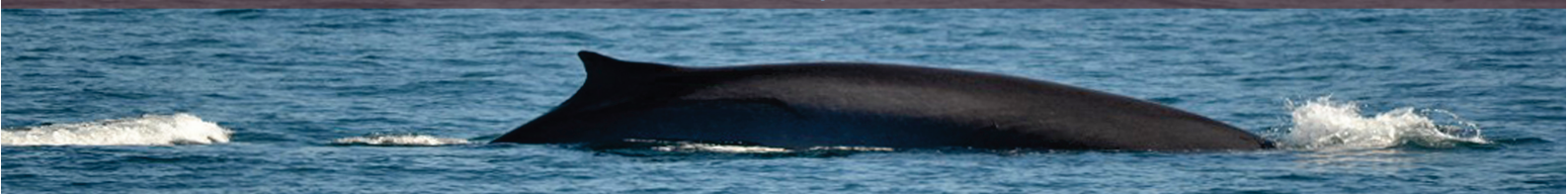


Impact of climate change on marine mammals

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INTRODUCTION

Last three decades have been warmer than any other since 1850

Human activities have been the cause through the increase of carbon dioxide emissions by 40%

Oceans have absorbed 30% of the emitted CO₂ and have stored more than 90% of the energy accumulated in the climate system.
As a result (Fig1) :

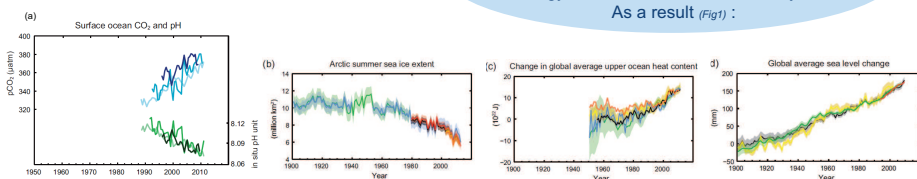


Fig1. Physical and chemical ocean properties alterations as a result of climate change. (a): Partial pressure of dissolved CO₂ at the ocean surface, and in situ pH, measure of acidity. (b): Extent of Arctic July-August-September (summer) average sea-ice. (c): Change in global mean upper ocean (0-700 m) heat content aligned to 2006-2010, and relative to the mean of all datasets for 1970. (d): Global mean sea level relative to the 1900-1995 mean of the longest running dataset. Figures adapted from IPCC, 2013.

Importance of marine mammals

- Ecological role: provide top-down control of food webs and recycling of nutrients.
- Conservation role: particular concern status, with 36% of species threatened.
- Ecosystem services role: effects on ecotourism companies & fishing industries.

AIMS

Determine the main impacts of climate change on marine mammals through an analysis of the studies that have been conducted to date

METHODS

Most of the reviewed studies attempt to determine if global species distribution will be affected by climate change

Types of studies

Qualitative analysis
based on species biology and ecology

Quantitative analysis
based on species occurrence

Electronical tags

Sightings database
(Fig2)

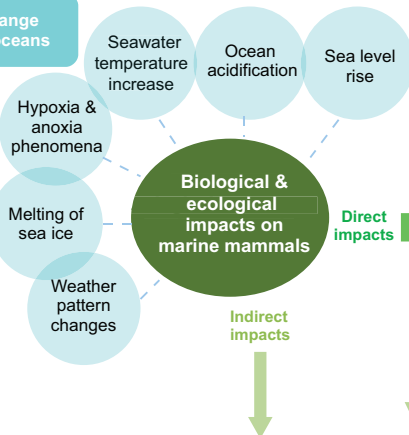
Environmental suitability models



Fig2. Deep-water cetacean sightings (from Whitehead et al, 2008).

RESULTS

Climate change effects on oceans



Changes in distribution ranges of species
(Fig3)

- Poleward range shift in species global distribution
- Expected contraction range in polar and temperate water species
- Expected expansion range in warmer and cosmopolitan species
- Biodiversity decrease at tropical zones
- Species with restricted distributions (by land mass or depth ranges) will be more vulnerable

Loss of optimal habitats

Sea-ice dependent polar species will be the most vulnerable

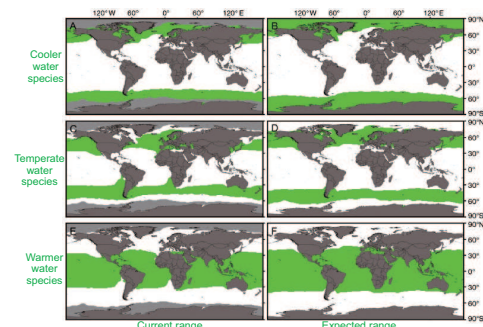


Fig3. Changes in cetacean species' range in response to increase in water temperature (adapted from MacLeod, 2009). Expected contraction range in cooler water species, poleward shift in temperate water species, and expansion range in warmer water species.

Changes in food webs dynamics

Climate change impact may cause asynchronies in the relationship predator-prey. Migratory species, like whales, will be especially sensitive.

Susceptibility to disease & contaminants

Increase in seawater temperature may augment pathogens development

What makes species more vulnerable to climate change?
(Fig4)

- Polar, subpolar and temperate regions species
- Species highly specialized
- Species with restricted distributions
- Species currently under threat : Synergy climate change + Other pressures



Fig4. Some species with restricted habitats: *Inia geoffrensis* (3th photo) and *Lagenorhynchus albirostris* (4th photo). Some polar and subpolar species threatened by loss of optimal habitat: *Ursus maritimus* (6th photo), *Delphinapterus leucas* (1st photo) and *Monodon monoceros* (5th photo). Also species currently threatened by other pressures, such as *Balaenoptera musculus* (2nd photo).

CONCLUSIONS

As a consequence of climate changes, main predicted impacts for marine mammals are poleward range shifts in species distribution and loss of habitats of those species with high specificity, such as polar species.

Studies up to date are insufficient to assert with certainty the predicted impacts. There is a need to increase marine ecosystems research and the species that inhabit.