We modelled the response (catch per unit effort [CPUE] at point in space and time ) with a Tweedie distribution and a log link \citep{tweedie1984, dunn2005, anderson2019synopsis}

where represents the mean, represents the power parameter, and represents the dispersion parameter. The parameters represent independent means estimated for each year, and and represent coefficients for log depth () and log depth squared (). The symbols and represent spatial and spatiotemporal random effects (respectively) drawn from Gaussian Markov random fields \citep{cressie2011} with covariance matrices and . The symbol  represents the spatially varying coefficients that represent local trends through time also drawn from Gaussian Markov random fields. Time, *t*, is entered into the model for multiplication with after centering it by its mean value. All three random fields have covariance matrices constrained by anisotropic Matérn covariance functions with independent scales but shared parameters controlling the rate of decay of spatial correlation with distance \citep{cressie2011; a Thorson paper}.

We approximated the random fields using 350 “knots” \citep{rue2009, lindgren2011} as calculated with the INLA R package \citep{rue2009} and used bilinear interpolation to predict at locations between the knots. We used the generalized delta-method to calculate standard errors. We found the minimum log likelihood using the R nlminb optimization routine with Template Model Builder implementing the Laplace approximation to the marginal likelihood. Specifically, we fit our models with the R package sdmTMB \citep{anderson2019synopsis, sdmTMB}, which interfaces automatic differentiation in Template Model Builder \citep{kristensen2016} with INLA.