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Climate of the Past Discussions

Interactive comment on "Refugia of marine fish in the Northeast Atlantic during the Last Glacial Maximum: concordant assessment from archaeozoology and palaeotemperature reconstructions" *by* A. J. Kettle et al.

Anonymous Referee #1

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There is only scant information about geographic ranges of marine species during the Last Glacial Maximum (LGM), when compared to terrestrial and limnic species, as respective archaeozoological information has been lost because of sea level rise. To mitigate this situation, the manuscript describes convincingly, that fish species in the NW Atlantic had a very different distribution in the Last Glacial Maximum, when sea temperatures were much cooler than at present. The novel concept of the manuscript is to use ecological niche modeling to predict the spatial range of marine fish during the LGM and to compare results with archaezoological findings. The subject is relevant as,

due to ocean warming, many fish species have recently shown substantial extension of their northern distribution ranges.

Title and abstract of the manuscript correctly reflect the subject. The introduction gives a good overview of the respective field of research, particularly of probable previous occurrence of NW Atlantic fish species in the Mediterranean during the LGM. Of particular interest are the comparisons of past and present distributions and the respective explanations of the differences using recent results from fish ecology and fish physiology. The methods and assumptions of the manuscript are valid and clearly outlined. The results are sufficient to support the interpretations and conclusions. The results section clearly demonstrates that the results from ecological niche modeling are consistent with archaeozoological findings. The manuscript finishes with two surprising, but convincing conclusions, whereby the ecological niche modeling supports archaezoological findings. (i) During the LGM, in contrast to previous assumptions, the species under consideration have occurred far away from their present distribution; whereby haddock, pollock and salmon even seem to have dwelled in the western Mediterranean. (ii) As also reported in different studies, the authors point out that several species found at archaeological sites are at present caught only in deep waters which were not accessible to fishermen up to a few centuries ago. The interesting speculation is that species such as haddock might have changed their habitat preferences because of systematic fishing pressure leading to local extinctions of shallow water populations. Relevant literature is cited (with exception of a few papers referring recent fish migrations, as indicated below).

The manuscript is highly interesting and deserves publication.

I do not find any faults in the manuscript and recommend publication after minor changes as indicated below.

1352/24-1353/1: Explain in more detail, why is it important, to understand how spatial distributions changed at cool climates during LGM, when you wish to predict changes

in geographic distribution of marine species with futue climate warming.

1356/10: I do not understand the meaning of “a lake in the North Sea”.

1365/26-28: The authors state that fish behaviour might have changed because of human exploitation. I wish to draw their attention to two recent papers demonstrating that strong fishing pressure indeed changes vital demographic parameters of fish populations and behavioural traits (Planque et al., J. mar. Syst. 79: 403-417; Perry et al. J. mar. Syst. 79: 427-435). For example, strong fishing pressure removes particularly the older, larger individuals and truncated age structures of fish populations result from this. Potential consequences are*, inter alia*, reduction in reproductive output, shorter life cycles, reduction of spawning period and recruitment decrease.

1369/1-3: The authors cite one paper according to which demersal North Sea fish species have shifted north by 170 km between 1962-2001. However, there are examples from small pelagic fish species which have extended and contracted their area of distribution by several thousand kilometers within a few years associated with climate variability, for example sardines off California (McFarlane et al. 2000. Prog. Oceanogr. 47: 147-169), Chile and Japan. Also, anchovies and sardines, which had their northern distribution range up to the Channel area, are found all over the North Sea up to Norway since the mid-1990s (Beare et al. 2004. Mar. Ecol. Prog. Ser. 284: 269-278). A very brief introduction to these and similar papers would strengthen the manuscript

Some indication of economic importance of the fish species under consideration should be given. For example: Annual average landings of last 20 years as % of total European catches.

Interactive comment on Clim. Past Discuss., 6, 1351, 2010.