

Water quality forecasts for Lake Barco and Lake Suggs

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July 28th, 2023



Objective

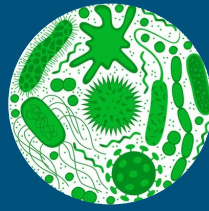
Forecast concentrations of chlorophyll a
in two Florida lakes for 30 days



Lake Barco



Lake Suggs






Decision maker's inquiries:

1. Should one lake be chosen for drinking water this month over the other?
2. What are the maximum concentrations that will occur in the next 30 days? And when will this maximum level occur?
3. Are chlorophyll concentrations likely to be higher or lower than normal for the time of year?
4. What are the chances that the lake(s) will be closed in the next month for swimming?

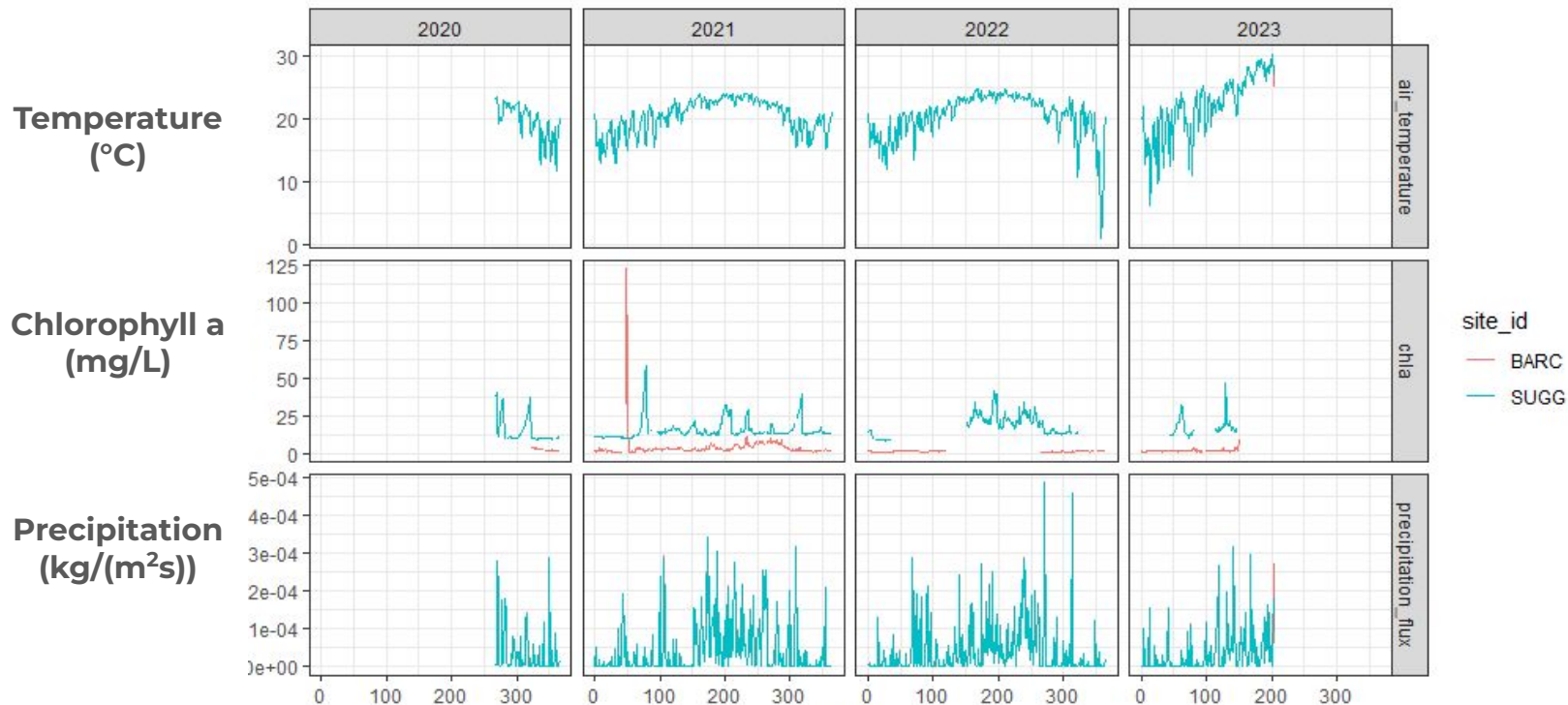
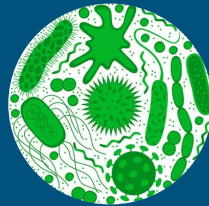


