Supporting Information

Tradeoffs between light and nutrient limitation in lake phytoplankton influence responses to future browning

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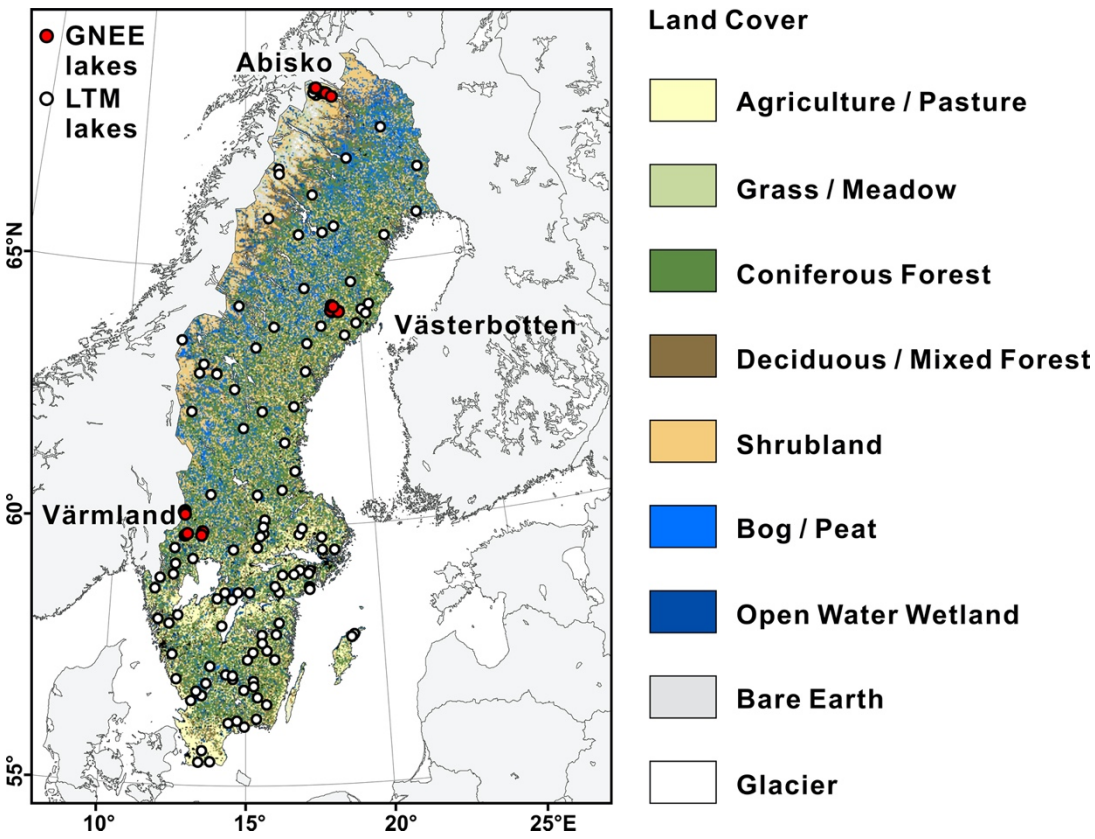
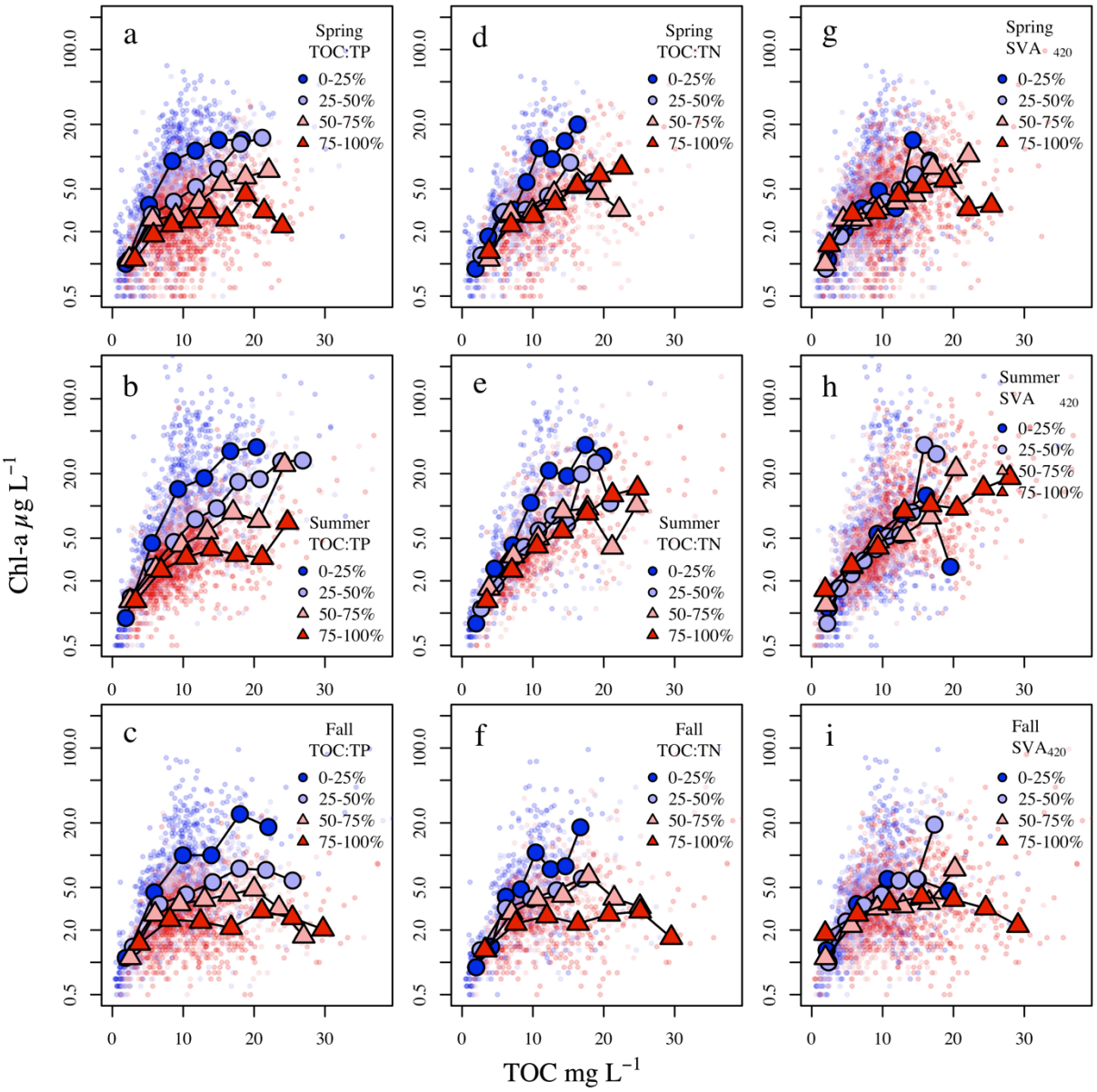
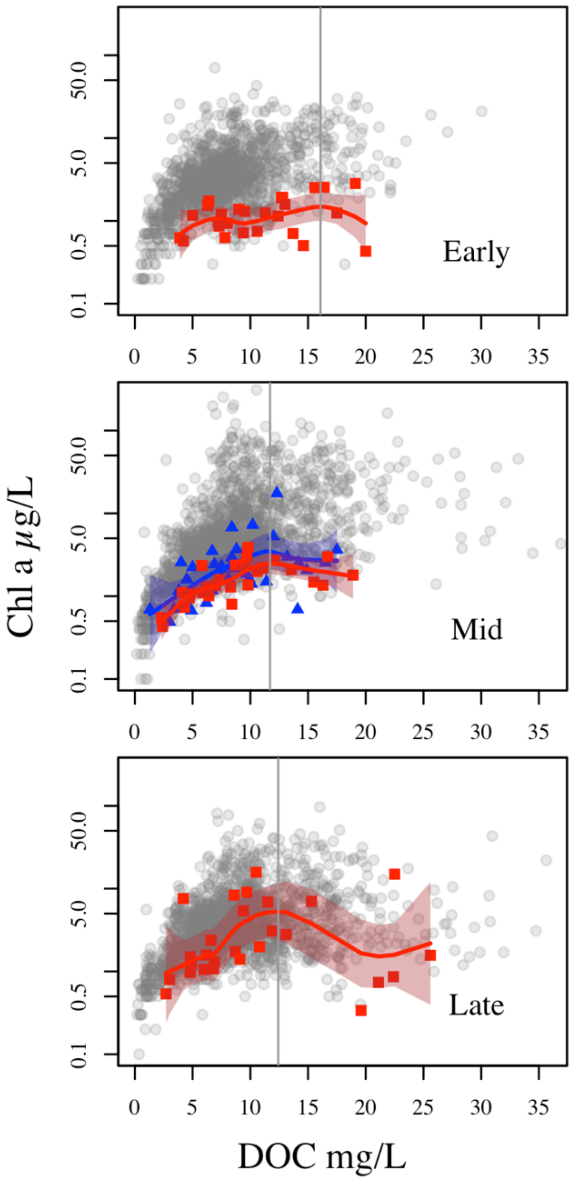


