Water Quality Case Study

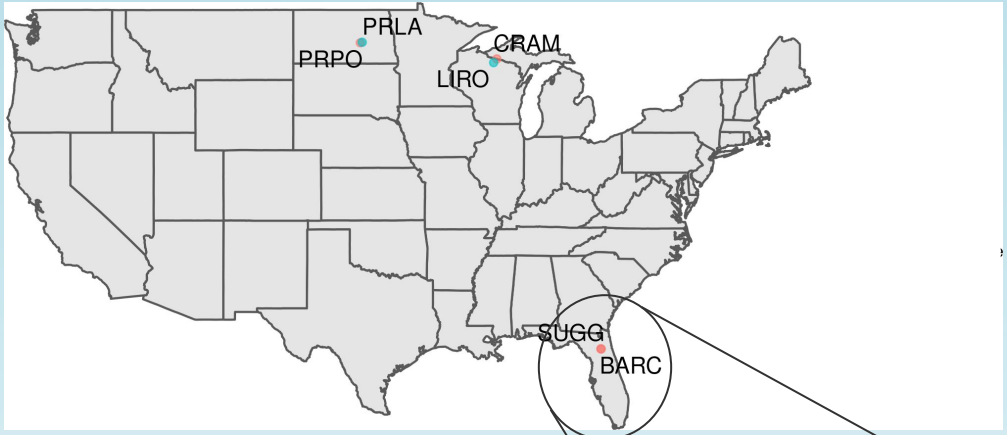
FORECASTING CHLOROPHYLL-A LEVELS IN TWO LAKES

TEAM 7

Overview

- Algae blooms reduce O_2 concentration which leads to reduced water quality and fish kills (eutrophication);
- Chlorophyll-a can be considered as a proxy for algae blooms;
- We have data from 2 lakes in Florida, Lake BARC and Lake SUGGS;
- We produce 30-day forecasts (using 3 regression models) from early June to early July to predict chlorophyll-a levels to answer decision-makers question;

Information about the lakes



- Mesotrophic;
- 3.2 m;
- Polymictic;

- Oligotrophic;
- 6 m;
- Polymictic;

https://jsta.rbind.io/blog/what-is-the-scope-of-neon-lakes-data/

Questions of interest

Decision-makers question:

Which lake is a better choice considering swimming activities?

Threshold: water is unsafe if chlorophyll-a levels exceed 20 mg/L;

Questions to answer the decision-makers:

- How do the forecasts of chlorophyll-a concentration differ between lakes?
- When the maximum chlorophyll-a levels occur?
- Which model is better to create predictions?
- How do our forecasts are compared to historical data for this time of the year?
- How accurately can we forecast changes in these lakes?

Our plan

Use the base model to answer some initial questions and have a first look at what may be happening in each lake

Extend the original model with new covariates, models and interactions

Compare the accuracy of the original model to our final models, and use validation data to assess their performance and differences

Model Specifications

Base Model- Dynamic model

- Linear -: Chlorophyll (t) = β_1 * Chlorophyll (t-1) + β_2 * AirTemp (t)

