

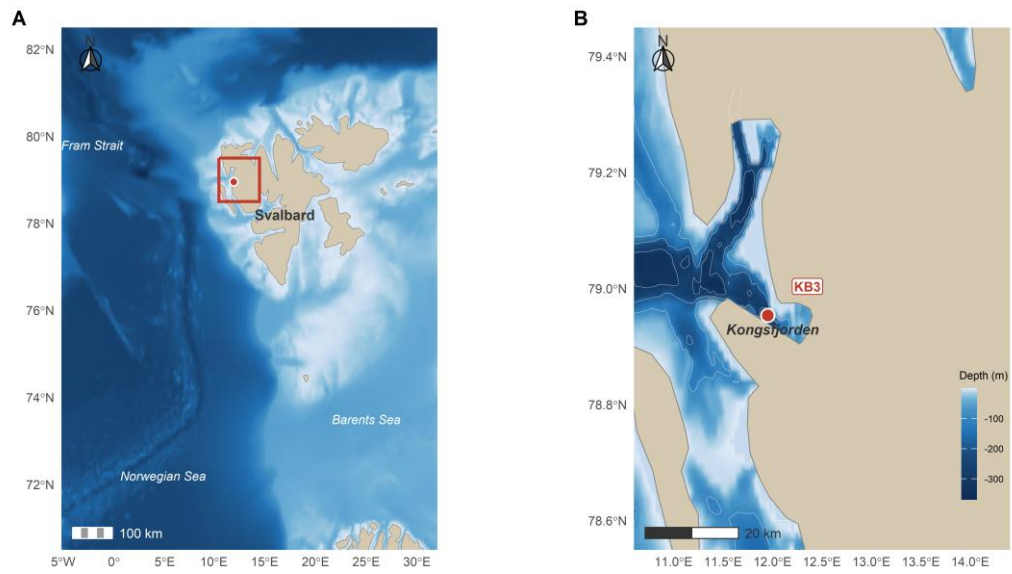


Figure S1. A) Location of sampling station KB3 (78°57.2'N, 11°57.2'E) in Kongsfjorden, (Svalbard, Norway). B) Detailed bathymetric map of Kongsfjorden with station KB3 indicated by the red dot. Bathymetry data from NOAA ETOPO (resolution 1 arcmin for inset, 4 arcmin for main map). Depth scale in metres.