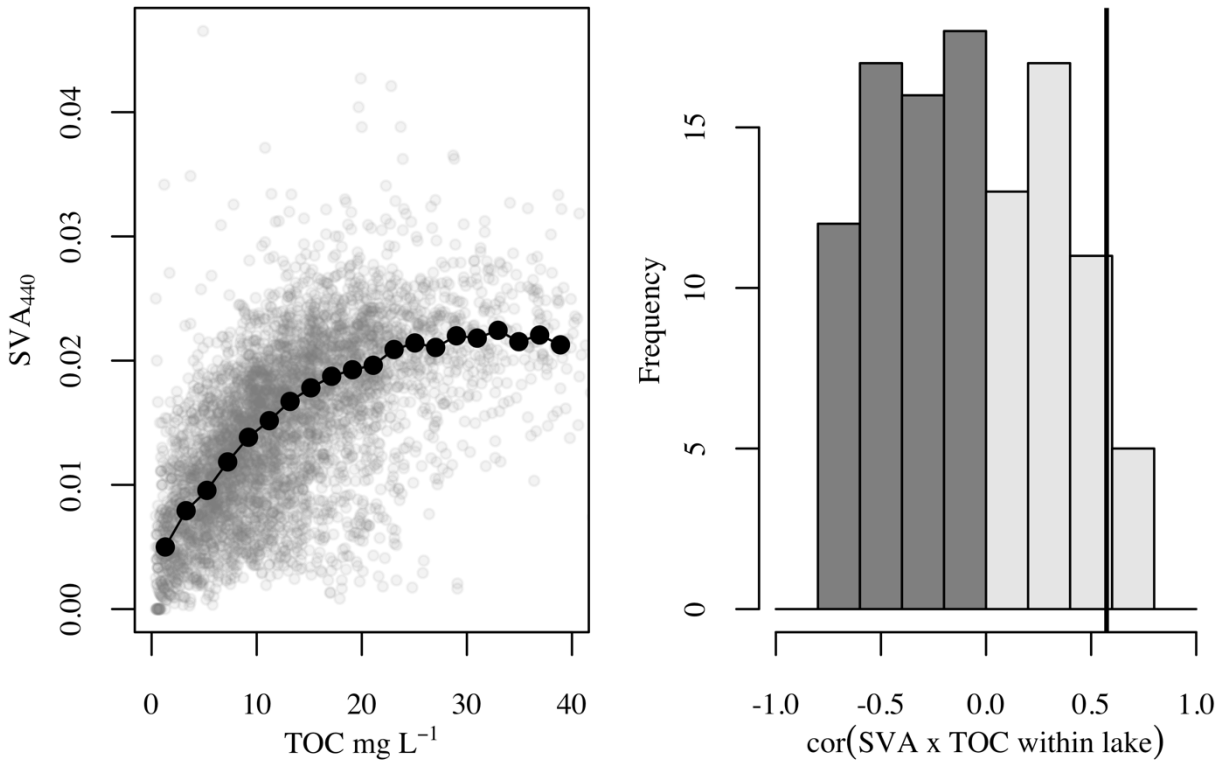
Supplemental Figure 1: Map of Sweden showing major landcover classes and long-term monitoring (LTM) lakes (white circles). Field sites (GNEE lakes) shown in supplemental fig 3 are shown as red circles. GNEE lakes were also used to develop the thermocline depth model to generate the areal chl-a estimates in Fig. 3.



