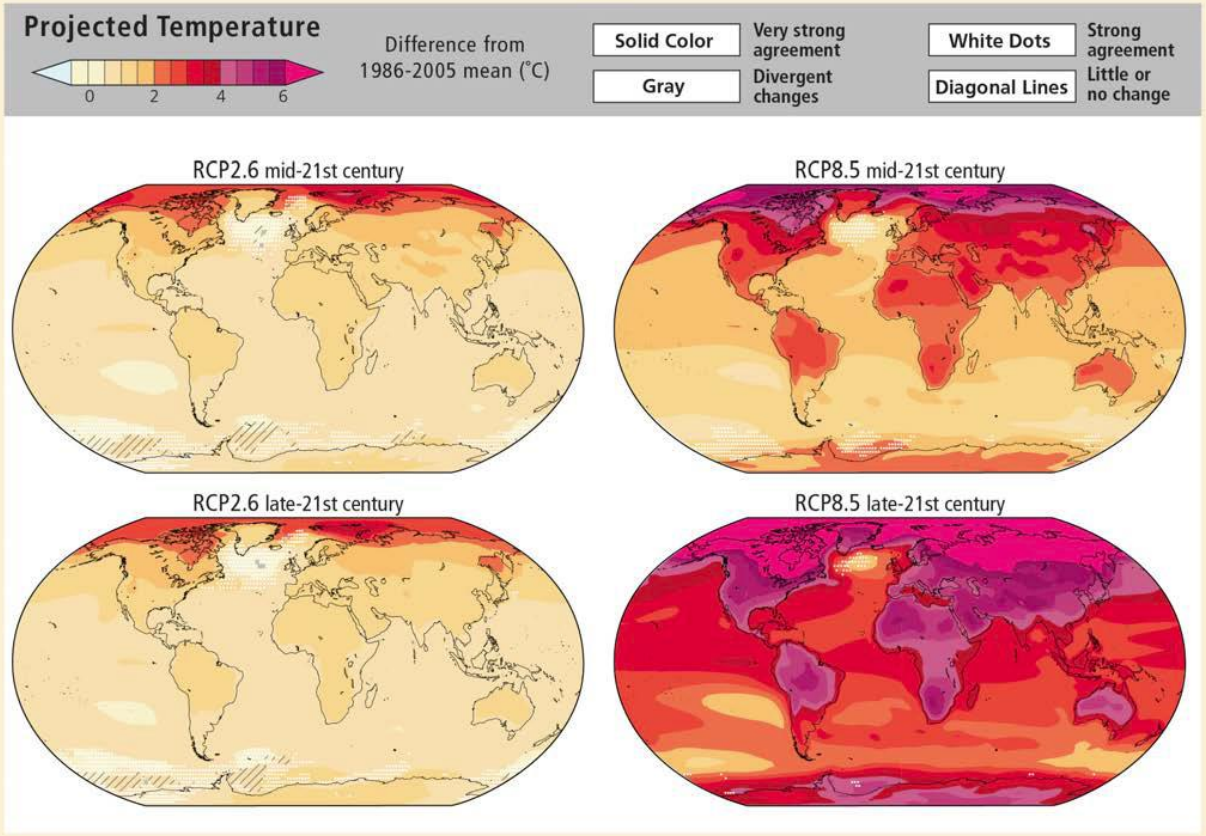
INTERGOVERNMENTAL PANEL ON climate change





Warming

Observations
(1901-2012)

Projections

mid 21st century

late 21st century

WGII RC-2
(SPM.4)

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.....warming affecting cold-specialized marine fauna: stenothermy in high polar areas