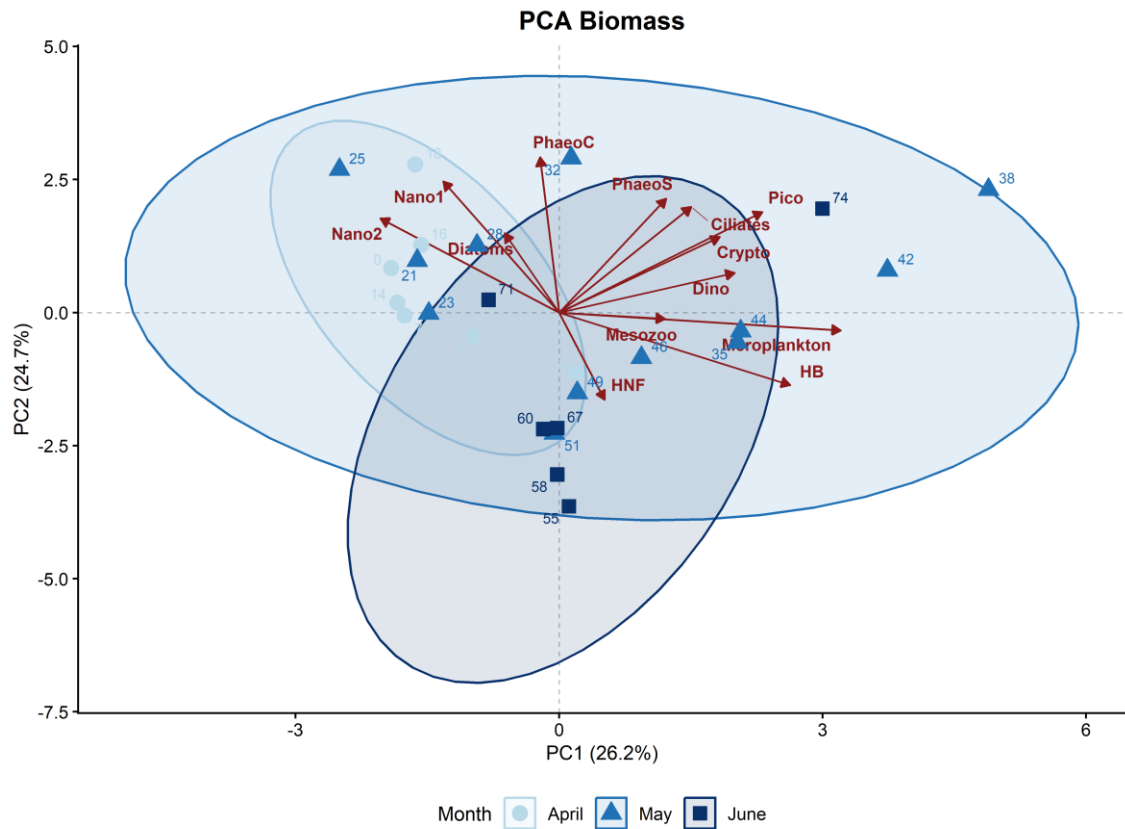


Figure S2. Principal component analysis (PCA) of biological biomass variables ($n = 13$) at station Kb3, April–June 2023. Missing values imputed by spline interpolation (imputeTS). PC1 (26.2%) vs PC2 (24.7%). Arrows indicate variable loadings. Points represent individual sampling days; shaded ellipses show 95% confidence regions per month. Total variance explained by PC1–PC2: 50.9%.

