IPCC WGII findings on the polar regions:

Ecosystem impacts of ocean warming and acidification

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Warming

Observations (1901-2012)

Projections

mid 21st century

late 21st century

WGII RC-2 (SPM.4)
warming affecting cold-specialized marine fauna: stenothermy in high polar areas
Different characteristics and specific vulnerabilities of polar areas

Antarctic ("closed system")

Arctic ("open system")
Differences between hemispheres: 
Arctic versus Antarctic

similarly low ocean temperatures reached

(a) Average temperature between 1911 and 2011
(b) Temperature range (historical maximum–minimum values)
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)

- <50%
- 21 – 50%
- 6 – 20%
- 1 – 5%
- No data
- 0 – 4%
- 5 – 19%
- 20 – 49%
- 50 – 100%
- >100%

WGII, Figure 6-14, SPM.6
High latitude warming: higher productivity and biodiversity contributing to improved fisheries productivity (reduced stocks at lower latitudes)

Figure 6-13
Enhanced precipitation in the Arctic exacerbating ocean acidification
Projections: Ocean acidification, risks for mollusk and crustacean fisheries and coastal protection by coral reefs

Change in pH (2081-2100 compared to 1986-2005, RCP8.5)

Mollusk and crustacean fisheries (present-day annual catch rate ≥0.005 tonnes km²)

Cold-water corals

Warm-water corals

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.
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 penguins species affected)

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

Arctic sea ice ecosystem

Thank you