New Models considered

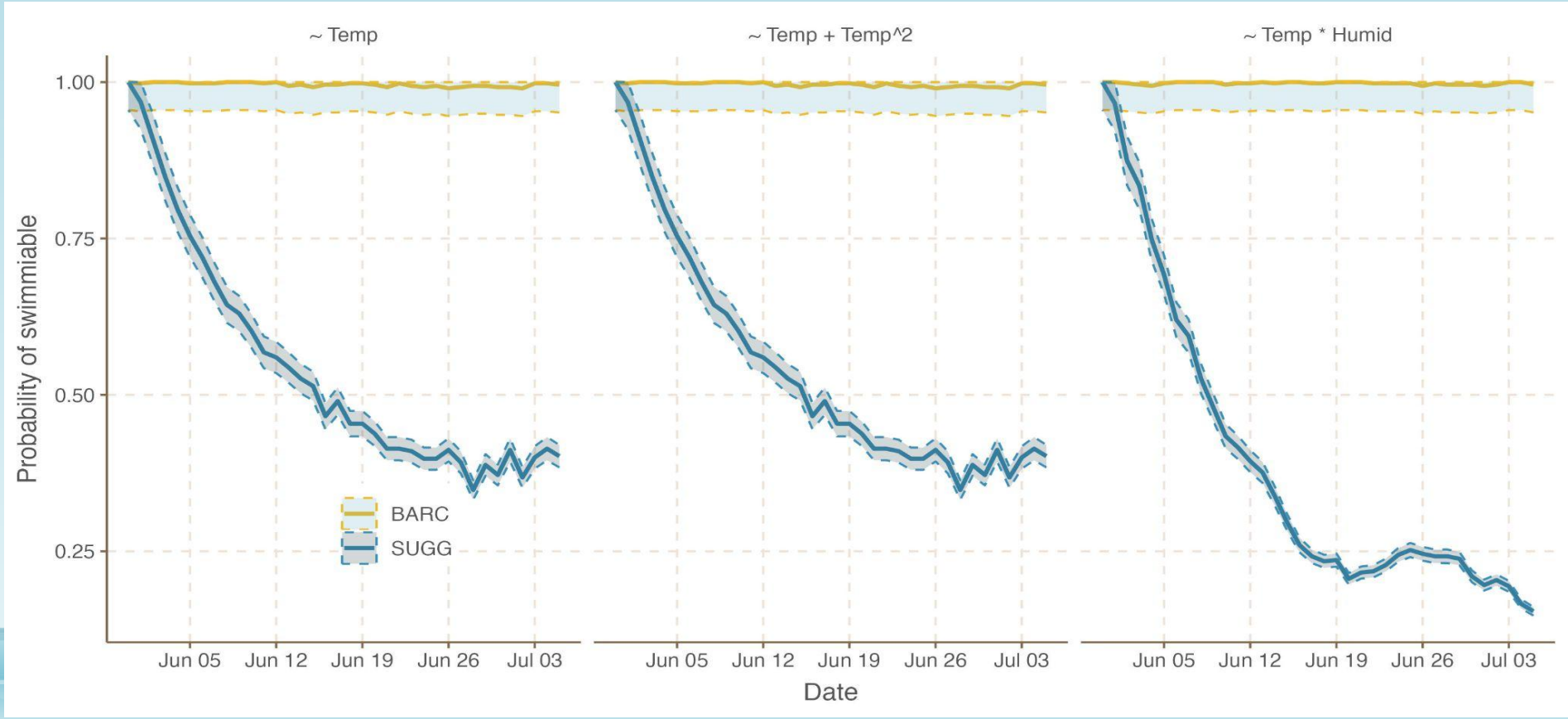
- Nonlinear -: Chlorophyll (t) = β_1 * Chlorophyll (t-1) + β_2 * AirTemp (t) + β_3 * AirTemp(t)^2
- Additional covariates

  -: Chlorophyll (t) = β_1 * Chlorophyll (t-1) + β_2 * AirTemp (t) + β_3 * Humid(t) + β_4 * AirTemp(t) * Humidity(t)

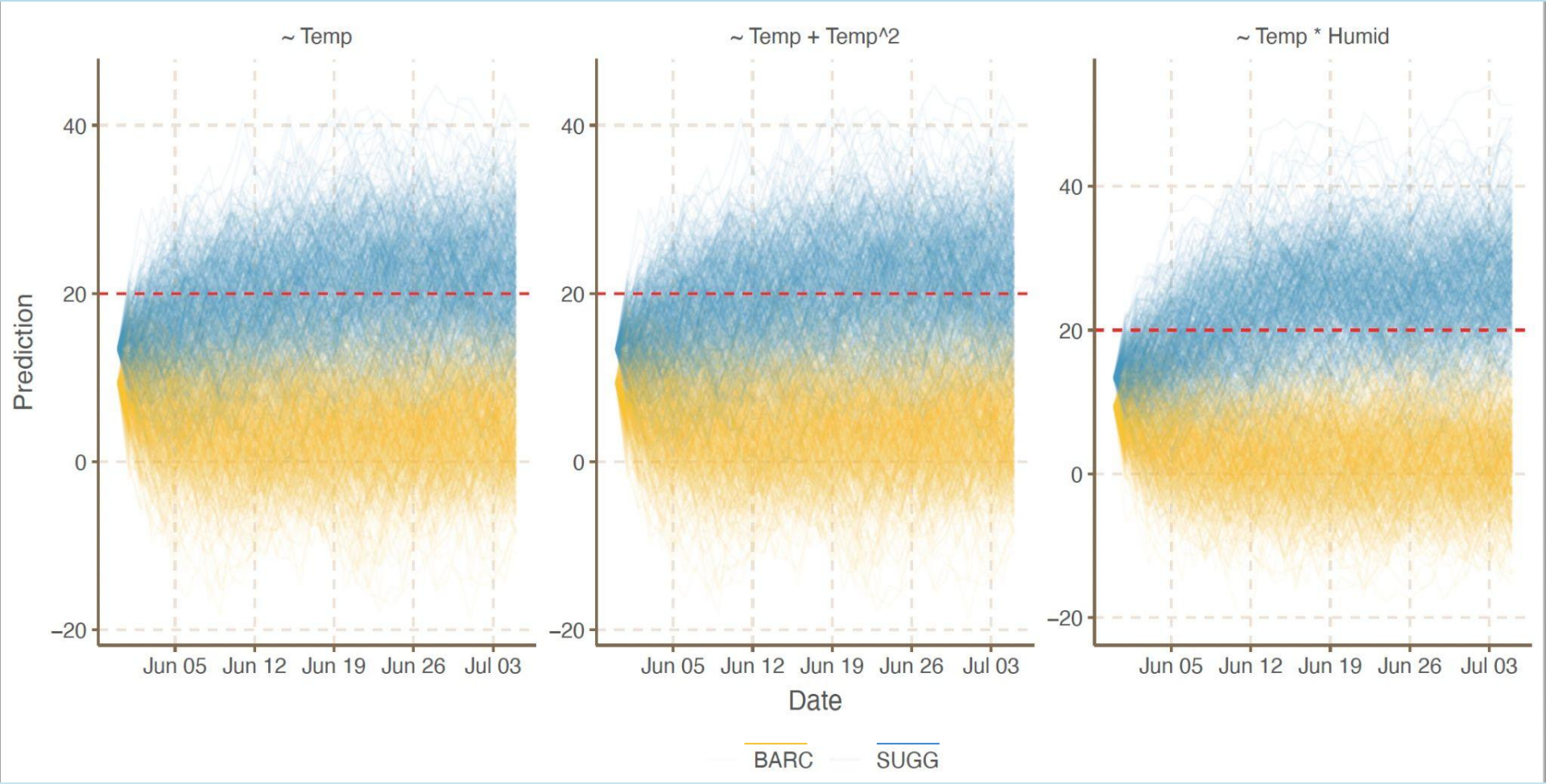
- Bayesian models were computed using JAGS with 3 chains and 5000 iterations. All parameters were given Normal priors with mean zero and SD of 100