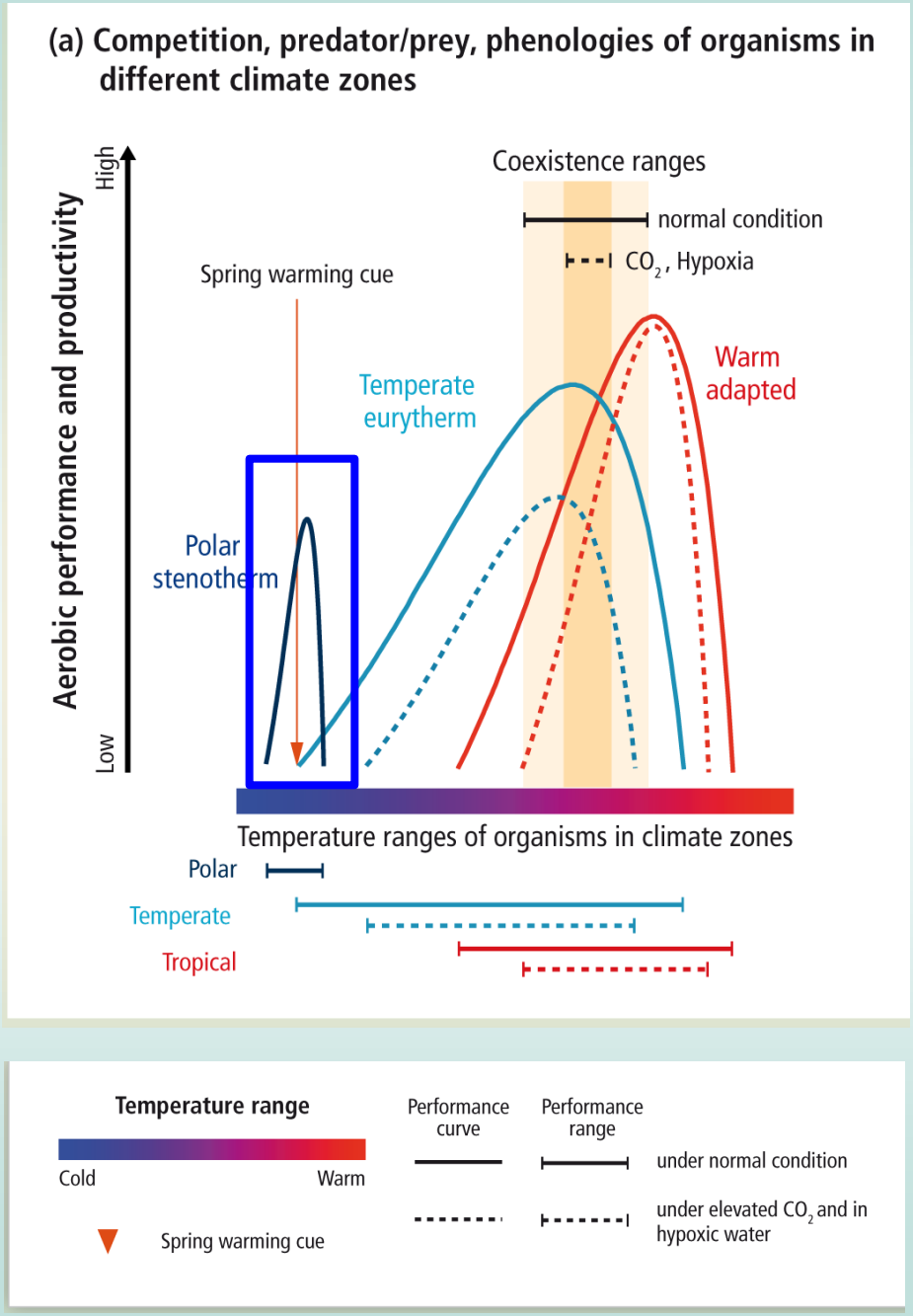
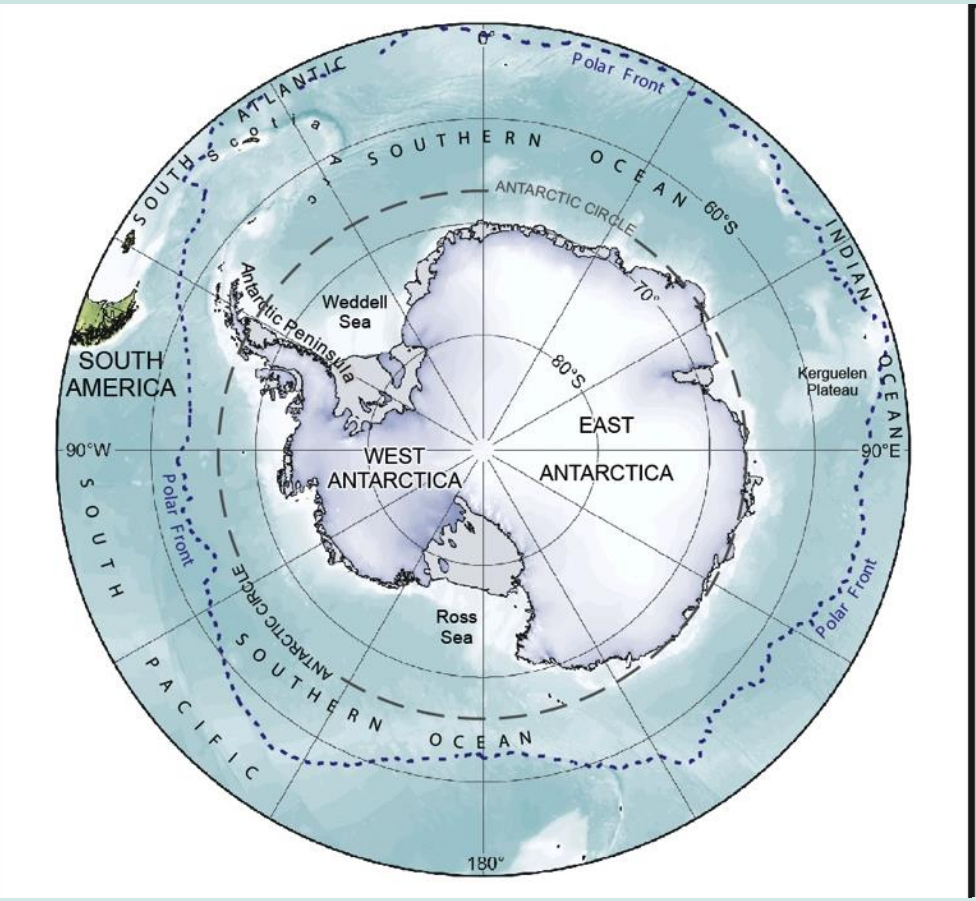