Supplemental Fig. 2: TOC plotted against Chl-*a* for the LTM data as in Fig. 1 of the main text, with data colored by quantiles of either TOC:TP (panels a-c), TOC:TN (panels d-f) or SVA_{420}(panels g-i).

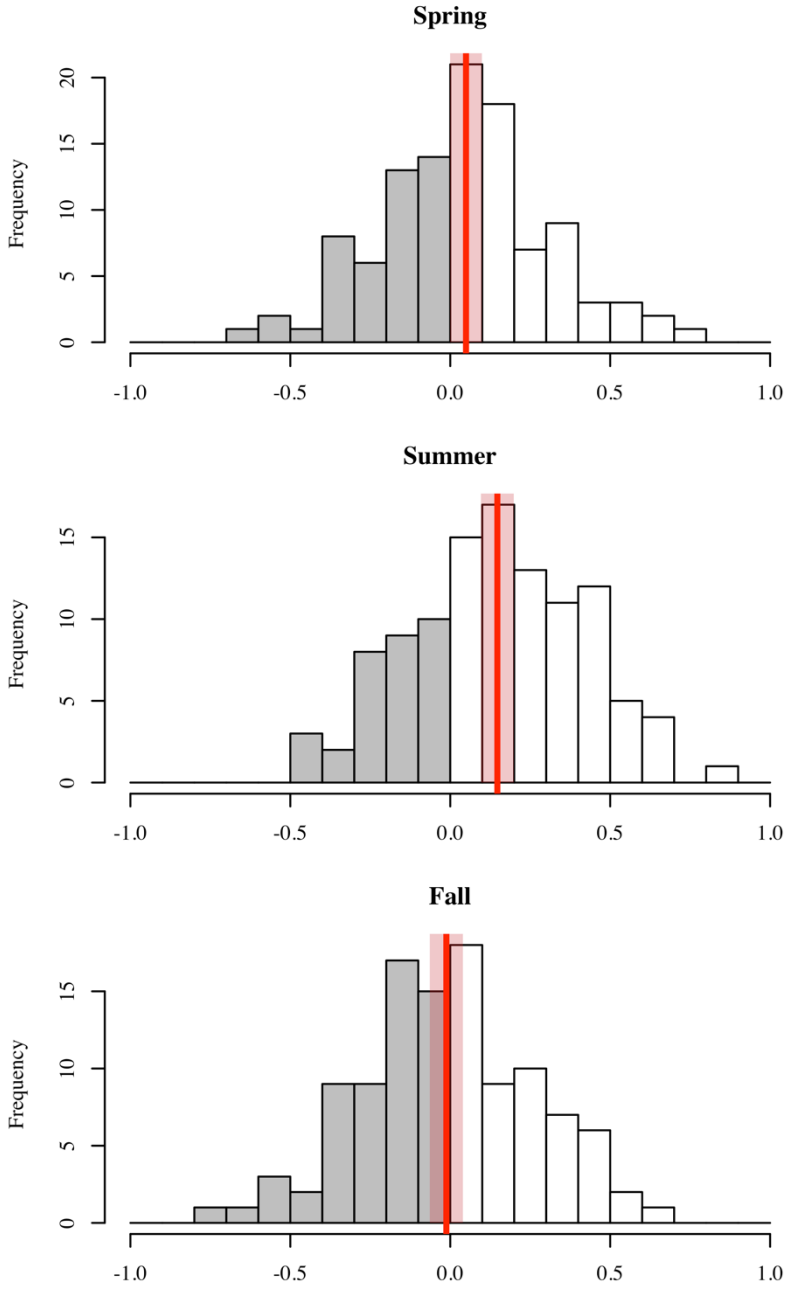


Supplemental Fig. 3: DOC plotted against Chl-*a* for 27 small, nutrient poor headwater lakes sampled during 3 seasons in 2016 (red squares; for description of sampled lakes see (Isles et al. 2020) in 3 regions from northern to southern Sweden. Another set of lakes collected in 2018 only in summer in similar regions is shown in blue triangles (Bergström et al. 2008). These small headwater lakes have chl-*a* at the low end of the distribution of the LTM data (light gray circles) for any given DOC concentration, reflecting relatively high DOC:TN and DOC:TP ratios. These data also show a decline in chl-a at high DOC concentrations in the Fall (late season) but not in spring or summer. Not that LTM data have measured TOC, rather than DOC, on the x-axis.

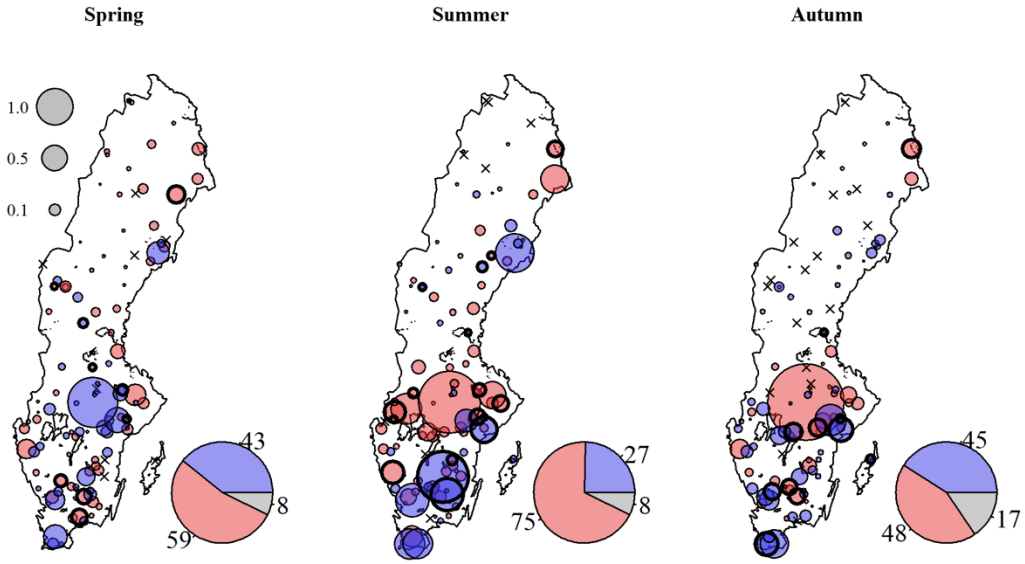


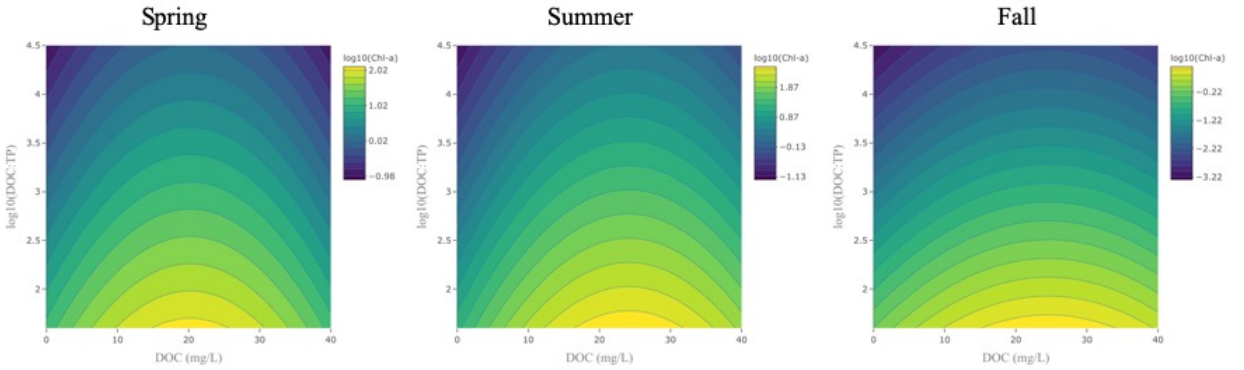
Supplemental Figure 4: Left: TOC plotted against SVA_{440} in the CLIML survey dataset showing spatial covariance of TOC concentration and TOC color. Red circles represent median values of SVA_{440} in 20 bins of equal width along the TOC gradient (samples with TOC > 40 mg L^{-1} excluded from this analysis). Right: histogram showing the distribution of correlations of TOC with SVA_{440} in individual lakes in the long-term monitoring dataset (subset to autumn samples for comparison with the CML data). Thick vertical line in right panel is the correlation across the CML dataset in the left panel.

