

Supplement S4. Validation of top models in the modeling procedures.

(a) Examination on model assumption in top models

In order to verify model assumption on residual independency, we examined normality, dispersion and outlier issue on residuals of each top model. The residuals were calculated from 15-time simulation data (Figure S4). In addition, independency of residual against the groups, including *forest type*, *forest age*, *treatment* and study site, was verified. The model validation indicates no problems (Table S4). The `testUniformity()`, `testDispersion()`, `testOutliers()` and `testCategorical()` function in DHARMA package were used in the model validation.

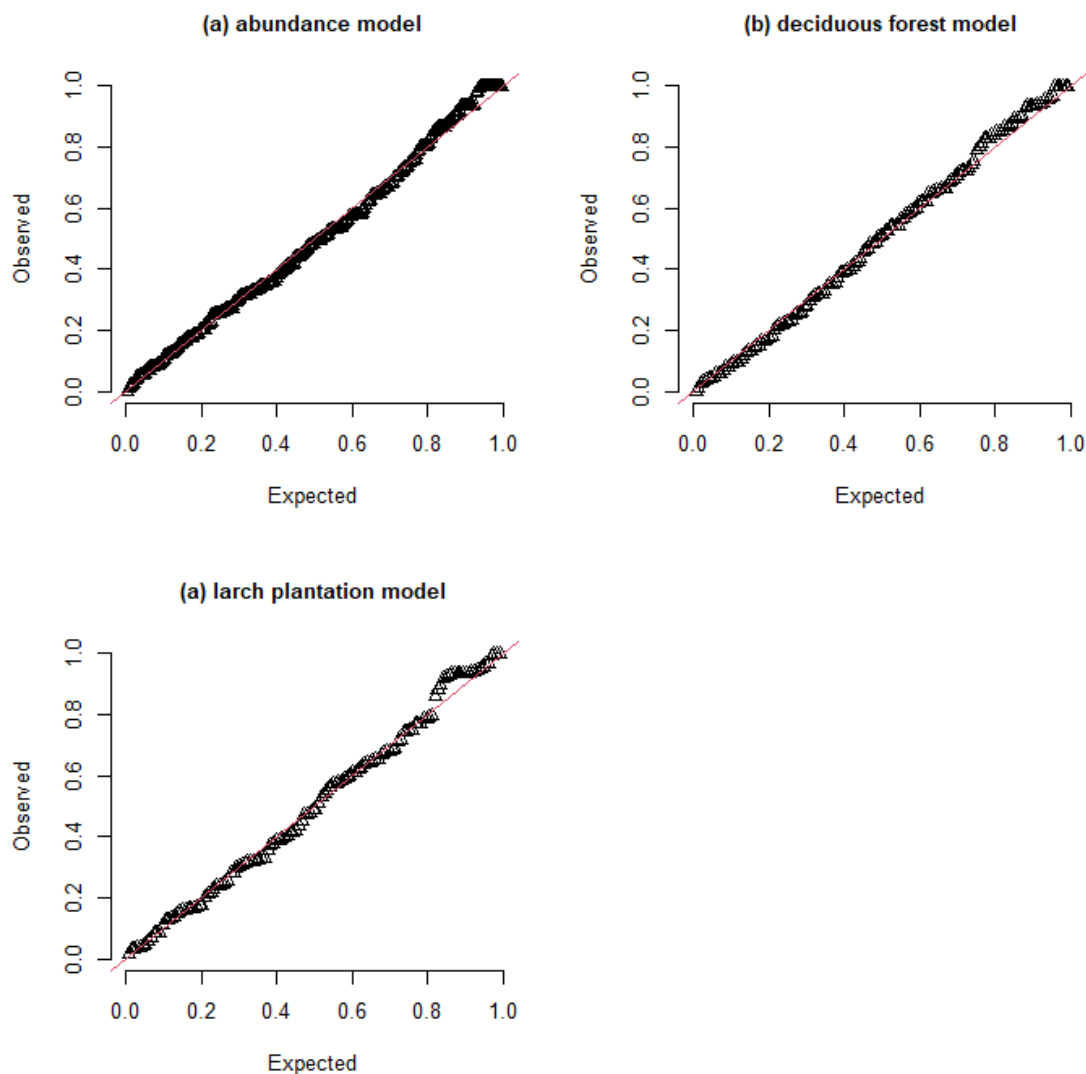


Figure S4 a. qqplots of (a) abundance model and microhabitat use model for (b) deciduous forest and (c) larch plantation.