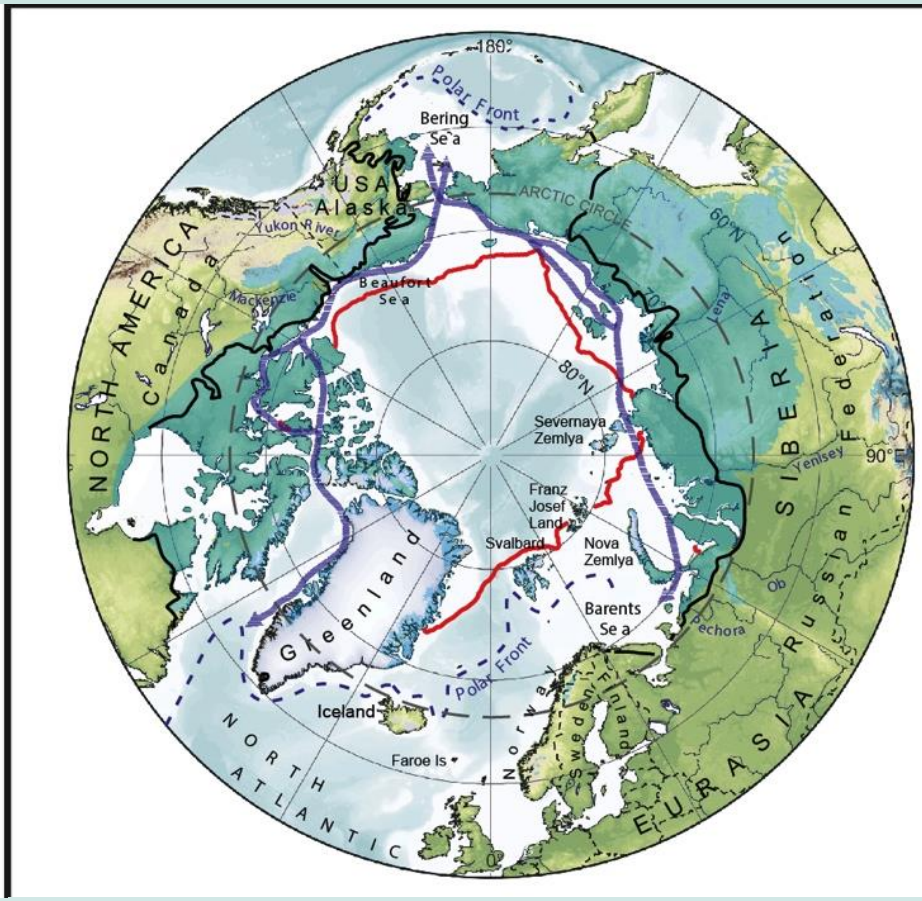
Figure 6-7

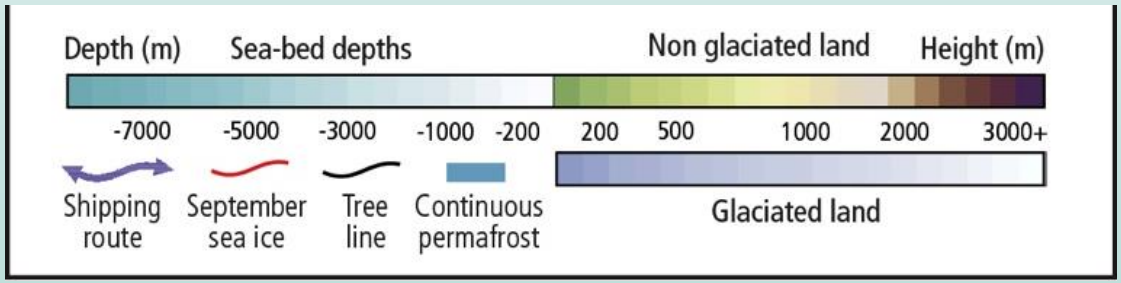
Different characteristics and specific vulnerabilities of polar areas

Antarctic ("closed system")

Arctic ("open system")





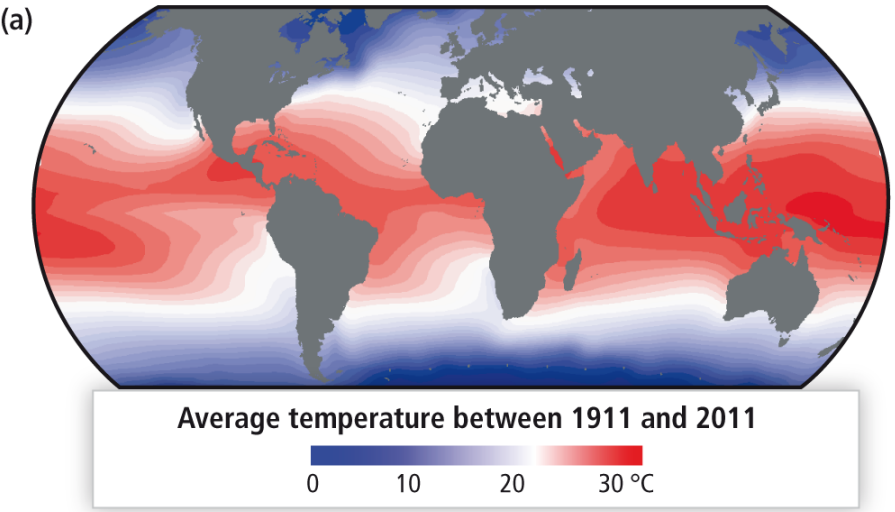


WGII 28.1

Differences between hemispheres:
Arctic versus Antarctic

similarly low ocean temperatures reached

temperature variability



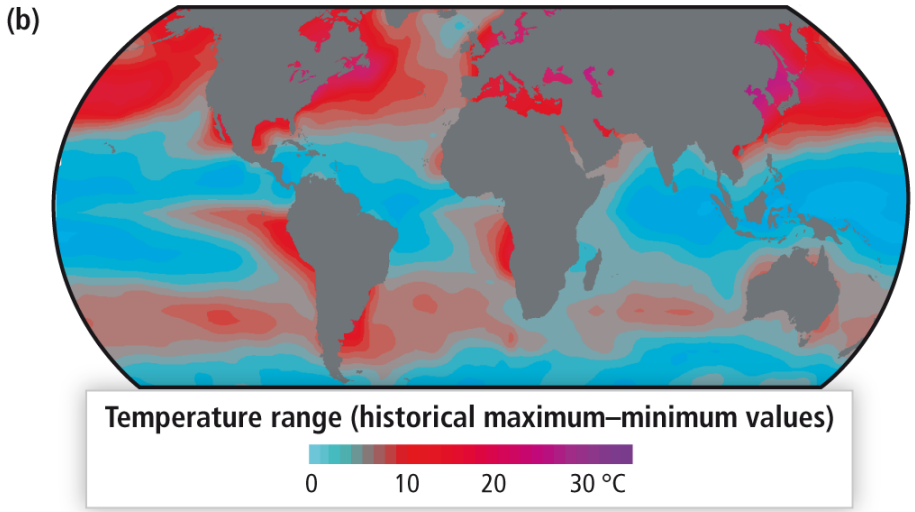


Figure 6-1

Functional tradeoffs in high polar (esp. Antarctic) stenotherms (narrow thermal windows):

- slow growth, low metabolism
- long development times
- long generation times
- low reproductive output
- low modes of activity in many species
- „no high polar tuna“

versus sub-polar (Arctic) eurytherms (wide thermal windows):

