ICES Theme session J

Climate change: Back to the future for marine predators.

Conveners: Morten Frederiksen, Denmark ([mfr@bios.au.dk](mailto:mfr@bios.au.dk)), Tore Haug, Norway ([toreha@imr.no](mailto:toreha@imr.no)) and John Pinnegar, UK ([john.pinnegar@cefas.co.uk](mailto:john.pinnegar@cefas.co.uk)).

This session was suggested by the ICES Working Group on Harp and Hooded Seals (WGHARP) who had made observations of possible effects of climate change on the populations of harp and hooded seals in the North Atlantic. In recent years we have seen expert reviews from the Intergovernmental Panel on Climate Change (IPCC) showing that climate change will induce temperature changes and associated adjustments in ocean circulation, ice coverage and sea level. Such changes will affect life-history parameters of marine top predators (mammals, birds, large pelagic fish) via changes in habitat features, e.g., ice cover and availability of food resources (bottom–up effects), or will alter the role that predators play in marine ecosystems (top-down effects). Theme session J intended to focus on presentations that show how environmental change has affected life-history strategies among large marine predators in the past, or how environmental change may affect the role that these species play as top-level predators in marine ecosystems in the future. The session included 13 oral presentations and one poster.

Seabirds have often been shown to be sensitive to climate change acting through changes in their food supply. One study re-examined data from a very well-studied species, the black-legged kittiwake in the UK. Using tracking data, important foraging areas were identified for a large number of colonies. Breeding success in these colonies was shown to be negatively related to winter sea surface temperatures and strong spring stratification. Output from climate models was then used to predict that observed declines in kittiwake breeding productivity would continue throughout the 21st century. Another study showed that for the dimorphic common guillemot, one morph (bridled) was more favoured by low sea temperatures in the wintering areas (affecting survival). The bridled morph is more common in the northern part of the range, and can be expected to decline in frequency over the coming decades.

Climate warming may both enhance northward invasions of temperate fish species from lower latitudes and change/increase the distribution of resident ones at higher latitudes. This may present challenges both for the intruders and the residents. Several presentations addressed such questions, and it was demonstrated that bluefin tunas now occur at high latitude sub-polar areas (Greenland waters), beyond its usual range, presumably feeding on mackerel which is another new immigrant to the area around Greenland and Iceland. Furthermore, a North Sea study assessed possible effects on the life history (represented by growth) of one resident species (saithe) resulting from environmental changes with subsequent reductions in prey availability, potentially caused by a recent emergence of the traditionally more southerly distributed hake into the area.

In the Baltic Sea, successful spawning of cod is dependent on episodic inflow of salt water. Such inflows have become less frequent in recent decades. A detailed study described the requirements for spawning in terms of size and timing of salt water inflows. Meanwhile cod has increased its distributional area northwards in the Barents Sea in recent years, both as an adaptation to higher temperatures but probably also due to substantial population growth. One implication of this is new feeding ground overlap with those of harp seals and minke whales, two other important top predators in the area. One of the presented studies demonstrated that both these mammal species have exhibited declines in body condition (blubber thickness) in recent (15-20) years, and competition for food with the increasing cod stock is suggested as a possible explanation.

Another study, involving grey and harp seals, showed how predation on commercial, well-monitored fish species may be radically influenced by alterations in abundance of other important forage and non-commercial fishes where information about abundance may be sparse. Such changes may particularly impact predator condition, with potential implications for changes in life history and population dynamics. It is generally assumed that change in forage fish distribution will trigger change in predator distribution. Results from joint Norwegian-Russian ecosystem surveys confirms this in that both forage fishes and several whale species tend to be distributed further north in the Barents Sea now compared to only a few years ago. The ecosystem surveys and other surveys with combined marine mammal observations and resource mapping using acoustics and trawls have facilitated more sophisticated understanding of associations between prey and predators. Thus, in the Norwegian Sea killer whales have been observed to be closely associated with the now very abundant mackerel in the area. Baleen whales, such as fin and humpback whales which were previously associated with krill and pelagic fish species, now appear to be associated with high and dense concentrations of juvenile cod and haddock. As in the Barents Sea, also cetaceans in the Norwegian Sea appear to be distributed further to the north now than a decade ago, probably as a result of changes in zooplankton concentrations and more northerly distribution of relevant forage fishes.

Seal species dependent on sea ice for reproduction would be expected to be particularly sensitive to climatic change. One study of harp seals in Canada demonstrated that in addition to direct mortality of pups, due to unseasonal break-up of sea ice, fecundity has also been reduced by an increasing frequency of late-term abortions. Abortion frequency again was linked to both capelin abundance and the amount of first-year ice, but it was suggested that ice cover in this context acted as a proxy for prey availability. For another ice-associated species, the hooded seal, population size in the Greenland Sea has been reduced to a small fraction of historical levels due to past unsustainable harvest. This would be expected to lead to improved fecundity due to release from density dependence, but no decline has been observed in the age of primiparity. This lack of improvement could be due to deteriorating feeding conditions in the area.

Following the 13 presentations, discussion within the session focussed on important knowledge gaps. It was suggested that comparative work in different geographic areas can sometimes prove insightful, e.g. the Barents Sea benefits from good data on forage organisms but suffers less good data on life history parameters for marine mammals. The opposite is true for the NW Atlantic.

Only one of the 13 talks included future projections. Participants considered why this might have been the case and what are the barriers to making accurate forecasts. Physical model outputs (e.g. those of the IPCC) are themselves very uncertain and so it is often difficult to predict what might happen at the regional and species level. No one scenario will ever give a perfect ‘prediction’ – no one scenario should be treated as a forecast, however they can help to inform the ‘direction of travel’ and enable us to develop adaptive management strategies.

It was suggested that in the terrestrial world, scientists are much more willing to make broad brush statements and engage in attempts at predictive modelling. Imperfect projections/data shouldn’t act as a barrier to trying to say something useful. Some of the papers here have indicated that changes we have been predicting in the past have now been observed – climate change impacts are not just theoretical and in the future.

Species distributions, growth and reproductive rates have changed in the past and they will undoubtedly continue to change in the future. The only poster submitted as part of this session demonstrated changes in the growth of Pacific cod over a 200 year time scale – comparing archeological (200+, 100+ YBP) and modern otoliths. Temperatures calculated from the δ18O in aragonite suggested a 2-3°C rise in coastal marine sea surface temperatures in the Gulf of Alaska over the last 200 years.