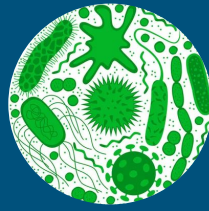
Available covariates

- Temperature 
- Precipitation 
- Wind speed 



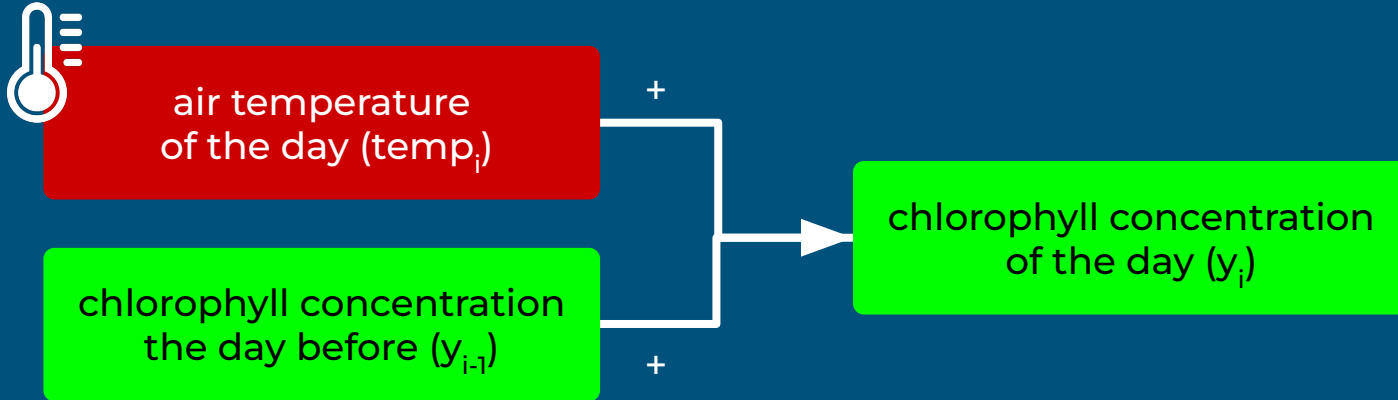
Data exploration

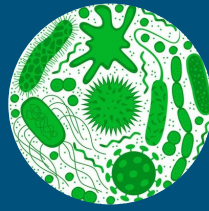




Model 1: Base model

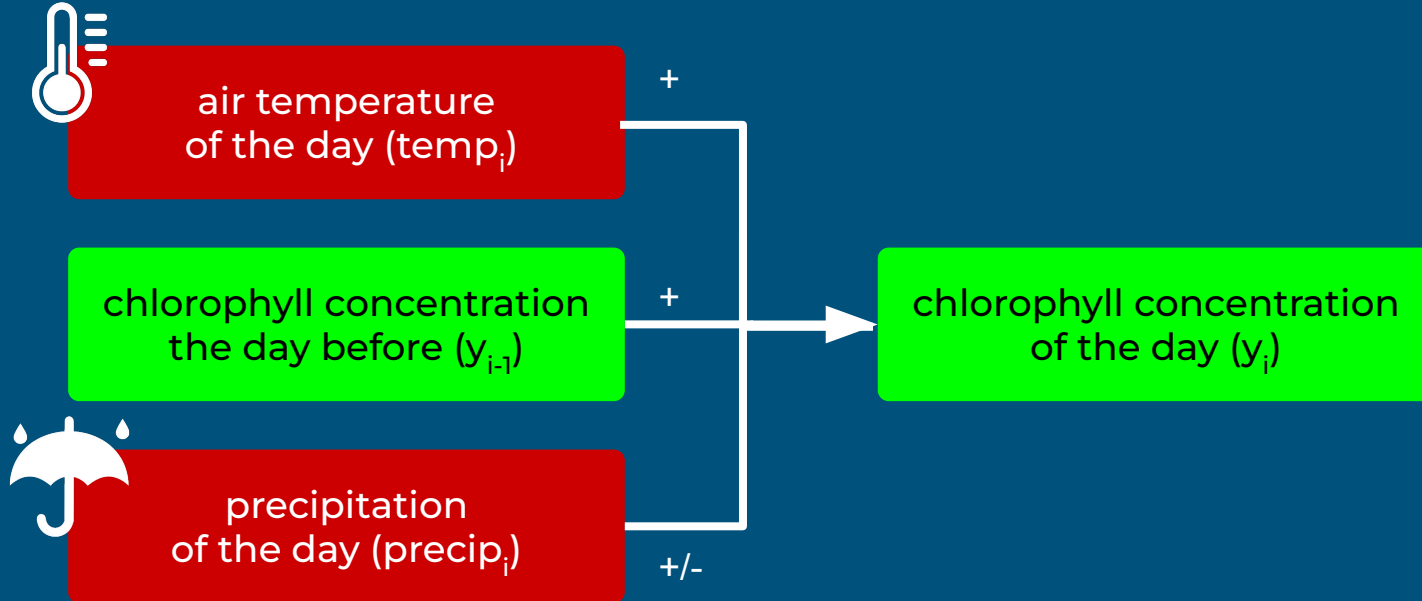
$$y_i \sim N(\beta_0 + \beta_1 y_{i-1} + \beta_2 \text{temp}_i, \tau)$$