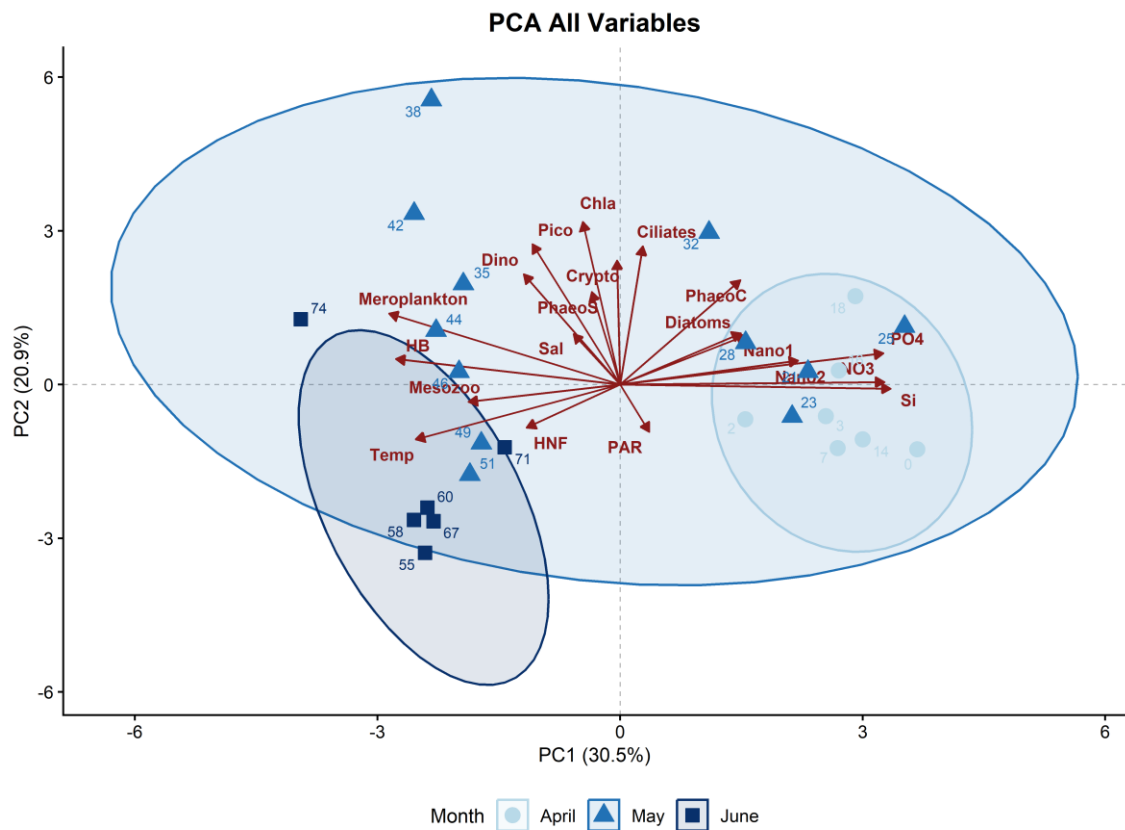


Figure S3. Principal component analysis (PCA) of biological and environmental variables ($n = 20$) at station Kb3, April–June 2023. Missing values imputed by spline interpolation (imputeTS). PC1 (30.5%) vs PC2 (20.9%). Arrows indicate variable loadings. Points represent individual sampling days; shaded ellipses show 95% confidence regions per month. Total variance explained by PC1–PC2: 51.4%.