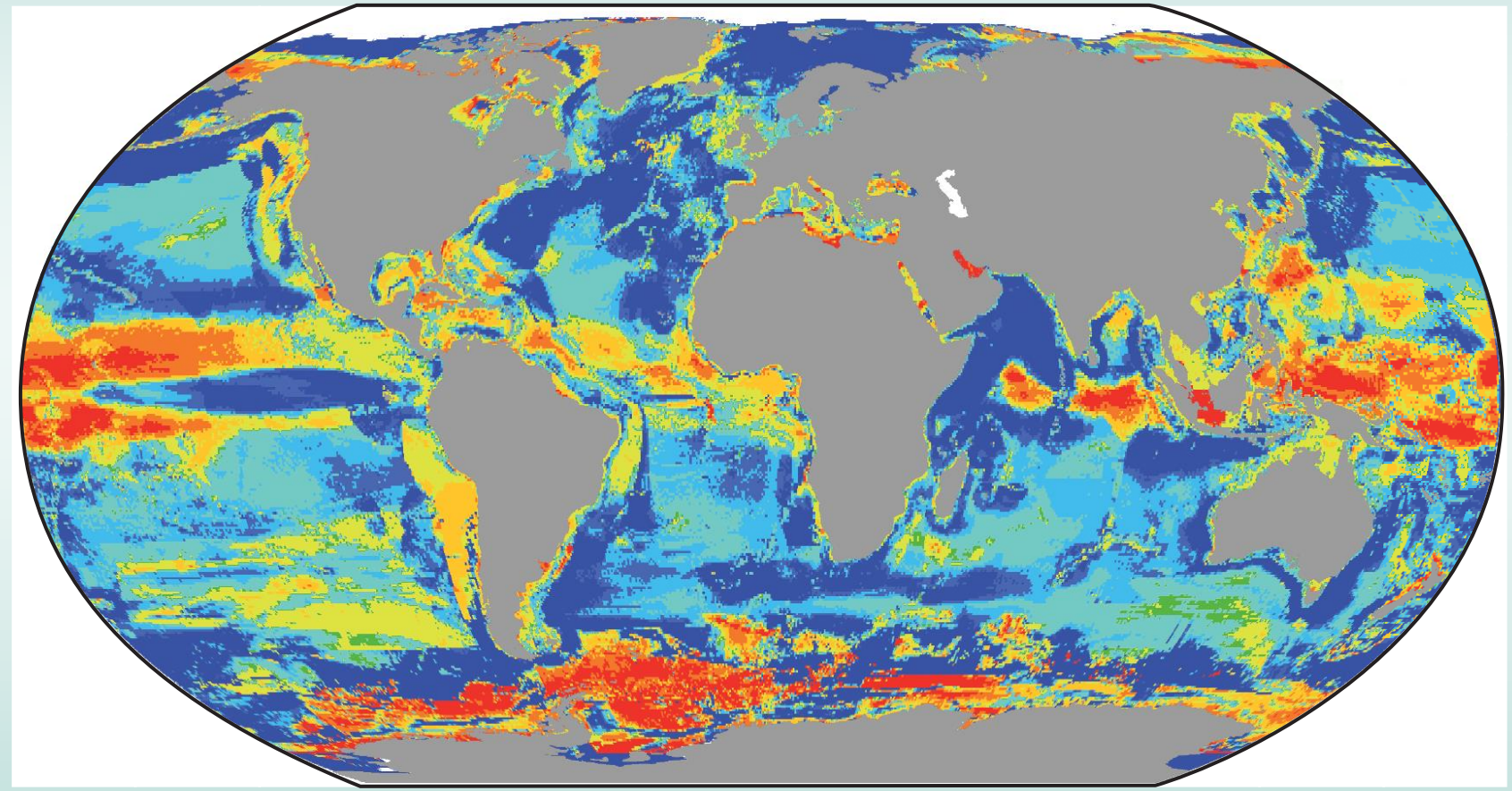
- elevated metabolism in spring and summer,
- growth and reproduction suspended in winter
- tolerant to sustain warmer summers

… resilience often has an energy cost ...
higher sensitivity of high polar than subpolar species to warming (!) and acidification (?)

PROJECTIONS

Ocean warming 2051-60: Poleward displacement of fish and invertebrate stocks

CHANGE IN MAXIMUM CATCH POTENTIAL (2051-2060 COMPARED TO 2001-2010, SRES A1B, 2°C warming)



WGII, Figure 6-14, SPM.6

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High latitude warming: higher productivity and biodiversity

contributing to improved fisheries productivity
(reduced stocks at lower latitudes)