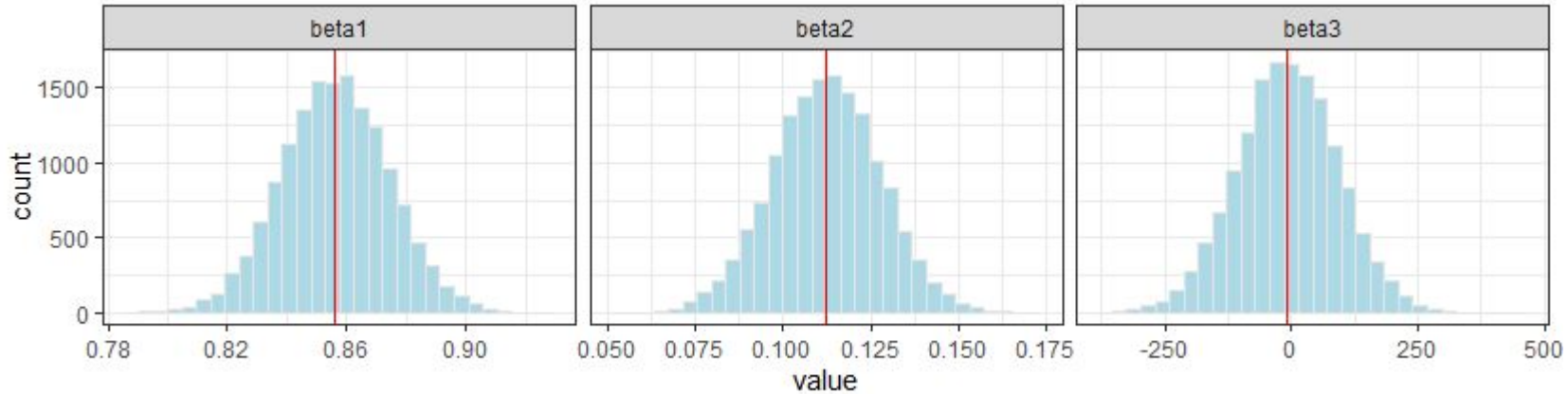


Model 2: Precipitation and temperature

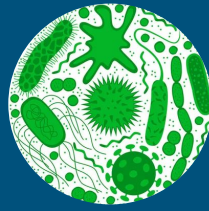
$$y_i \sim N(\beta_0 + \beta_1 y_{i-1} + \beta_2 \text{temp}_i + \beta_3 \text{precip}_i, \tau)$$