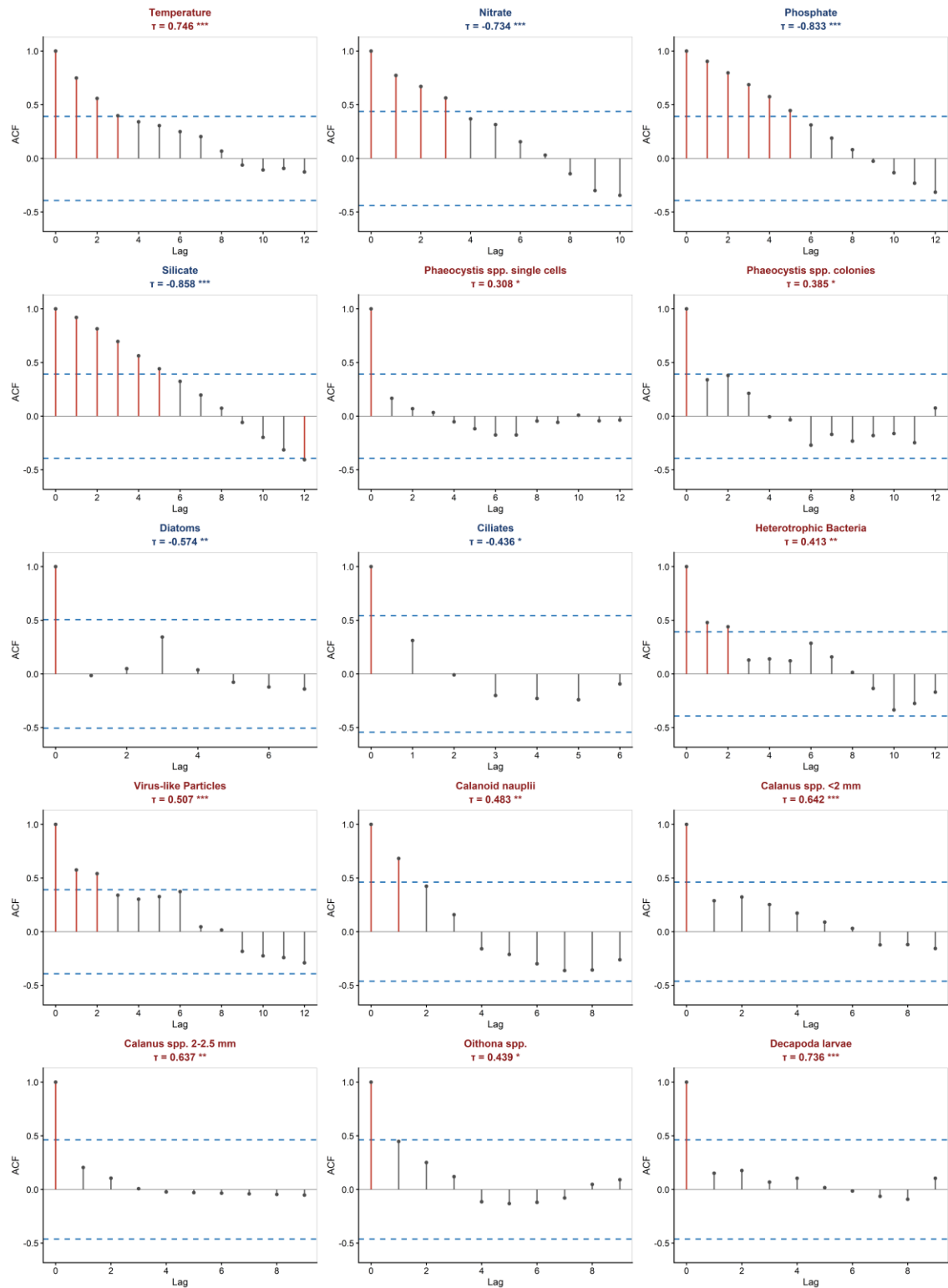


Figure S4. Autocorrelation functions (ACF) for the 15 variables showing significant monotonic trends (Mann-Kendall test, $p < 0.05$) at station Kb3, April–June 2023. The Mann-Kendall τ statistic and significance level are indicated above each panel. Red titles indicate significant increasing trends; blue titles indicate significant decreasing trends. Dashed blue lines show the 95% confidence interval for the ACF.

