- We developed a highly spatially resolved discrete-event simulation model of mixed fishery interactions with multiple populations.

- The simulation framework incorporates i) delay-difference population dynamics, ii) population movement using Gaussian Markov Fields to simulate patchy, heterogeneously distribution populations, and iii) individual-based fishery dynamics for multiple fleet characteristics using an explore-exploit strategy.

- The framework allows users to explore assumptions in modelling observational data and examine dynamics at a fine spatiotemporal scale.

- We simulate fifty years of multiple fisheries exploiting four separate populations with different demographics and find nuanced spatio-temporal patterns in exploitation.

- A simulated spatial closure shows that when aggregating point data on fishing activity to a grid, the scale of aggregation matters for the ability to achieve fishery-conservation objectives.

- The simulation framework is available as an R package and we suggest multiple potential uses of the package (e.g. survey design evaluation, testing index standardisation, in-year fishery and biological modelling) for researchers.