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A matter of scale: Identifying the best spatial and temporal scale of environmental variables to model the distribution of a small cetacean

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Abstract

The importance of scale when investigating ecological patterns and processes is recognised across many species. In marine ecosystems, the processes that drive species distribution have a hierarchical structure over multiple nested spatial and temporal scales. Hence, multi-scale approaches should be considered when developing accurate distribution models to identify key habitats, particularly for populations of conservation concern. Here, we propose a modelling procedure to identify the best spatial and temporal scale for each modelled and remotely sensed oceanographic variable to model harbour porpoise (Phocoena phocoena) distribution. Harbour porpoise sightings were recorded during dedicated line-transect aerial surveys conducted in the summer of 2016, 2021 and 2022 in the northeast Atlantic. Binary generalised additive models were used to assess the relationships between porpoise presence and oceanographic variables at different spatial (5, 20 and 40 km) and temporal (daily, monthly and across survey period) scales. Selected variables included sea surface temperature, thermal fronts, chlorophyll-a, sea surface height, mixed layer depth and salinity. A total of 30,514 km was covered on-effort with 216 harbour porpoise sightings recorded. Overall, the best spatial scale corresponded to the coarsest resolution considered in this study (40 km), while porpoise presence showed stronger association with oceanographic variables summarised at a longer temporal scale (monthly and averaged over survey period). Habitat models including covariates at coarse spatial and temporal scales may better reflect the processes driving availability and abundance of prey resources at the large scales covered during the surveys. These findings support the hypothesis that a multi-scale approach should be applied when investigating species distribution. Identifying suitable spatial and temporal scale would improve the functional interpretation of the underlying relationships, particularly when studying how a small marine predator interacts with its environment and responds to climate and ecosystem changes.

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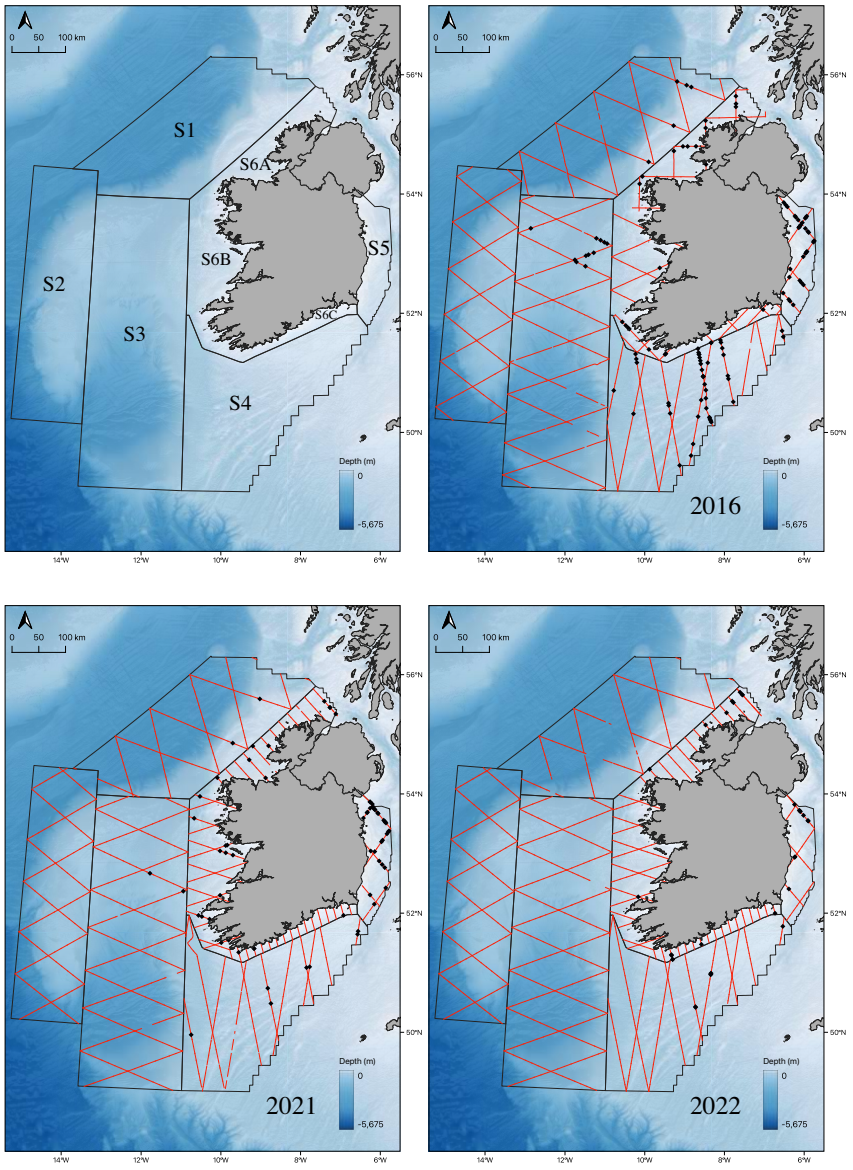