- We then draw 500 random samples from the posterior to forecast for each lake

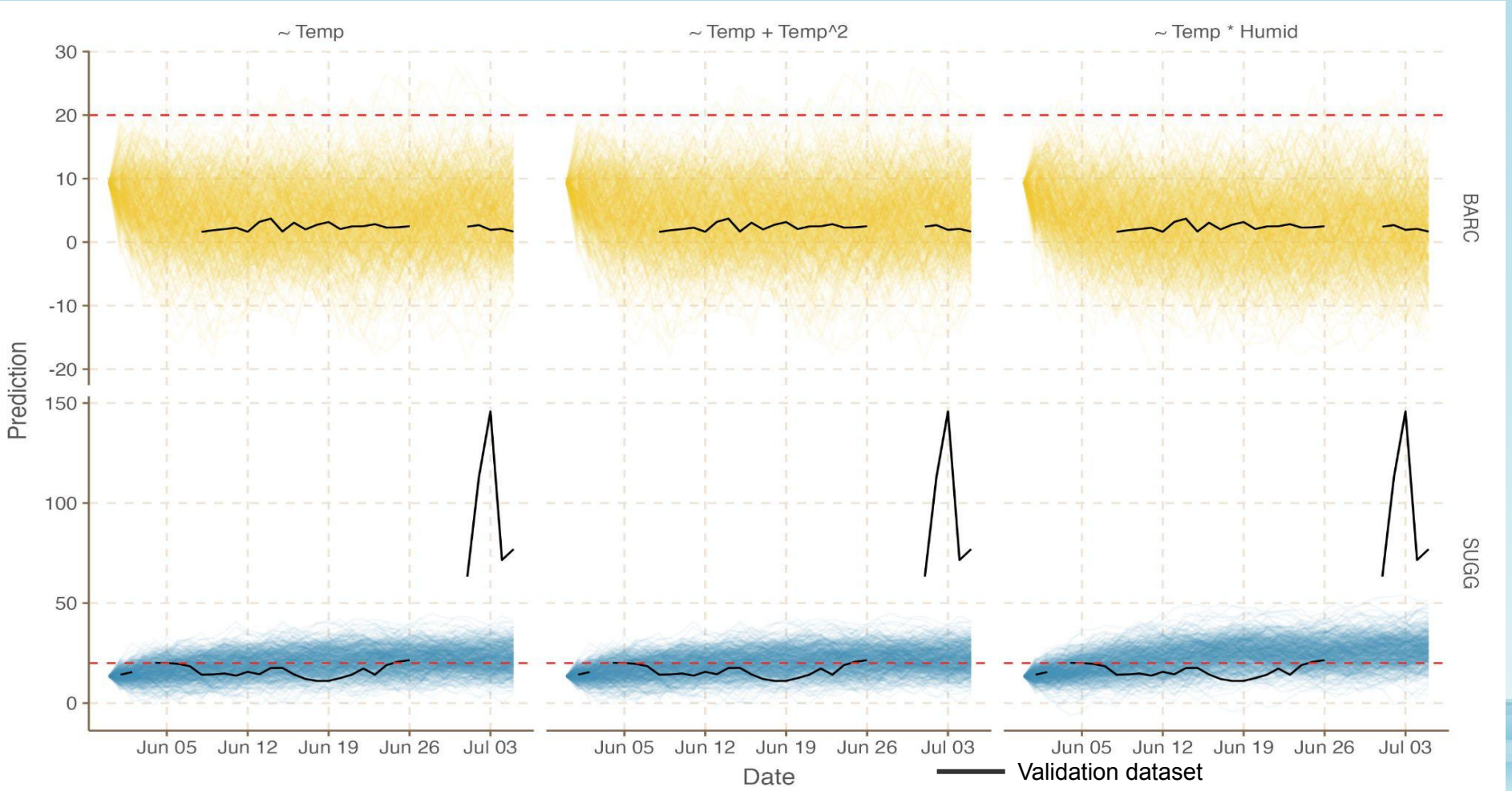
Swimmable Probability



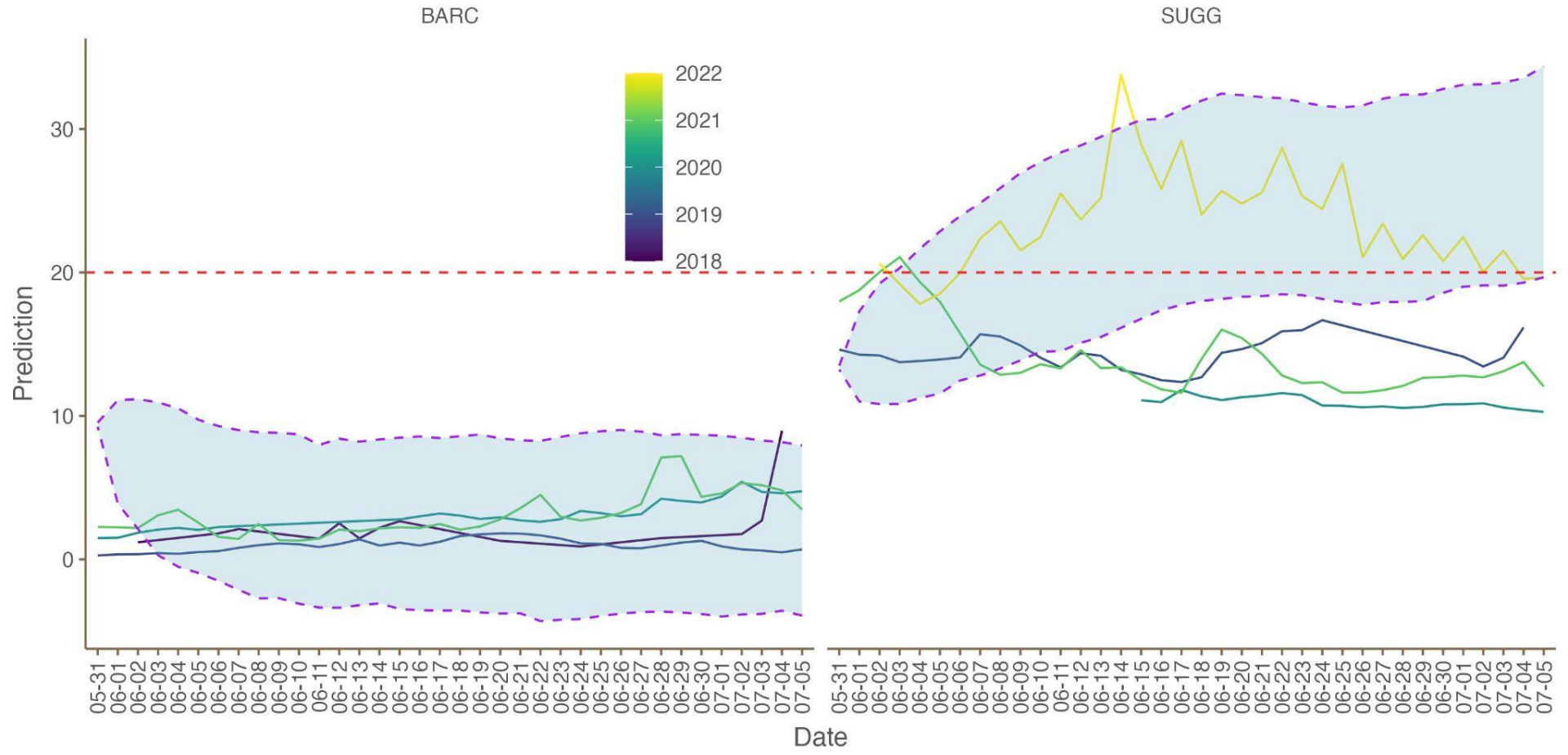
Comparing Predictions for the two Lakes



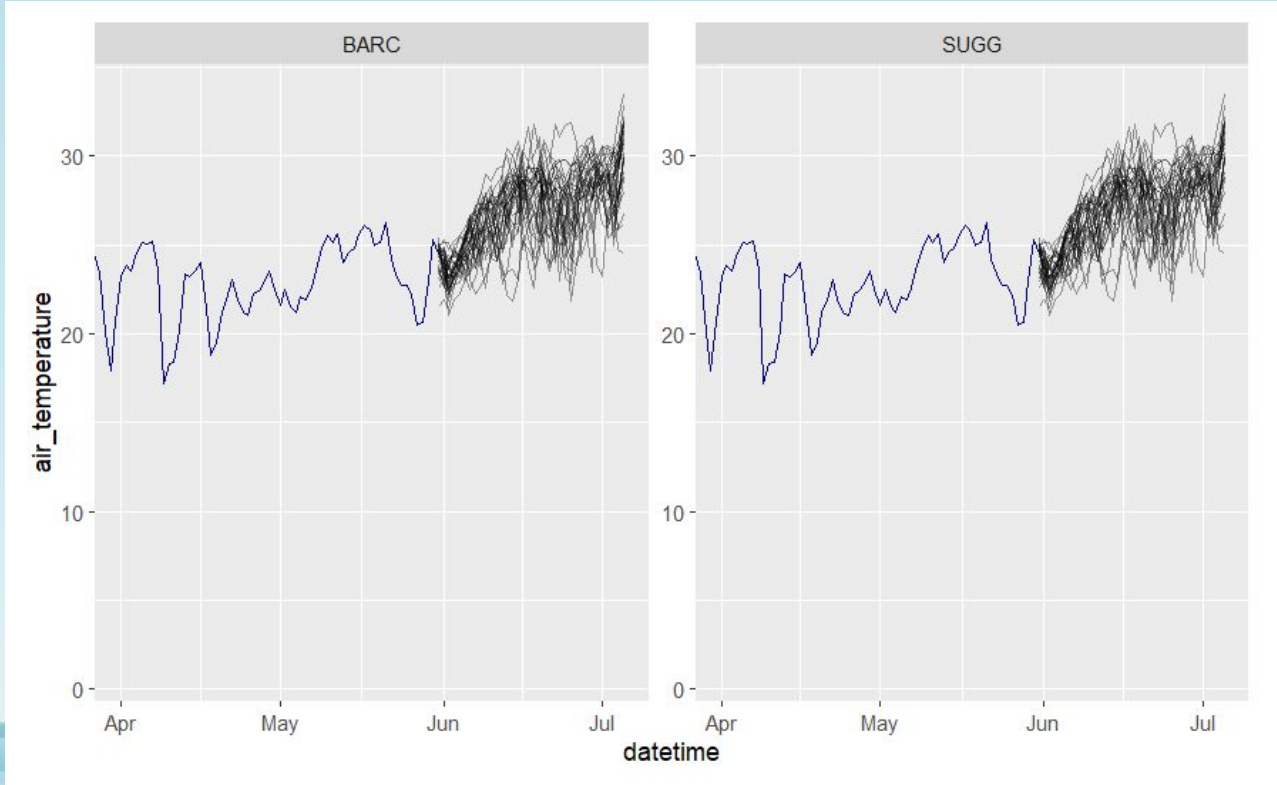
Comparing Predictions with validation data



Comparison prediction with records in previous years



Uncertainty



Results and Recommendations

- BARC lake appears to be in much better condition than SUGG lake.
- Temperature and humidity influence our forecasting results.
- Our forecast is more accurate for BARC lake than SUGG lake, based on validation data and previous trends for May to July.
- This follows from the more erratic historic patterns seen in SUGG lake.
- BARC lakes year to year trends appear more stable.
- We present our full forecast over 500 samples to propagate uncertainty and allow decision makers to be aware of the possibilities of chlorophyll levels.

Our forecasts suggest that a decision maker may need to act and shut SUGGS lake down in early June for swimming activities

Thank you!

Questions?