Supplemental Fig. 5: histograms showing within-site Pearson correlation coefficients (over time) between TOC and chl-*a* for each season. Grey bars are negative correlations, white are positive. Red line represents the mean correlation. Red shaded area represents the 95% confidence interval around the mean (calculated as 1.96 standard errors); if the confidence interval does not include 0, the mean correlation is considered positive (only observed during summer).



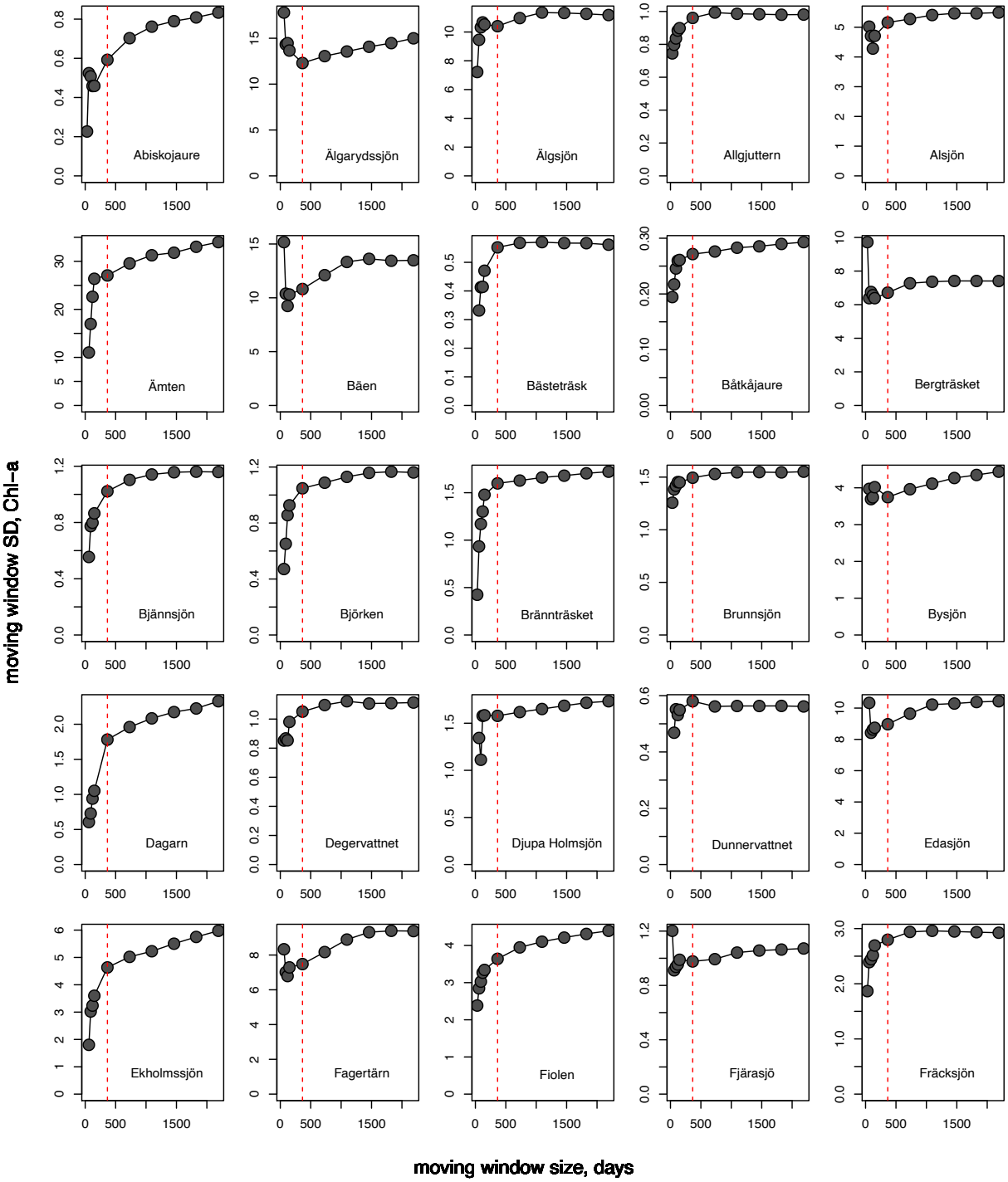
Supplemental Fig. 6: Temporal trends in lake chlorophyll-*a* (µg L^{-1} y^{-1}), calculated based on the Thiel-Sen slope estimated using the R package rkt. Red circles represent increases, blue represent decreases, and x's represent no change with time. The size of the circles is proportional to the magnitude of the slope, and circles with dark borders are considered statistically significant changes (alpha = 0.05). The pie charts and associated numbers represent the number of lakes in each season with positive (red), negative (blue) or no slope (gray).