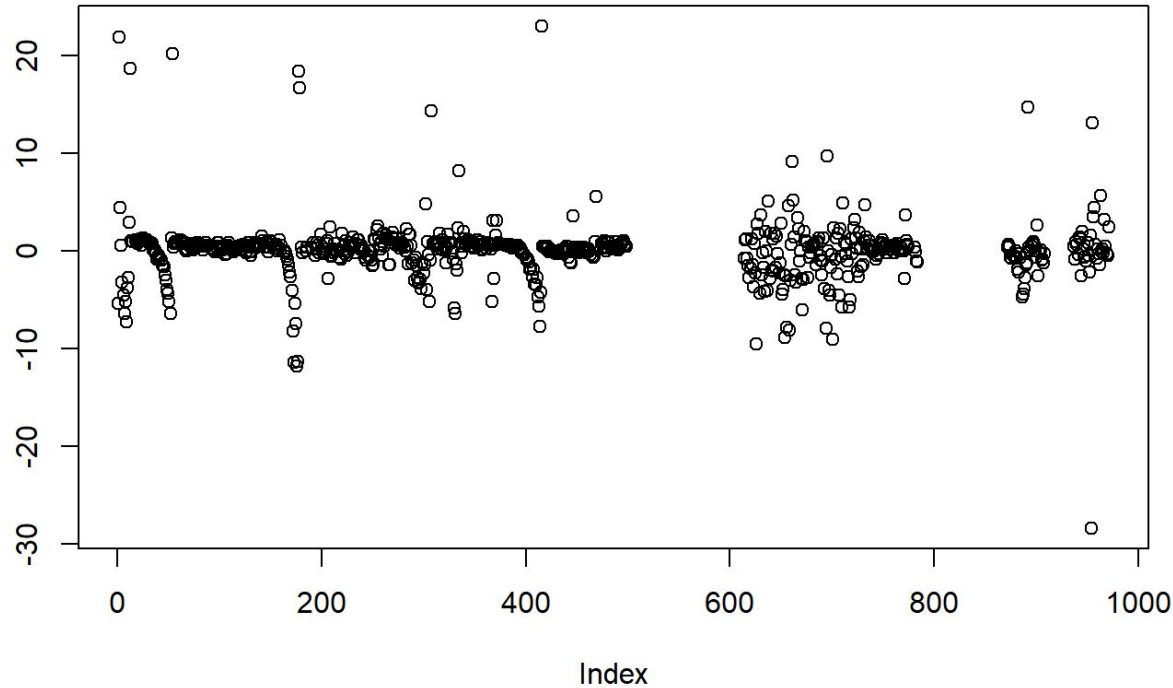
Model 2: Parameters



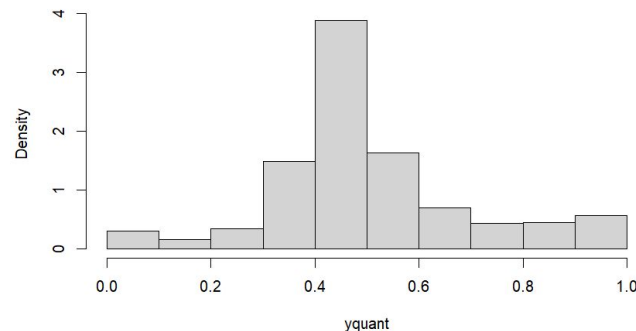
Model 2: Evaluation



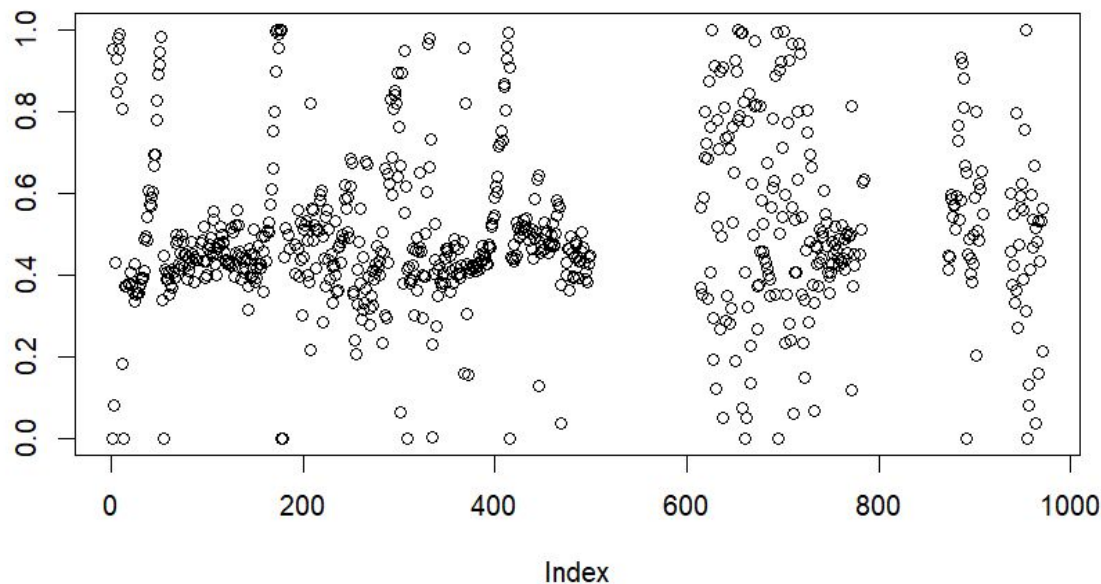
residuals



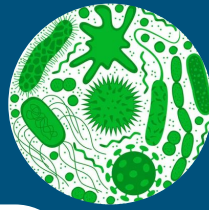
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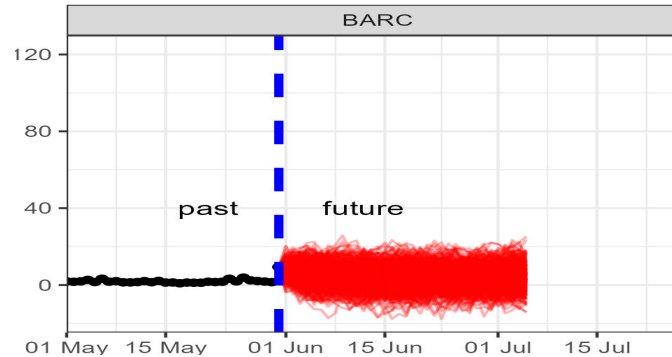
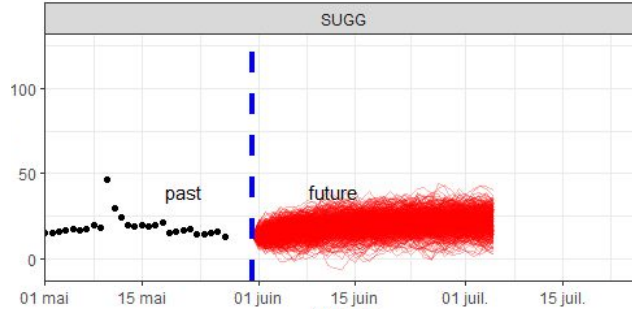
**y
quantiles**

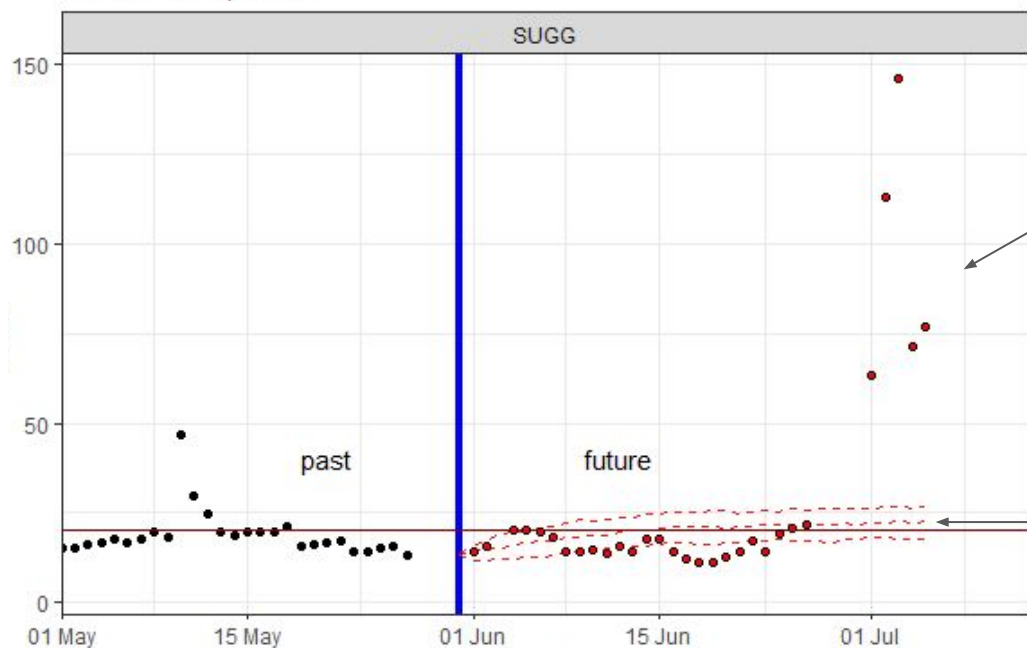
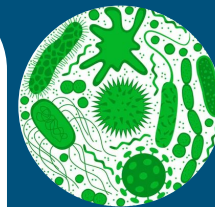