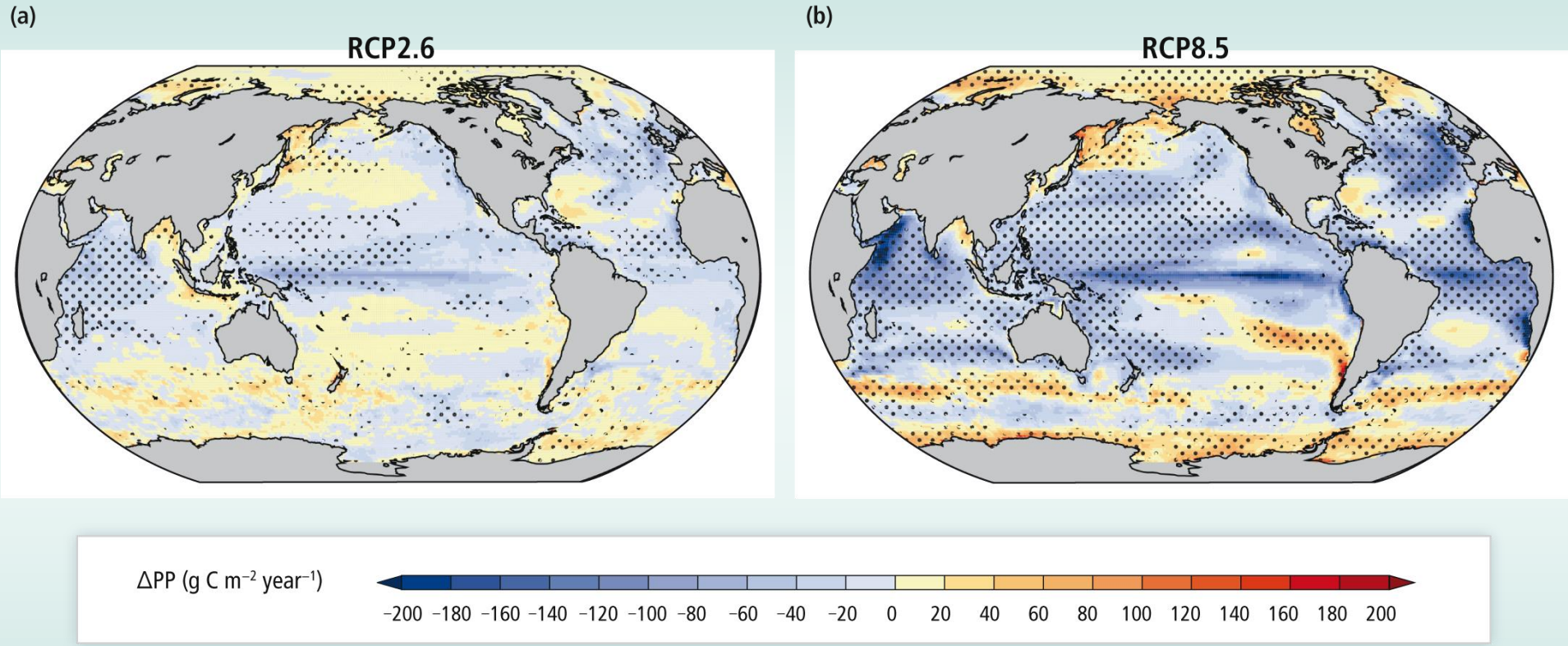
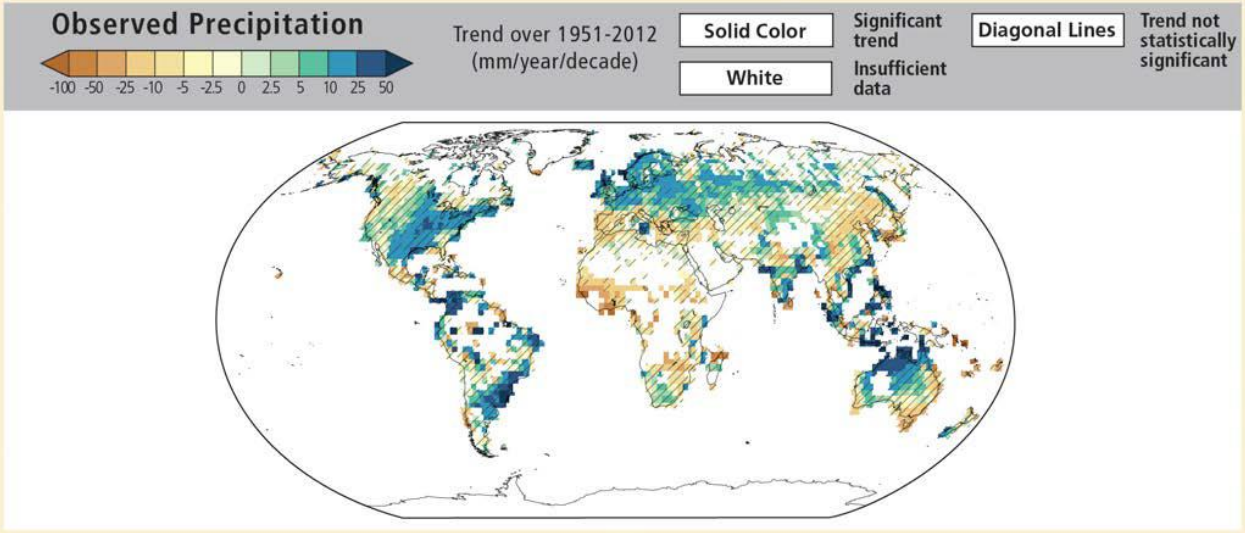
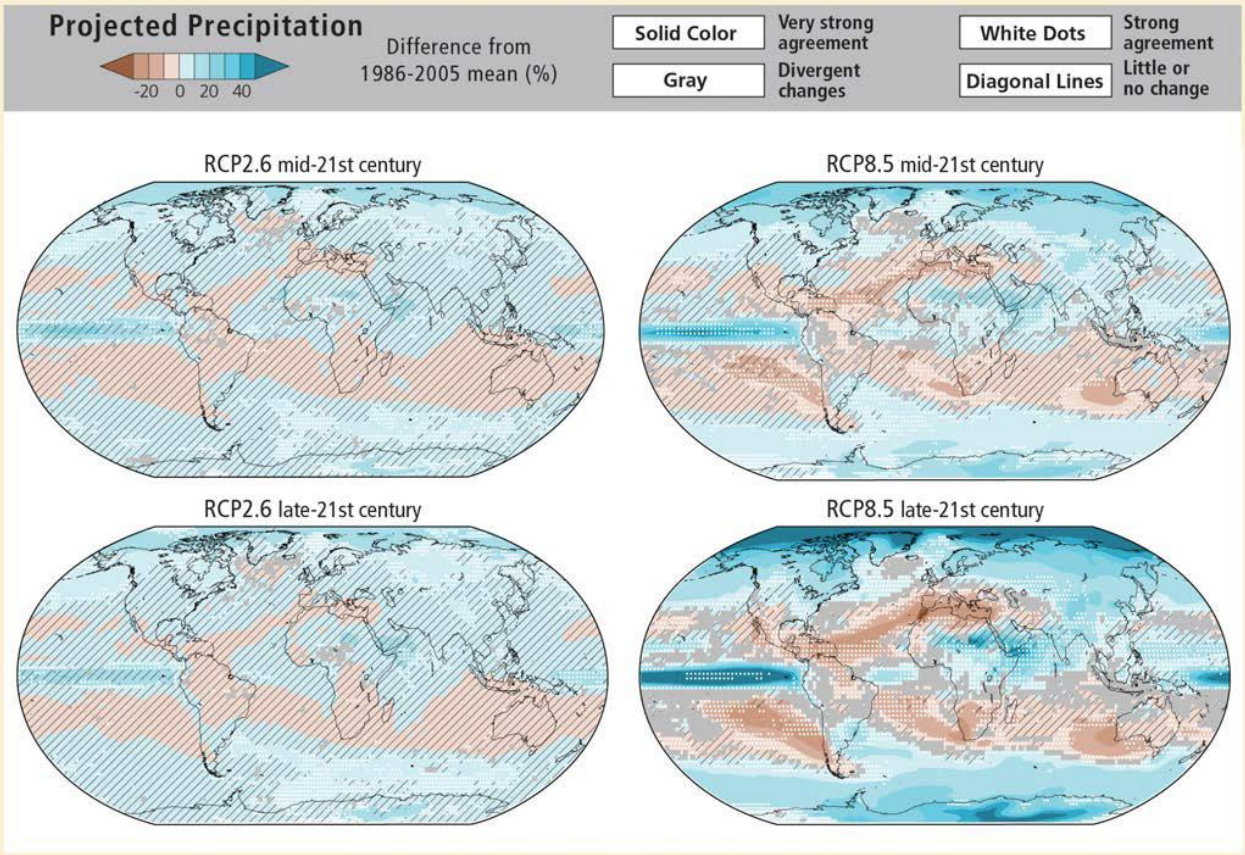


