Global Climate Change and Marine Ecology

2. Projected changes in the ocean
3. Projected changes in the marine ecology
   • Polar ecosystem changes due to sea ice changes
   • Changes in zooplankton due to ocean acidification
   • Changes in coral due to warming and acidification of ocean
   • Dead Zones
4. The foundation of the marine food web will be highly perturbed
5. Summary

1. Human emissions of greenhouse gases and aerosols has change the climate

Background shading shows changes in surface temperatures over the period 1970 to 2004. The 2x2 boxes show the total number of data series with significant changes (top row) and the percentage of those consistent with warming (bottom row) for (i) continental regions and (ii) global-scale: Terrestrial (TER), Marine and Freshwater (MFW), and Global (GLO).

2. Changes in the ocean physics and chemistry

- The relevant human-induced changes in the ocean for the marine ecology (past and future) include:
  - Reduction in the extent and thickness of sea ice
  - Increased CO₂ makes the global upper ocean more acidic
  - Warming of the upper ocean

Upper ocean pH has decreased by 0.15
3. Projected changes in the polar regions

**Less extensive and thinner sea ice will:**
- Large decrease in primary production (phytoplankton) in the highly productive marginal sea ice regions
- Increase primary production and a poleward shift in warm water species of plankton and algae in the newly ice-free regions  
  - More food for (warm water) cod
- Changes in phenology (timing of phytoplankton blooms, zooplankton blooms, stages of development, etc) and therefore species interactions
- Melting Arctic ice-sheets will reduce ocean salinities, causing species-specific shifts in the distribution and biomass of major constituents of Arctic food webs, including the potential loss of some polar species, such as the narwhal.
- Changes in food supply for many marine birds
- Less polar bears

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**Less Polar Bears**

- Population today: ~ 20,000 - 25,000
- Specialized predators on ice breeding seals
- Females have cubs in winter dens and need nearby food in the spring
- When there is sea ice nearby, there is always food (seals).
- Climate change will make the sea ice retreat sooner, leaving the bears a longer period at the end of summer with no food (until the sea ice returns)
- Already a problem in Hudson Bay  
  - Break up of sea ice in spring is 3 weeks earlier than in 1970
  - Bears have declined about 2% per year since 1984
- If sea ice declines according to some projections polar bears will face a high risk of extinction with warming of 2.8°C above pre-industrial