Model 2: Forecasts



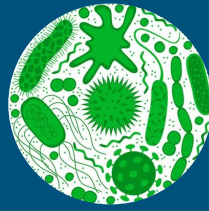
**Chlorophyll a
(mg/L)**





**Observed
chlorophyll a
(mg/L)**

**Predicted
chlorophyll a
(mg/L)**



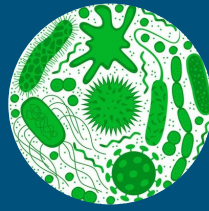
Decision maker's inquiries:

- 1. Should one lake be chosen for drinking water this month over the other?**
2. What are the maximum concentrations that will occur in the next 30 days? And when will this maximum level occur?
3. Are chlorophyll concentrations likely to be higher or lower than normal for the time of year?
4. What are the chances that the lake(s) will be closed in the next month for swimming?

Should one lake be chosen for drinking water this month over the other?



Lake Barco



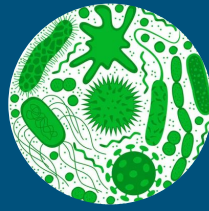
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What are the maximum concentrations that will occur in the next 30 days?
And when will this maximum level occur?



rank	max observed (mg/L)	max predicted (mg/L) - 0.95 quantile
1	145.79 (July 3rd)	33.22 (July 4th)
2	112.92 (July 2nd)	33.08 (July 3rd)
3	76.94 (July 5th)	33.07 (July 2nd)

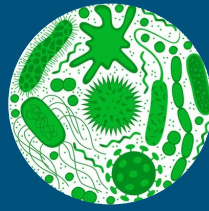


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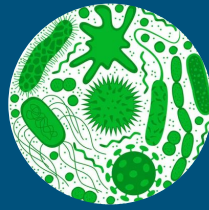
Are chlorophyll concentrations likely to be higher or lower than normal for the time of year?





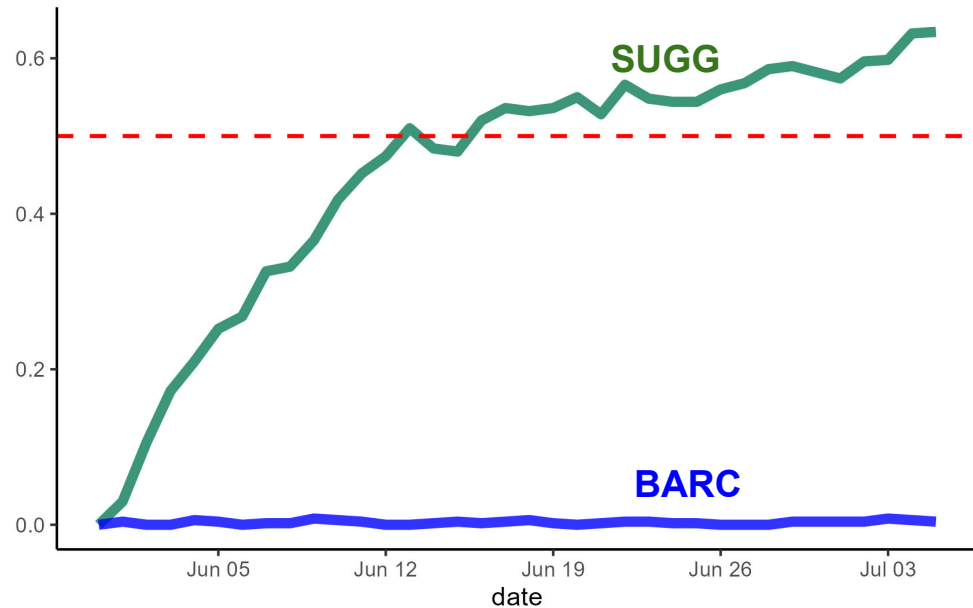
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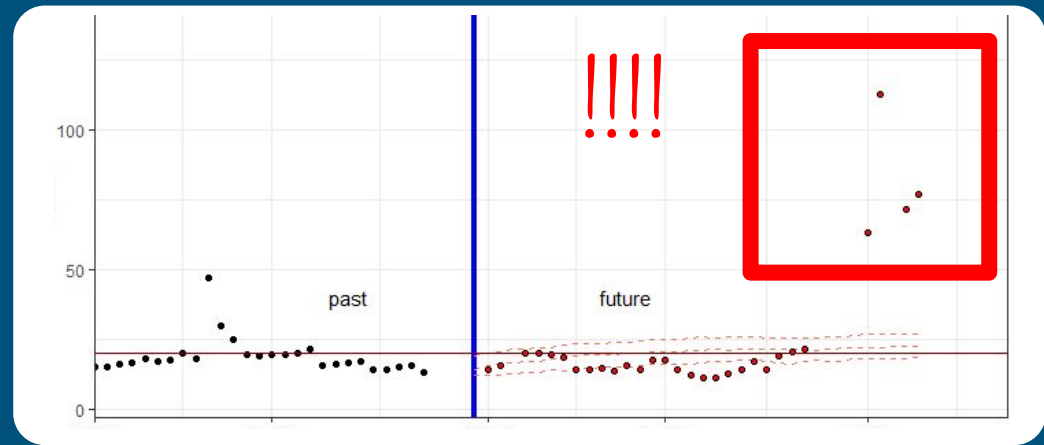