Figure 6-13

Precipitation



Observed



Projected

Enhanced precipitation in the Arctic exacerbating ocean acidifciation

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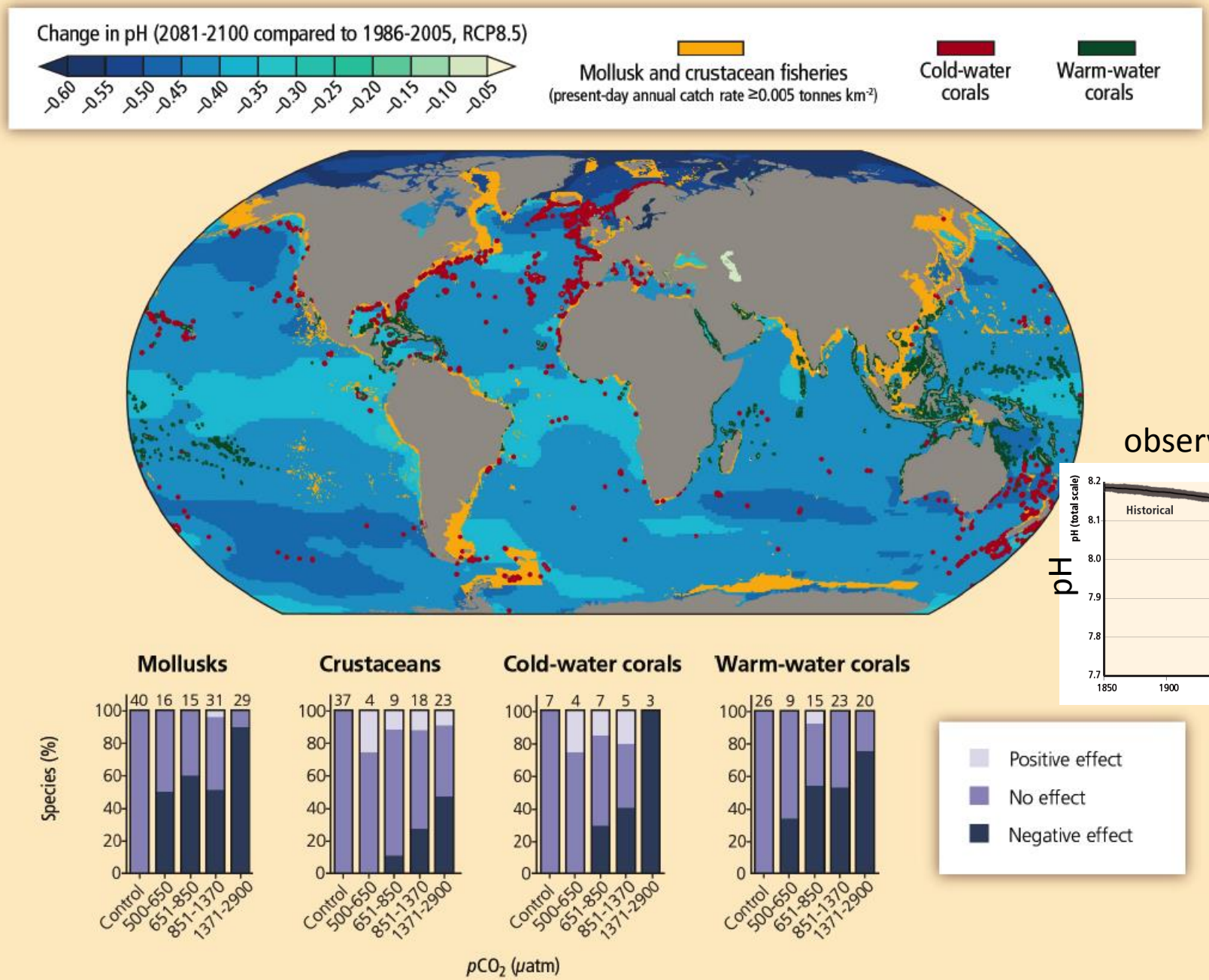
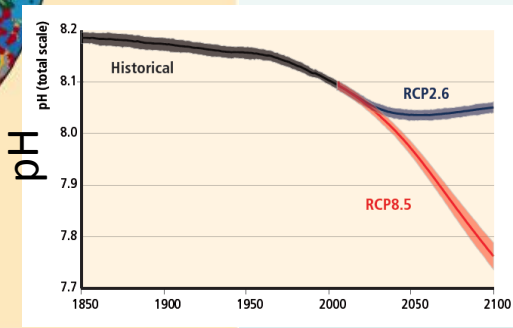
Projections: Ocean acidification, risks for mollusk and crustacean fisheries and coastal protection by coral reefs