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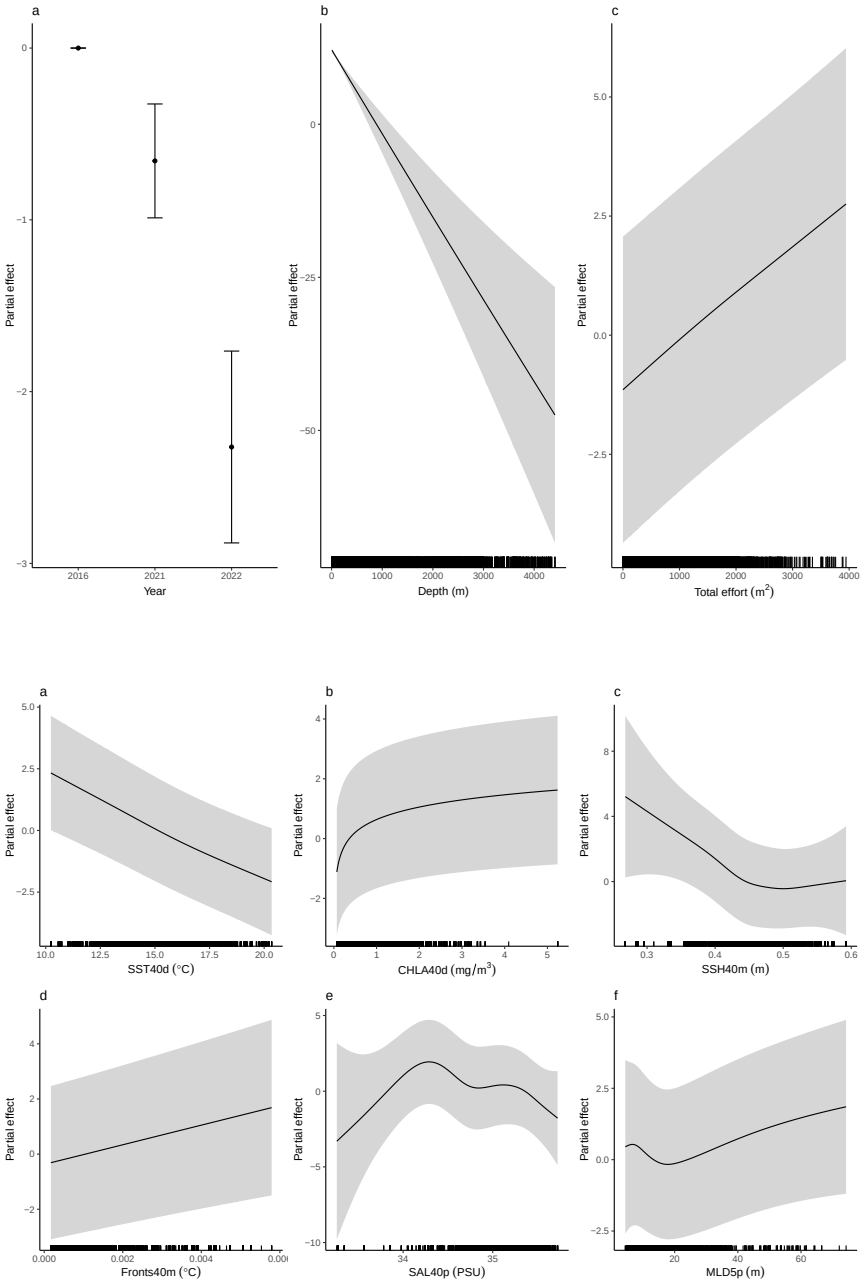

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