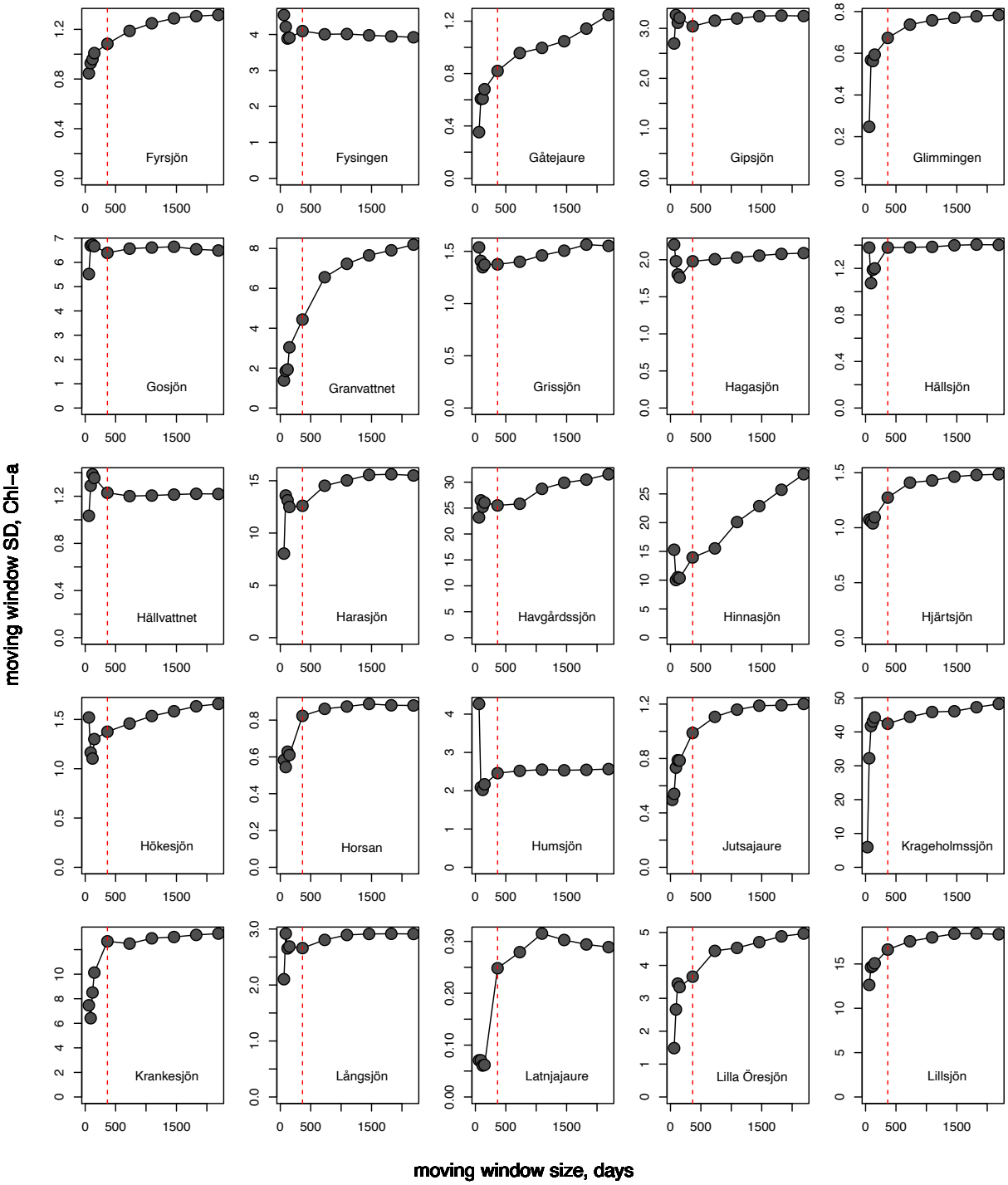


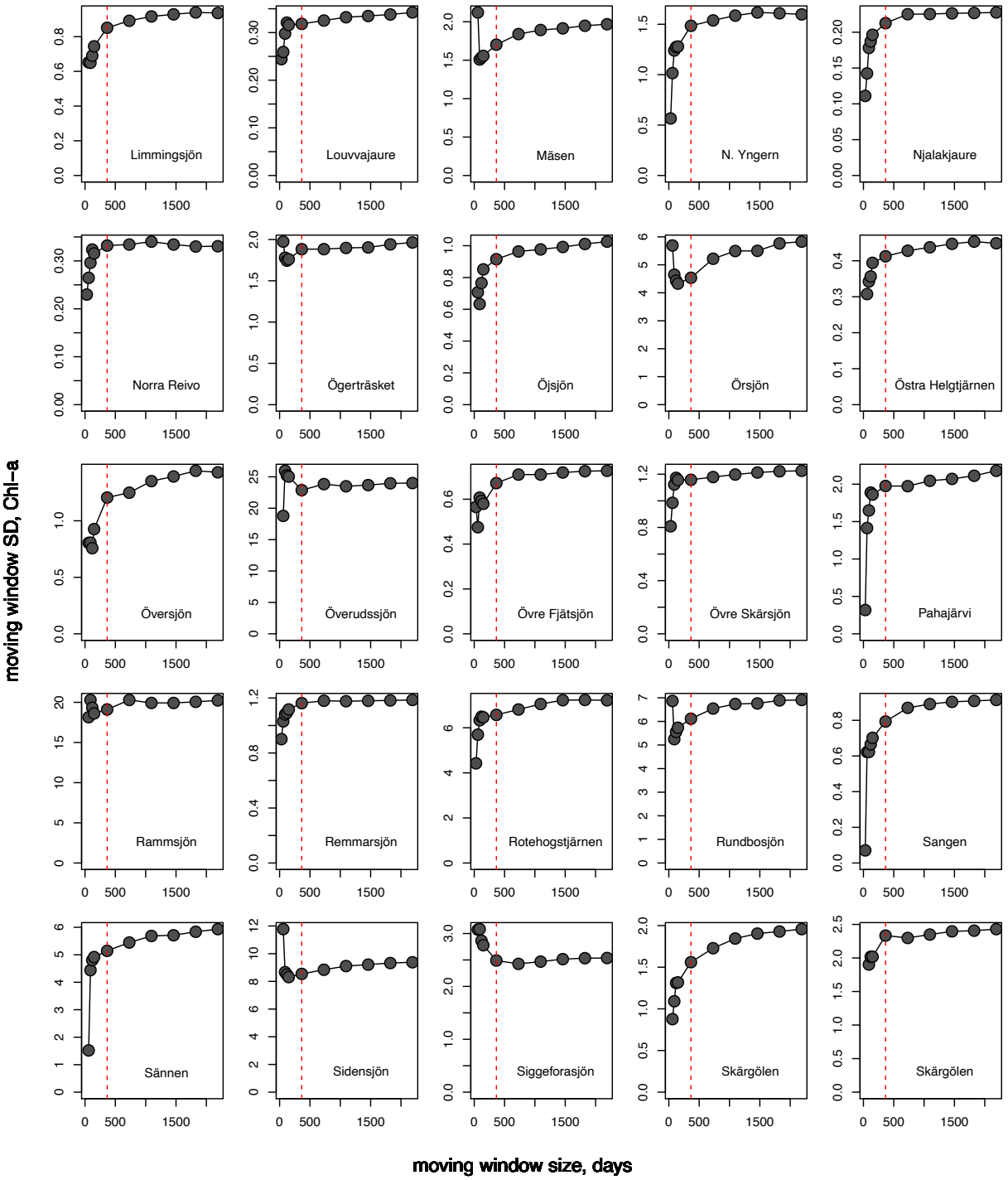


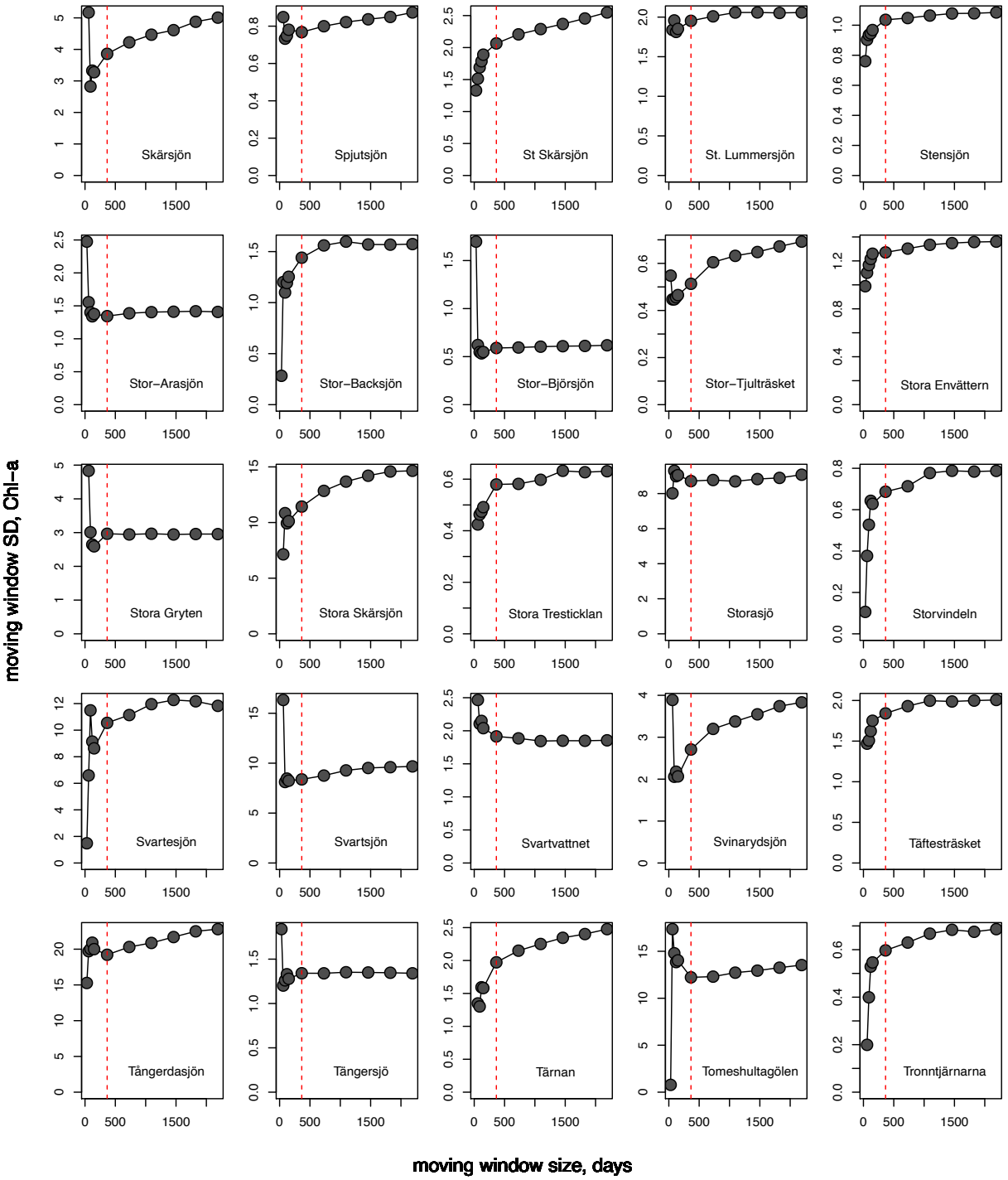
Supplemental Figure 7: Figures showing modelled $\log_{10}$(chl-*a*) predictions for the Spring, Summer, and Fall based on Swedish LTM data. Model equations for each season are given in Table 1 in the main text.