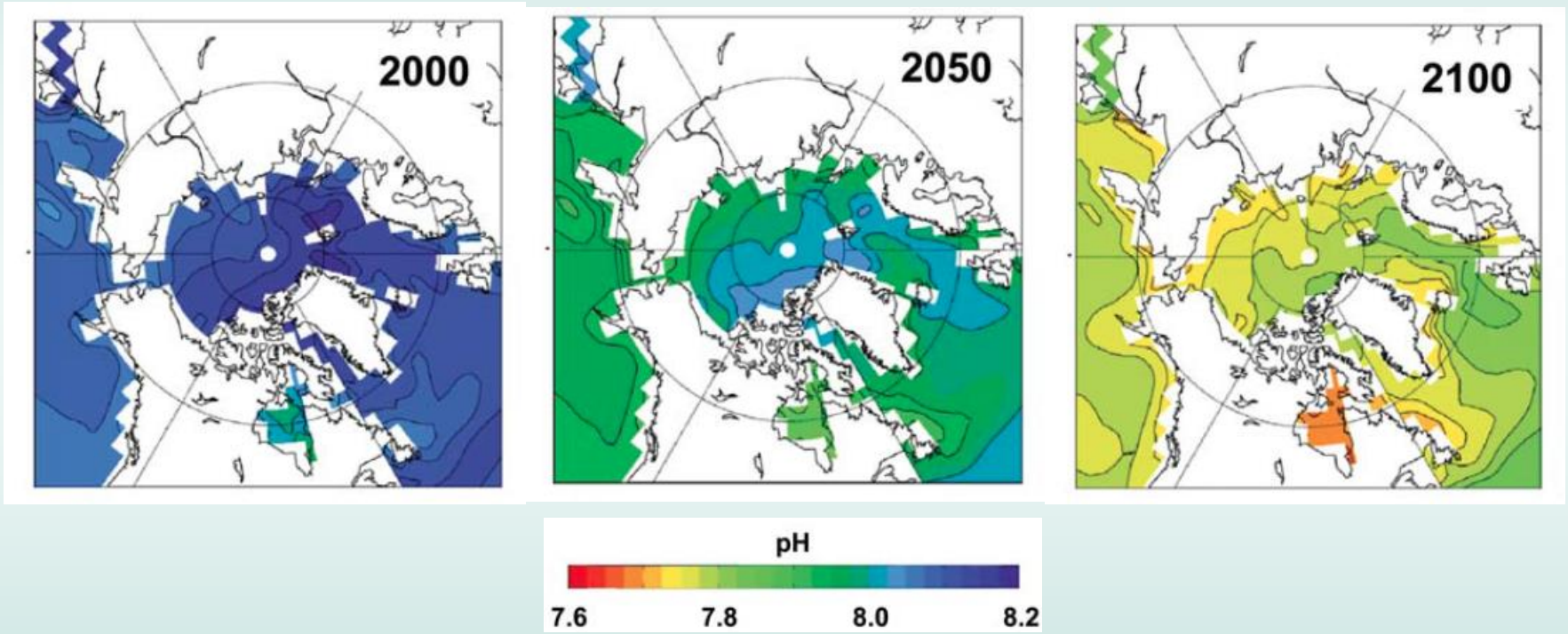
observed projected



until 2100

WGII, SPM.6

Arctic marine waters will experience widespread and rapid ocean acidification (some regional variability)



Does a high degree of acidification meet high sensitivity of polar fauna?

