Text for methods: Methods

We found spatial patterns on the residuals corresponding to Lottia density and XXX. We therefore checked if the best model explaining variations in those variables was robust to spatial autocorrelation in the residuals using spatial models spatial model through INLA, following steps detailed in in Zuur et al. (2017, chaps 10 and 12). Those models were based on data averaged by location, Gaussian residuals and using a Gaussian Markov random field (GMRF) based on the Matérn correlation to model the spatial autocorrelation, using the methods detailed in Pardal et al. (2021). Briefly, the GMRF was constructed through a mesh (Fig SX1) limited by the sea and the coastline. The mesh was constructed with triangles (maximum edge: inner triangles = 4 km; outer triangles = 20 km; cutoff sides =0.8 km). We used semi-diffuse penalised complexity priors to specify the parameters of the Matern correlation. We run the models with two different values of the maximum range (500 and 1000 km) , e.g P(MaxRange < 1000km = 0.95) and a value for the prior of the marginal standard deviation (σu) depending on the response variable, corresponding to the expected standard deviation based on the range of values of the data and assuming Gaussian distribution. We also explored the effect of changing priors for the range (MaxRange = 100) but such models had indication of overfitting, as shown by larger effective number of parameters and lower number of equivalent replicates than the previous models. All spatial models removed the spatial autocorrelation in the residuals (see Appendix SS) and retained wave fetch as a predictor (see results) irrespective of the change in the priors for the range.

Results *Lottia*

Text

For Lottia densities, model selection gave a delta DIC < 1 for models with and without Tetra and hence the model retained did not include tetra. Best models retained Chlorophyll-a and Wave fetch as predictors with density increasing towards areas with lower chlorophyll-a and higher wave fetch.

Table SX-Lottia density. Summary statistics for models to the location averaged *Lottia* densities fitted through INLA with chlorophyll and wave fetch as predictor. Spatial models differed in the prior for the range of the Matern spatial correlation function (i.e. the distance at which spatial autocorrelation becomes minimal, either 500 or 1000 km). The parameter estimates comprise the posteriors the range, σu , and the effect of chlorophyll and wave fetch (parameter estimate= β, credible interval 95% = CI)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Intercept | | Chlo-a | | Wave fetch | |
| Model | σu | Range | β | CI 95% | β | CI 95% | β | CI 95% |
| Spatial 1000 | 0.58 | 108.8 | 2.44 | -0.86, 5.79 | -0.55 | -0.86, -0.25 | 5.68 | 0.16, 11.20 |
| Spatial 500 | 0.58 | 55.2 | 2.40 | -0.83,5.67 | -0.55 | -0.82, -0.55 | 5.73 | 0.28, 11.19 |

Results Tetra

For *Tetraclita*, initial inspection of residuals suggested important deviations from Gaussian distribution. Hence, a separate set of models were fitted using gamma residuals. Those models were retained as they showed lower DIC than all those fitted using Gaussian residuals (Table SX2) in addition to improvement in the behaviour of residuals in the process of model validation (Fig Residuals Tetra). For model selection retained SST as predictor (Table SX3) irrespective of the prior used for the range (500 or 1000 km).

Table SX2 Model selection for Tetra density

|  |  |  |  |
| --- | --- | --- | --- |
| Residuals | Predictors | Spatial 500 | Spatial 1000 |
| Gaussian | SST+WF | 450 | 450 |
| Gaussian | WF | 454 | 455 |
| Gaussian | SST | 452 | 452 |
| Gamma | SST+WF | 424 | 423 |
| Gamma | WF | 437 | 437 |
| Gamma | SST | 423 | 423 |

Table SX3-Tetra-density-gamma. Summary statistics for models to the location averaged *Tetraclita* densities fitted through INLA with SST as predictor and gamma residuals and logarithmic link function. Spatial models differed in the prior for the range of the Matern spatial correlation function (i.e. the distance at which spatial autocorrelation becomes minimal, either 500 or 1000 km). The parameter estimates comprise the posteriors the range, σu , and the effect of chlorophyll and wave fetch (parameter estimate= β, credible interval 95% = CI)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Intercept | | SST | |
| Model | σu | Range | β | CI 95% | β | CI 95% |
| Spatial 500 | 0.15 | 73 | 13.33 | 8.24, 18.62 | -0.41 | -0.62,-0.20 |
| Spatial 1000 | 0.15 | 314 | 13.53 | 8.38, 18.95 | -0.42 | -0.63, -0.21 |