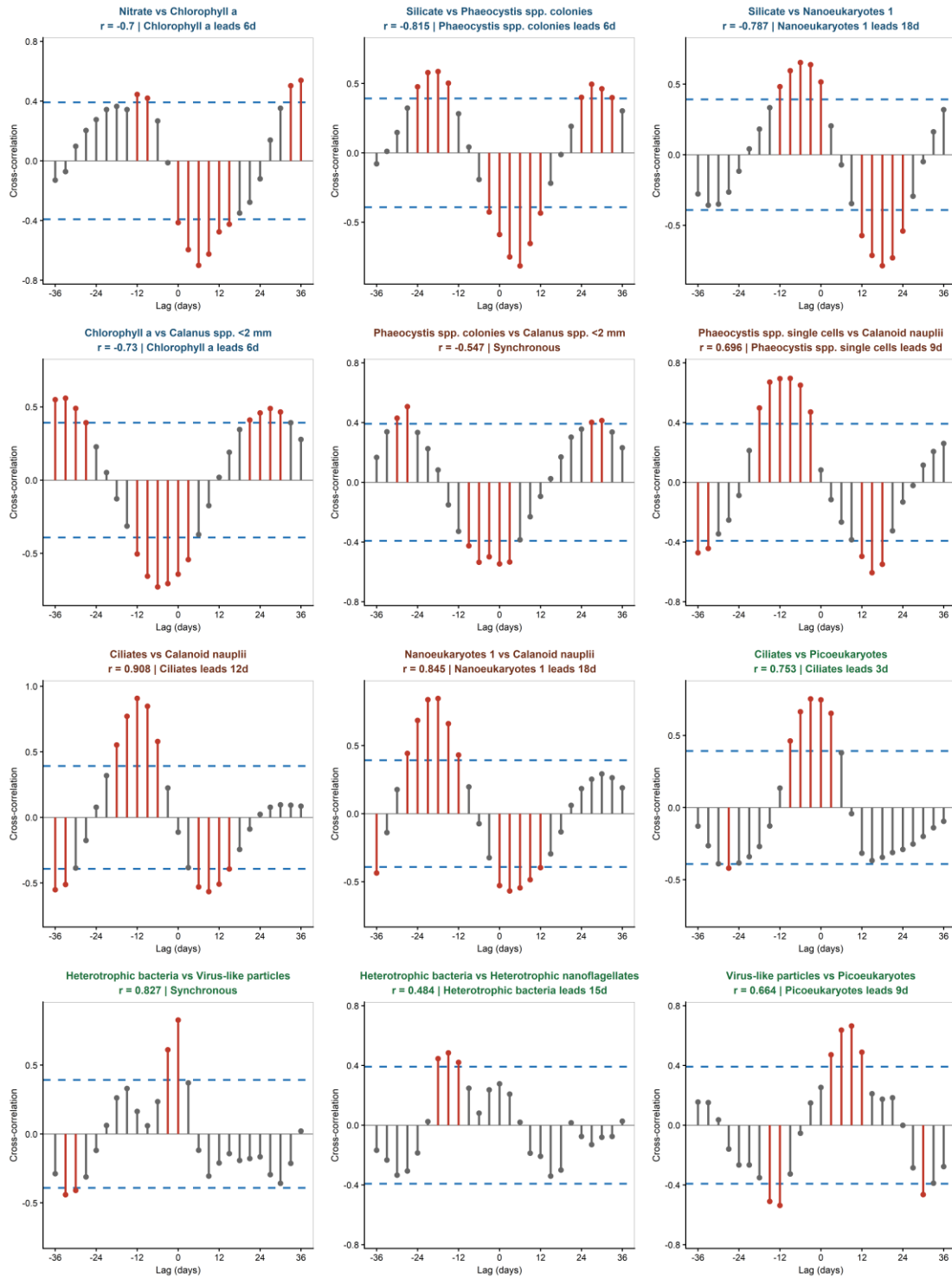


Figure S5. Cross-correlation function (CCF) analysis between selected biological and environmental variables ($n = 25$ sampling days). Time series were linearly interpolated to a 3-day grid and linearly detrended prior to analysis. Red bars indicate cross-correlations exceeding the 95% confidence interval (dashed blue lines; $CI = \pm 0.392$). Positive lags indicate that the first-named variable leads the second. Panels are grouped by category: physical-biological (rows 1–2), trophic (rows 2–3), and microbial fraction (row 4). Lag.max = ± 36 days.

