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Can we use catch declarations data to map fish spatial distribution?

Integrating multiple data sources to build more informative maps of marine species distribution is a major challenge in fishery ecology. Classically, maps are derived from fish research surveys data. Those data benefit from a standardized sampling design and a controlled catchability, but usually occur once or twice a year and may sample a relatively small number of locations. Fishermen catch declarations can provide a valuable and intensive additional data source to inform fish spatial distribution. However, integrating those data to inform maps remains challenging. First, when at sea, fishermen are not fishing randomly but may preferentially sample areas of high biomass. This is commonly referred to as preferential sampling (PS) and can lead to biased spatial predictions if not accounted for in inference. Second, fishing operations are usually daily aggregated and reported at coarse administrative spatial units (0.5° latitude by 1° longitude rectangles). These declarations are then reallocated on the GPS locations that are classified as fishing in the vessel path. Such reallocation implies strong hypotheses that may artificially increase or transform the available information. Typically, the aggregated catches are commonly reallocated uniformly on GPS positions, which may drastically smooth the spatial signal and ultimately bias estimates and spatial predictions.

We propose a spatial hierarchical framework integrating both data sources while allowing to assess and correct for the misleading effect of PS and reallocation. The model accounts for PS by explicitly modelling the link between the sampling process of commercial data and the species distribution. In addition, the observation process is modified to propose a model that is fed with commercial data at the scale of fishing declarations rather than the reallocated catch at the scale of GPS locations. We use simulations to demonstrate the superiority of the method to improve the accuracy of spatial predictions and to estimate unbiased species-habitat relationship.

Finally, we applied the framework to three demersal species (hake, sole, and squids) in the Bay of Biscay with contrasted PS behaviors. The results support the main findings highlighted in the simulations and paves the way towards high resolution spatio-temporal distribution modelling of marine exploited species.