Table S4 a. Summary of model validation.

Test		Abundance model	Microhabitat use model	
			Deciduous forest	Larch plantation
Normality	D	0.06	0.06	0.08
	<i>p</i>	0.28	0.73	0.67
Dispersion	dispersion	1.20	0.93	1.06
	<i>p</i>	0.27	0.75	0.31
Outlier	expected frequency	0.07	0.06	0.07
	observed frequency	0.06	0.04	0.02
	<i>p</i>	0.40	0.27	0.13

(b) Examination on spatial correlation in top models

We examine a spatial autocorrelation in the residuals of the top models (Supplementary table D2 and Supplementary figure D2). There was no spatial autocorrelation in the residuals of the microhabitat use models (Moran's $I < 0.04$, $p > 0.17$). However, we confirmed a positive correlation in the residuals, corresponding to 2021 data, of abundance model (Moran's $I = 0.10$, $p < 0.01$). In the spline autocorrelation plot, it appeared that the spatial autocorrelation is positive below 200 m scale (Supplementary figure D3). Since there was no variable at microhabitat scale, it is natural results. The spatial scale of forest variable in abundance model is over 500 m. Thus, we concluded that the spatial autocorrelation at smaller scale (< 200 m) would not be problematic in the abundance model.

Table S4 b. Moran's I of residuals in the abundance and microhabitat use models.

Model	Moran's I	
	2020	2021
Abundance model	0.03	0.10***
Microhabitat use model for deciduous forest	0.03	0.02
Microhabitat use model for larch plantation	0.01	0.01

*** $p < 0.001$

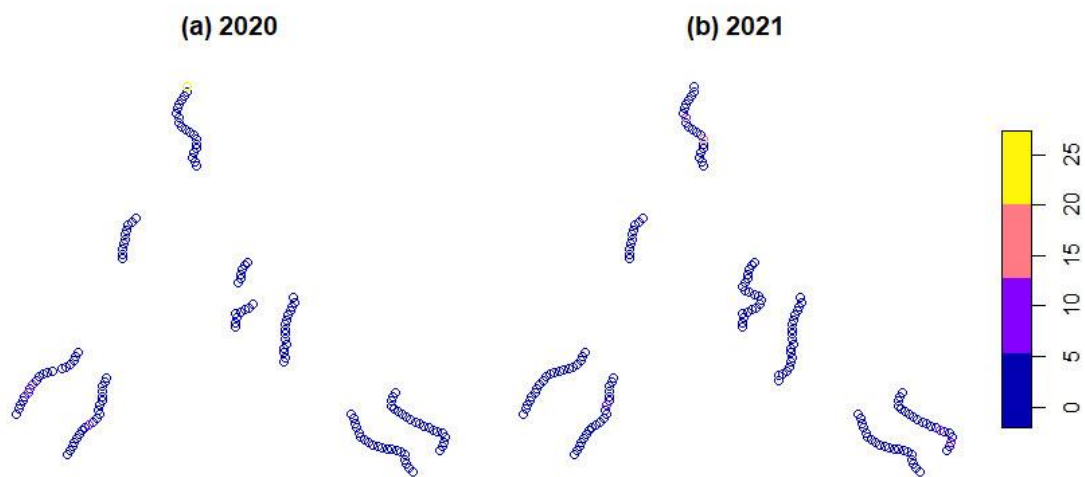


Figure S4 b part 1. Map of residuals in the abundance model.

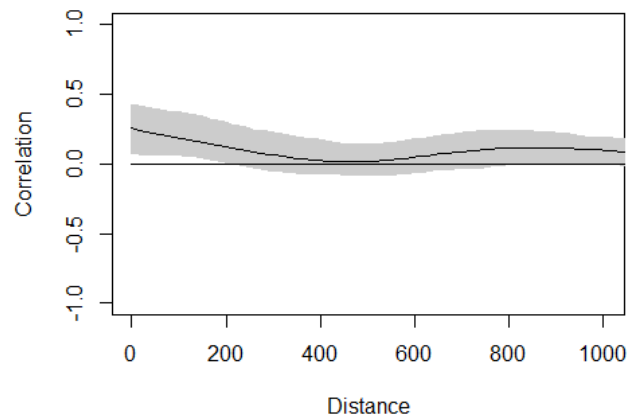


Figure S4 b part 2. Spline correlation of residuals for 2021 data in the abundance model.