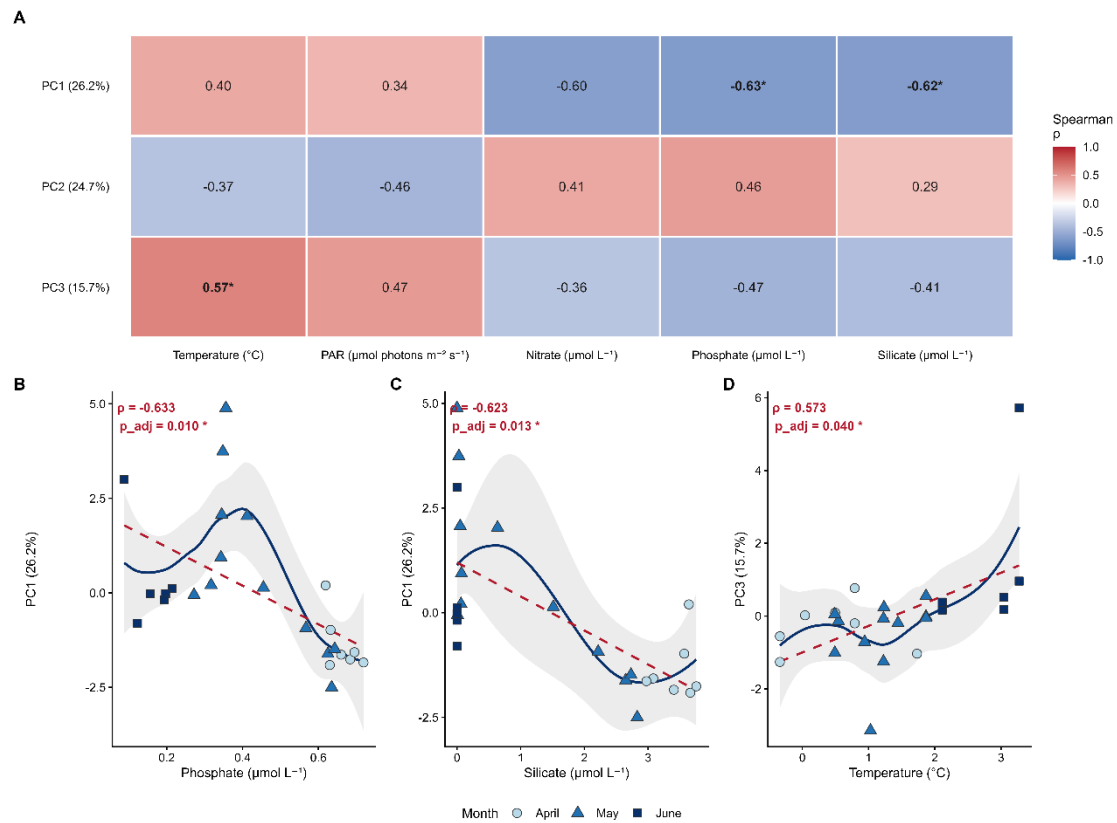


Figure S6. (A) Heatmap of Spearman correlation coefficients (ρ) between the first three principal components of the biomass PCA (PC1: 26.2%, PC2: 24.7%, PC3: 15.7% of variance) and five environmental variables (temperature, PAR, nitrate, phosphate, silicate). Asterisks indicate significant correlations after Bonferroni correction for multiple comparisons ($\alpha = 0.05$). (B–D) Scatterplots of the three significant pairs: PC1 vs. phosphate (B), PC1 vs. silicate (C), and PC3 vs. temperature (D). Blue lines show LOESS smoothers with 95% confidence intervals (grey shading); red dashed lines show linear fits. Spearman ρ and Bonferroni-adjusted p -values are given in each panel.

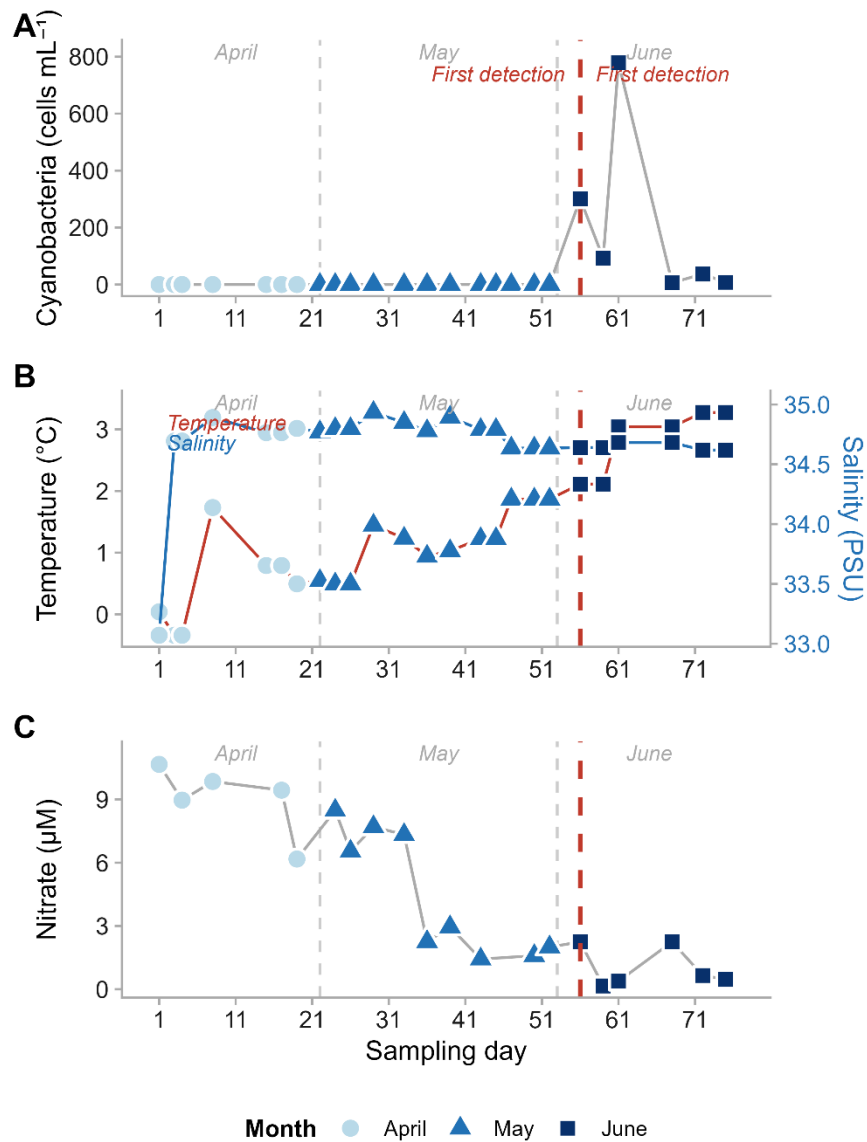


Fig. S7. Temporal dynamics of cyanobacteria abundance (cells mL⁻¹), temperature and salinity, and nitrate (μM) at station KB3 during spring-summer 2023. The dashed red vertical line indicates the first detection of cyanobacteria (sampling day 56). Colors and symbols as in Fig. 1.