Temporal patterns in offshore bird abundance during the breeding season at the Dutch North Sea coast

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ESM 5; GAM without accounting for temporal auto-correlation

Here we explore further the output of model A, without added auto-regressive term to account for temporal auto-correlation, following a similar structure as the main result. Bird abundance was significantly related to sun azimuth (p<0.001) and week of the breeding season (p<0.001), but not to astronomic tide (p=0.167). The complete model explained 18.3% of data deviance (R^2= 0.17). Of the three predictors, week of the breeding season had the strongest estimated effect on bird abundance (8.5% of deviance), followed by sun azimuth (5.3%), and tide (0.3%, non-significant). Year as a random effect was significant (p<0.001), and accounted for 0.5% of deviance. The effect size estimate and confidence intervals (2*standard error) of the significant predictor effects are visualized in Fig. 1. The effect of sun azimuth (Fig. 1A) shows two peaks in predicted number of birds h^{-1} during the day, one in the morning after sunrise (169 birds h^{-1}) and a second, smaller peak in the afternoon (130 birds h^{-1}) and lowest predicted abundance after sunset (77 birds h^{-1}). The effect of week of the breeding season (Fig 4B) shows an increase in mean predicted bird abundance from the last weeks of May to late June (week of June 19th), rising from 76 birds h^{-1} to 169 birds h^{-1}. After this peak hourly abundance dropped to a mean predicted 120 birds h^{-1} in the last week of July.

Table 1 Overview of the generalized additive model output for model B, including parameter estimates for the intercept and random effect (year), and the estimated degrees of freedom (edf) and estimated deviance explained for the environmental predictors, (n=1879)

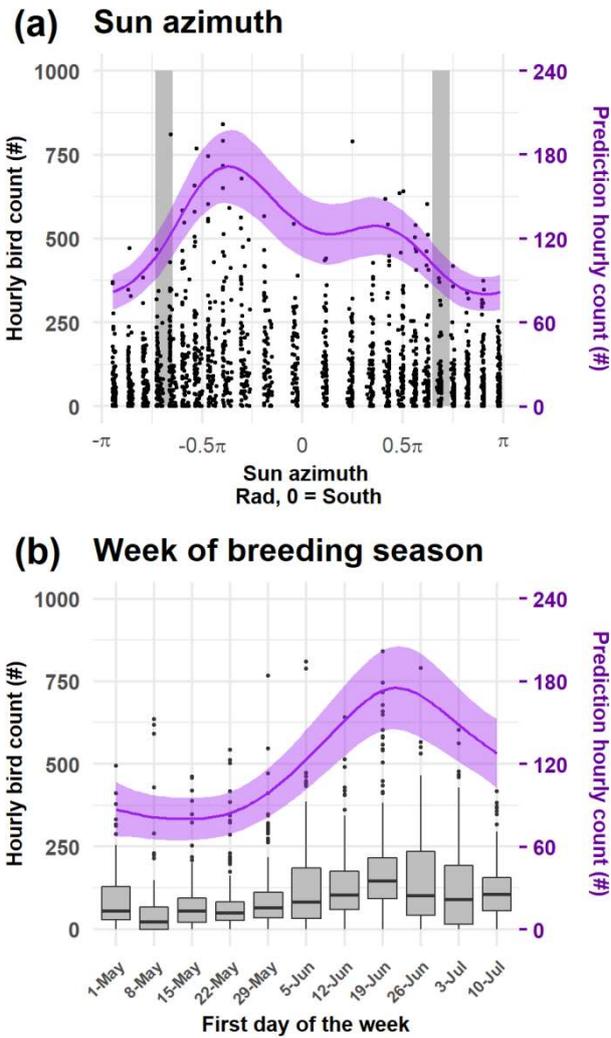| Parametric coefficients	estimate	edf	est. dev. explained	p-value
Intercept	4.585			<0.001
Year=2020	0.154		0.5%	<0.001
Smooth terms				
Sun azimuth		5.002	5.3%	<0.001
Week of the breeding season		4.433	8.5%	<0.001
Tidal water height		1.774	0.3%	0.125

Fig. 1 Smoothed effects of the significant individual predictors in the hourly abundance model A (n=1879). Left Y-axis shows hourly bird count (black dots / boxplots), whereas the right Y-axis shows predicted hourly bird count (purple line = effect size, area = effect size±2·se). a) Effect of sun azimuth, in radians from South (X-axis). Sunrise occurs between Azimuth = -.73π to -.64π, sunset between Azimuth = .64π to .73π, indicated by the grey areas. B) Effect of week in the breeding season, date indicates the first day of each week (X-axis)