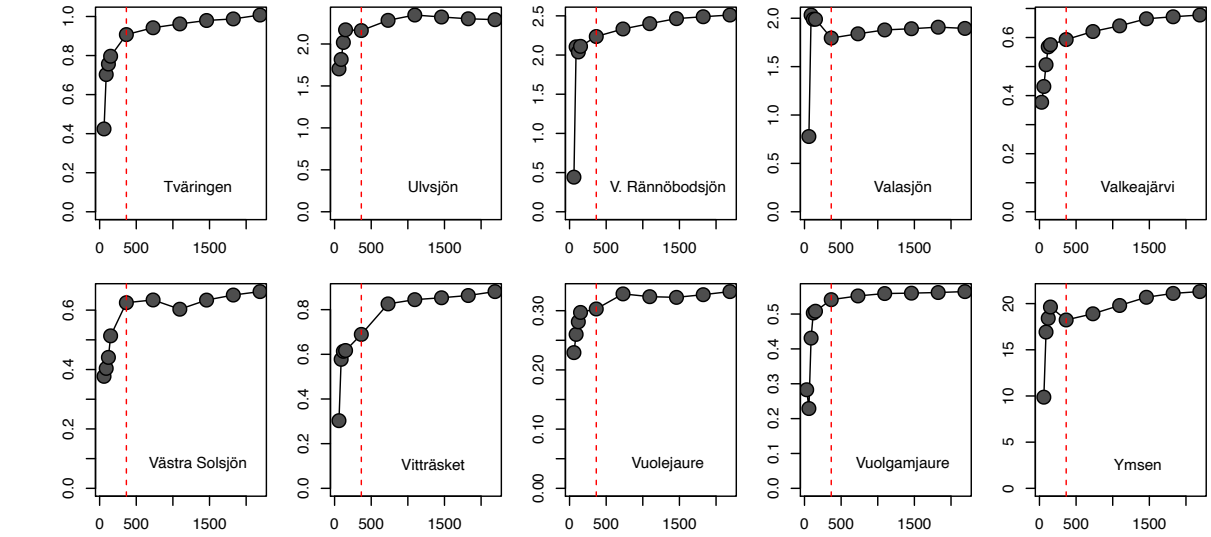
Supplemental Fig. 8: Temporal semivariograms for Chl-a in each of the LTM lakes, showing average standard deviation of chl-a (y-axis) for different sizes of moving window along the time series (x-axis). Dashed vertical lines represent 1-year moving windows.




moving window SD, Chl-a
moving window size, days
Fyrsjön
Fysingen
Gåtejaure
Gipsjön
Glimmingen
Gosjön
Granvattnet
Grissjön
Hagasjön
Hällsjön
Hällvattnet
Harasjön
Havgårdssjön
Hinnasjön
Hjärtsjön
Hökesjön
Horsan
Humsjön
Jutsajaure
Krageholmssjön
Krankesjön
Långsjön
Latnjajaure
Lilla Öresjön
Lillsjön


moving window SD, Chl-a
moving window size, days
Limmingsjön
Louvvajaure
Mäsen
N. Yngern
Njalakjaure
Norra Reivo
Ögerträsket
Öjsjön
Örsjön
Östra Helgtjärnen
Översjön
Överudssjön
Övre Fjätsjön
Övre Skärsjön
Pahajärvi
Rammsjön
Remmarsjön
Rotehogstjärnen
Rundbosjön
Sangen
Sännen
Sidensjön
Siggeforasjön
Skärgölen
Skärgölen


moving window SD, Chl−a
moving window size, days
Skärsjön
Spjutsjön
St Skärsjön
St. Lummersjön
Stensjön
Stor−Arasjön
Stor−Backsjön
Stor−Björsjön
Stor−Tjulträsket
Stora Envättern
Stora Gryten
Stora Skärsjön
Stora Tresticklan
Storasjö
Storvindeln
Svartesjön
Svartsjön
Svartvattnet
Svinarydsjön
Täftesträsket
Tångerdasjön
Tängersjö
Tärnan
Tomeshultagölen
Tronntjärnarna



moving window SD, Chl-a

moving window size, days