What are the chances that the lake(s) will be closed in the next month for swimming?

Probability of
[chlorophyll a] > 20 mg/L



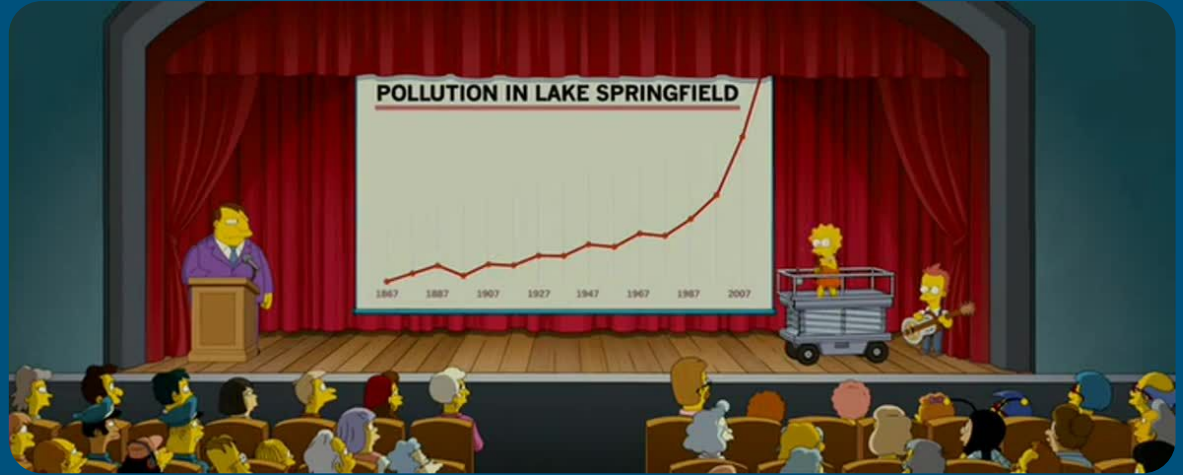
Conclusion

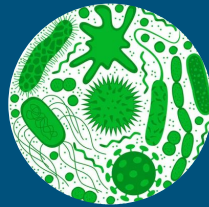


Chlorophyll a is difficult to predict

Other models could include a lag for the covariates or non-linear relationships to better model pollution peaks

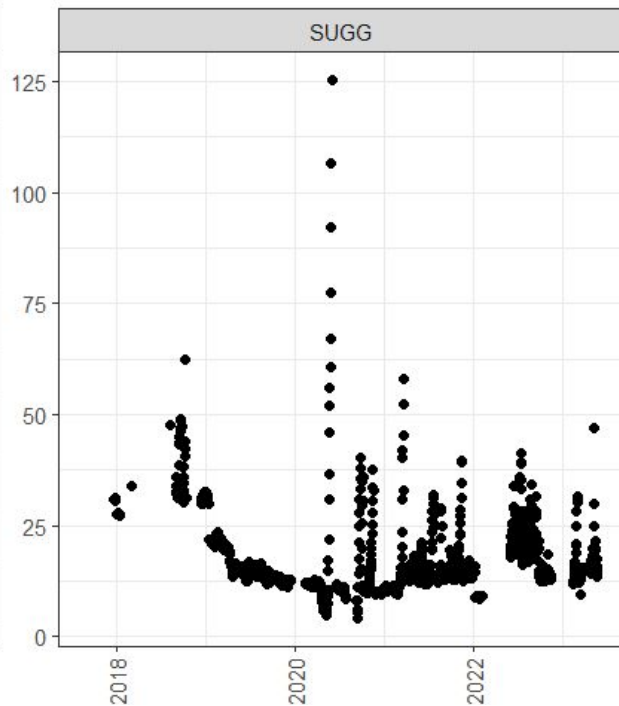
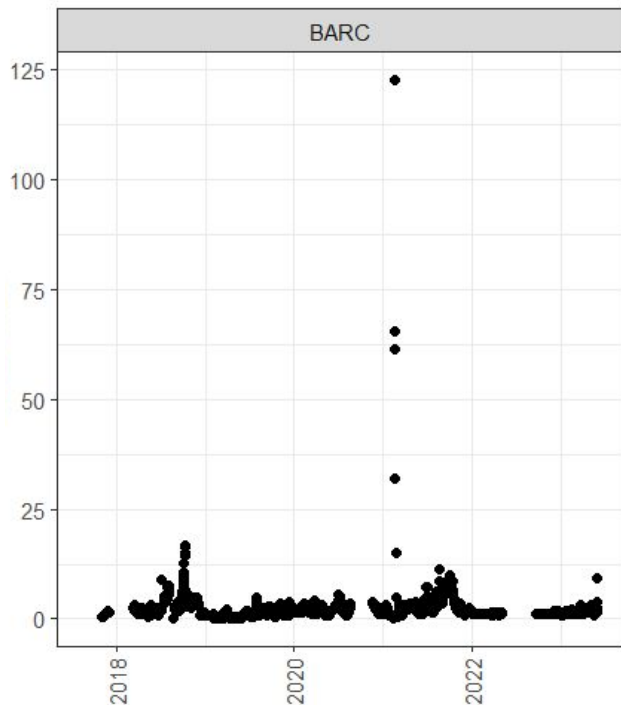
Thank you!
Questions?