Arctic Monitoring and Assessment Programme (AMAP)
Arctic Ocean Acidication 2013

Denman et al. 2011

Vulnerable ecosystems

Arctic sea ice ecosystem

Warming and acidification affect a special ecosystem in the Arctic

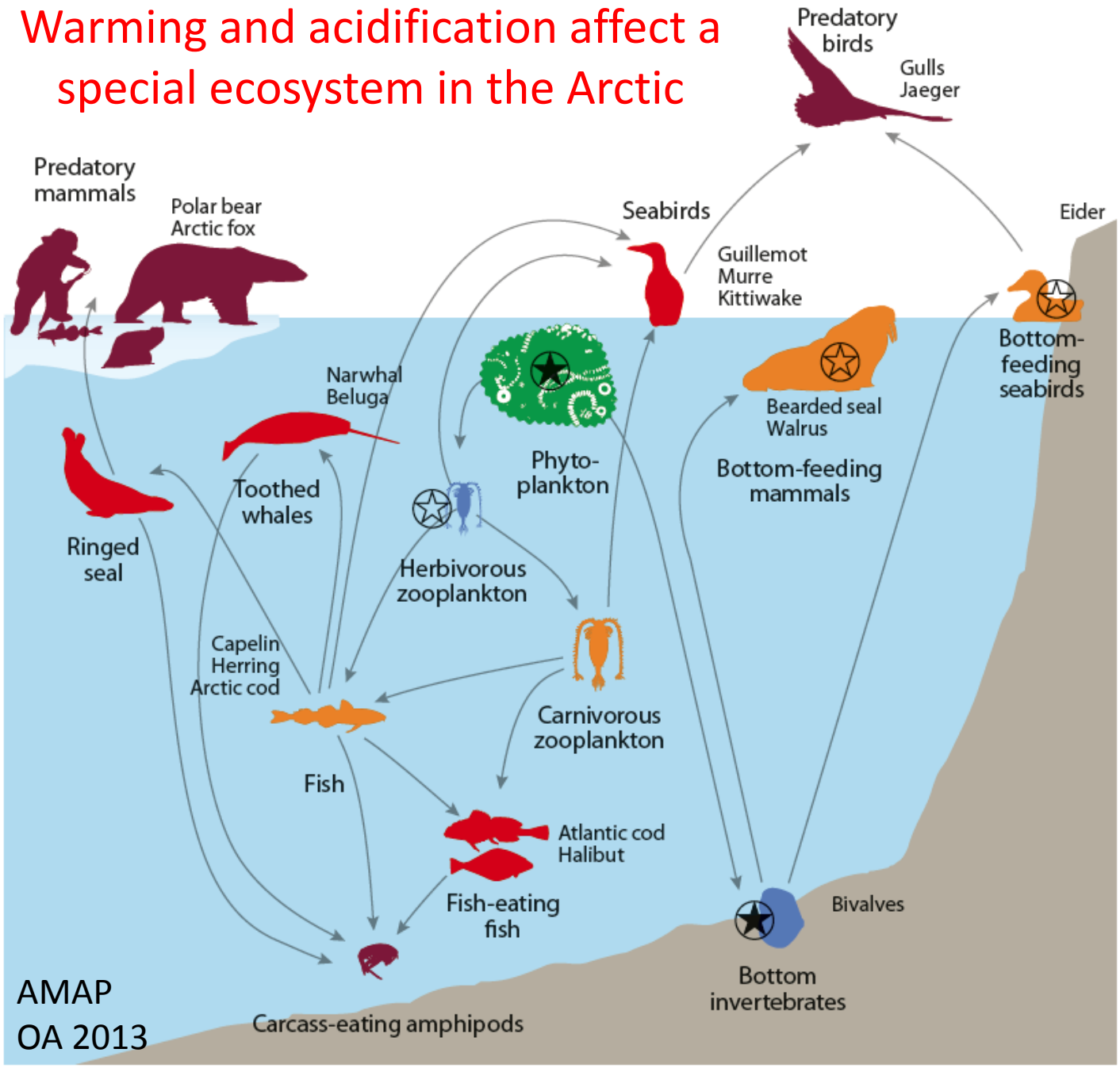
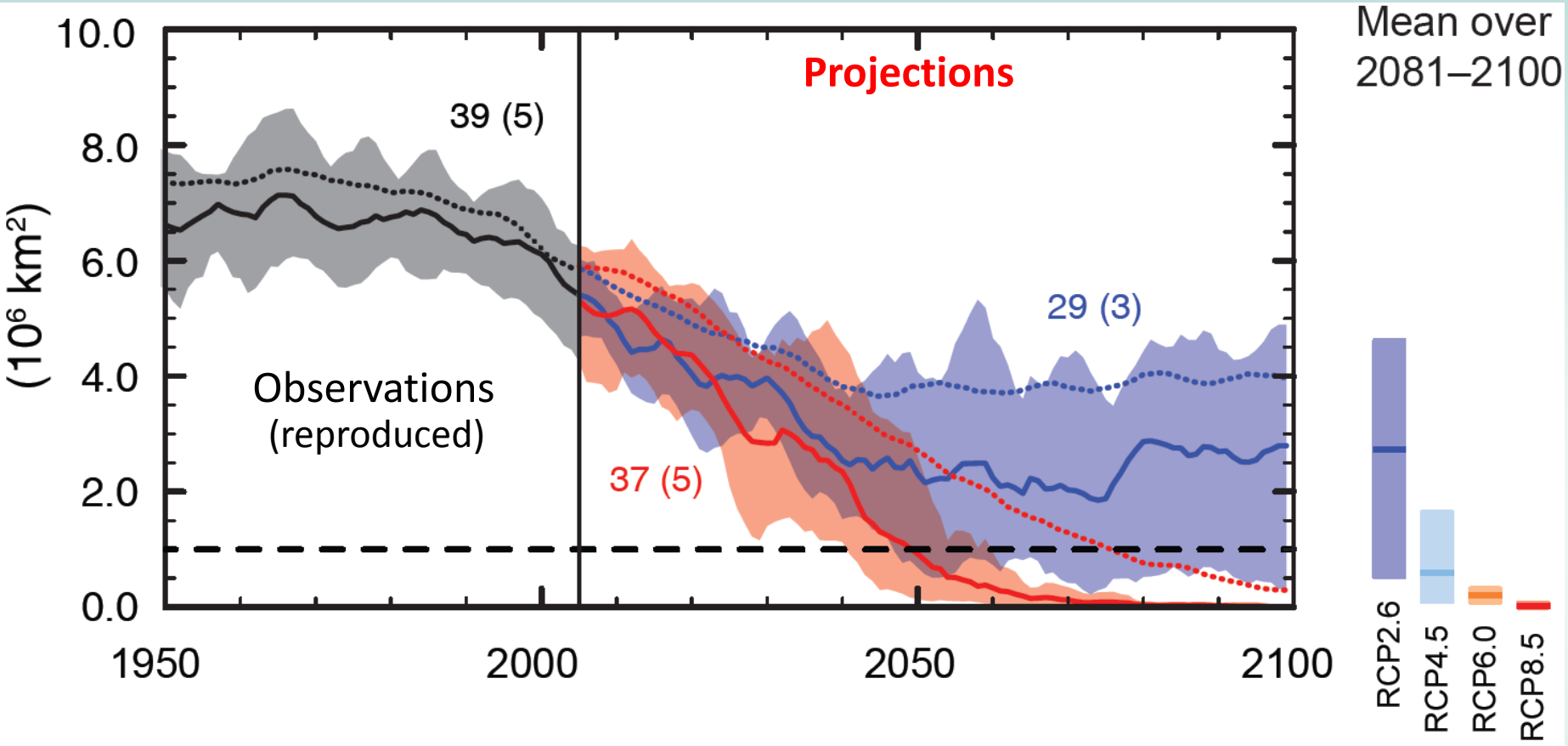
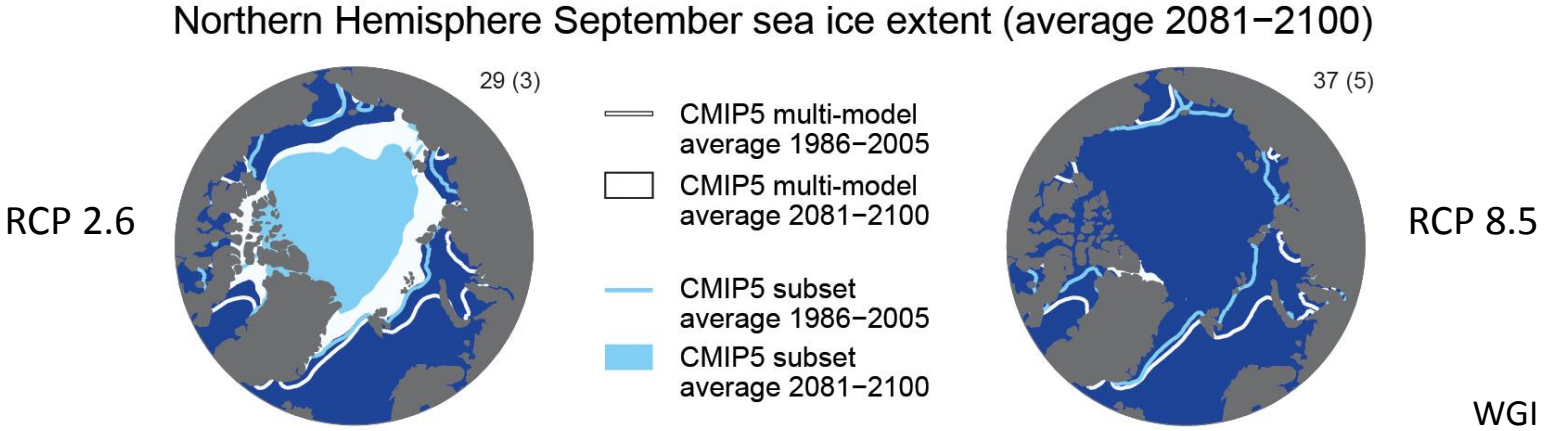


Figure 4.5. Generalized Arctic food web, with trophic levels very likely to be directly affected by ocean acidification noted with a filled star, and species likely to be indirectly affected (such as via a predator-prey relationship with a directly affected species) noted with an open star. Source: adapted from Murray et al, 1998.

AMAP Report OA 2013

Northern Hemisphere September sea ice extent: Marginalization with continued warming





WGI SPM.7b, 8c

Northern Hemisphere September sea ice extent: Marginalization with continued warming

…retreat of ice associated ecosystems also along the Antarctic peninsula and in the Antarctic sea ice zone (incl. krill and some pinguins species affected)

...marginalization of high polar systems due to warming (!), exacerbated by acidification (!?)


Vulnerable ecosystems
Arctic sea ice ecosystem
Thank you