Data exploration

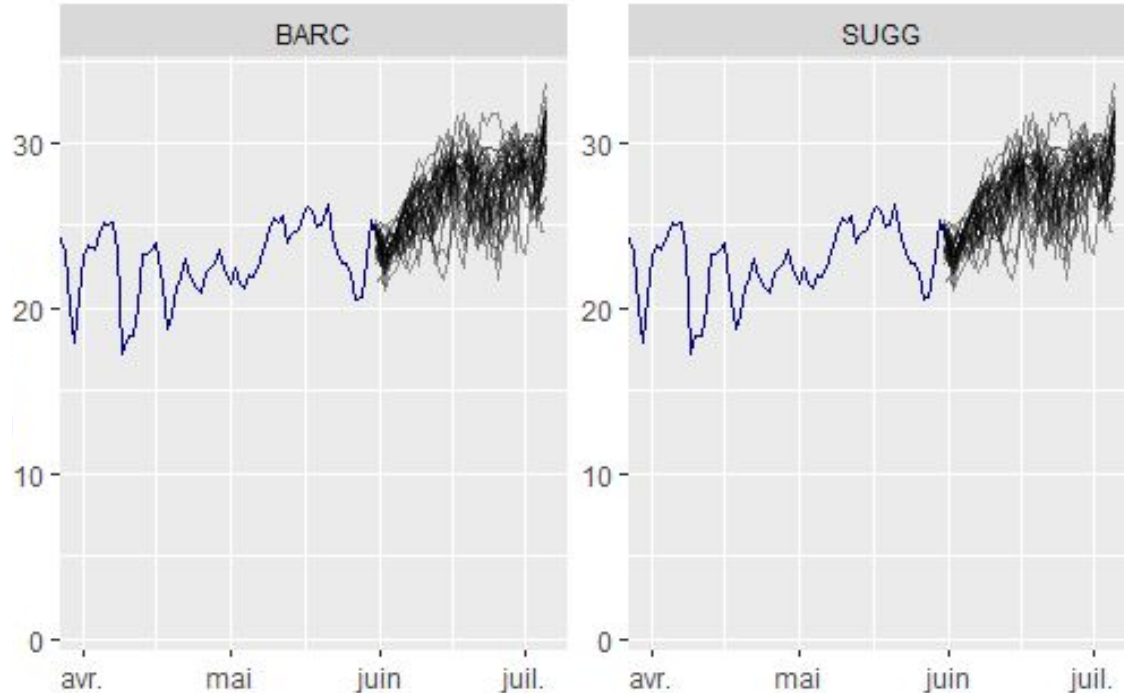
Chlorophyll a
(mg/L)



Data exploration



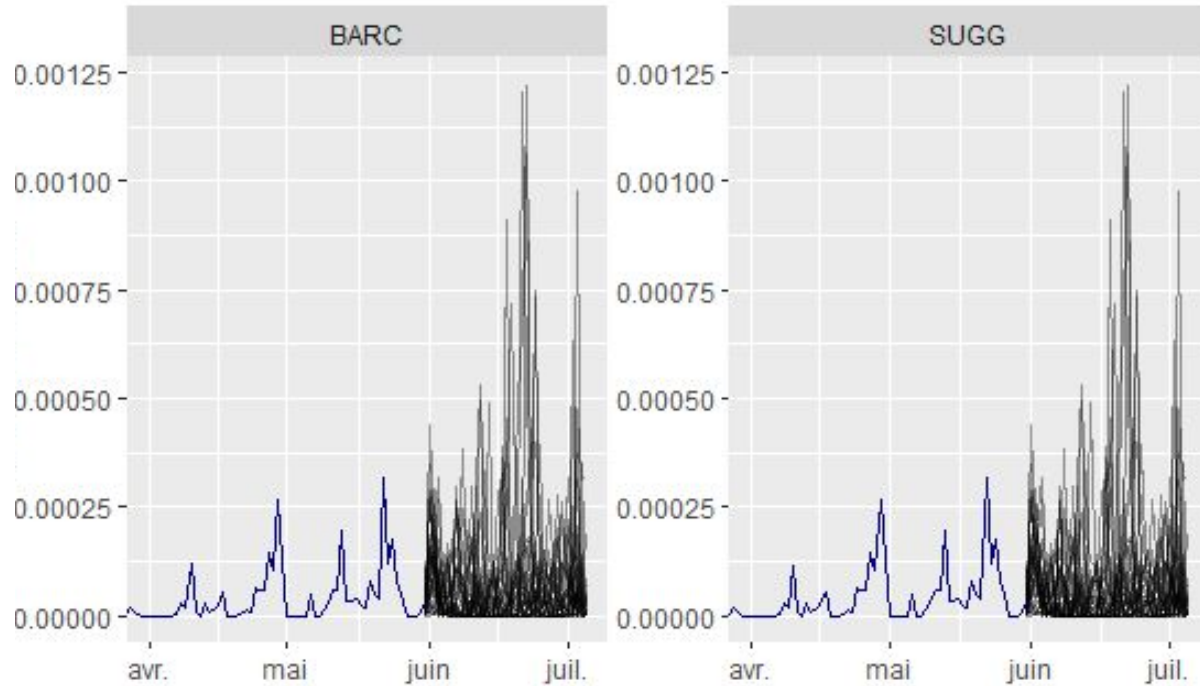
Temperature
(°C)



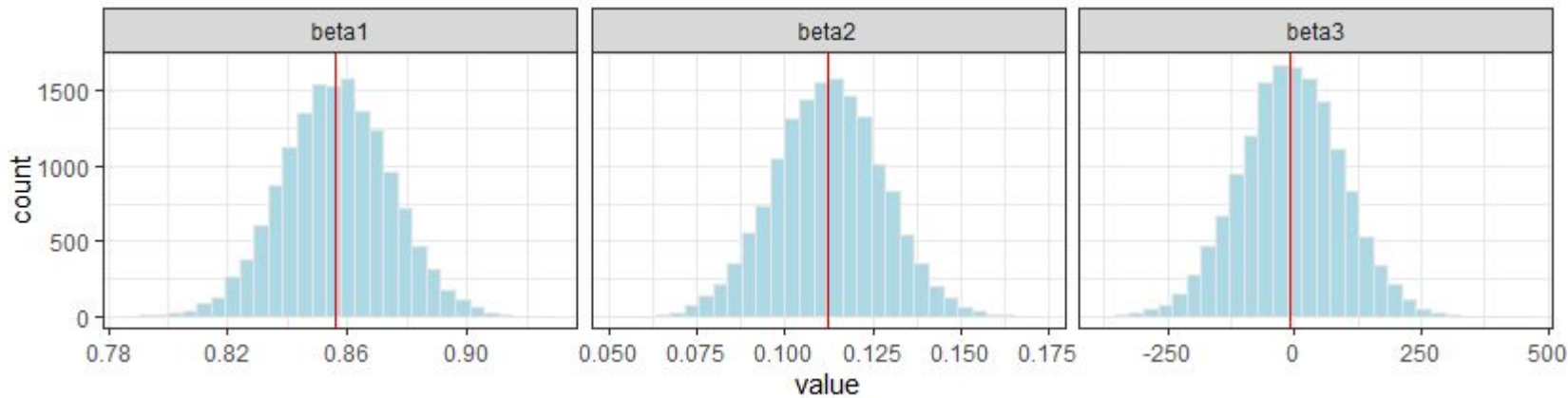
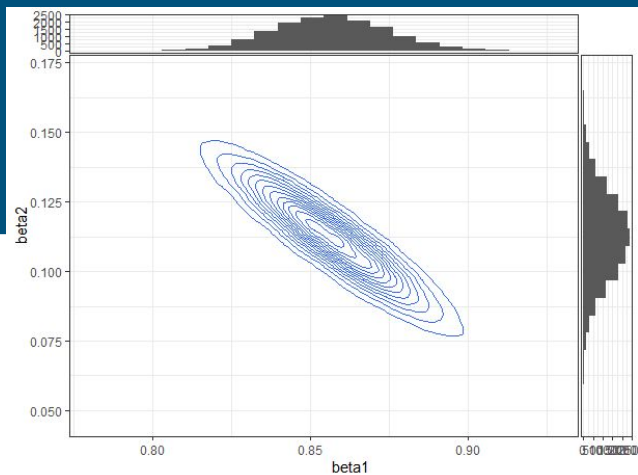
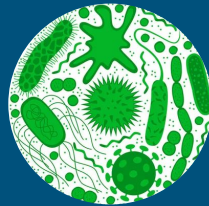


Data exploration

**Precipitation
(kg/(m²s))**



Model 2: Evaluation





Model 2: Evaluation

beta1		beta2		beta3		chla_latent[1]	chla_latent[2]		
Min.	:0.7868	Min.	:0.0514	Min.	:-371.010	Min.	:37.78	Min.	:39.90
1st Qu.:	0.8441	1st Qu.:	0.1019	1st Qu.:	-73.011	1st Qu.:	37.78	1st Qu.:	40.25
Median	:0.8563	Median	:0.1124	Median	: -6.920	Median	:37.78	Median	:40.32
Mean	:0.8563	Mean	:0.1123	Mean	: -7.256	Mean	:37.78	Mean	:40.32
3rd Qu.:	0.8686	3rd Qu.:	0.1226	3rd Qu.:	59.483	3rd Qu.:	37.78	3rd Qu.:	40.38
Max.	:0.9261	Max.	:0.1698	Max.	: 448.942	Max.	:37.78	Max.	:40.75