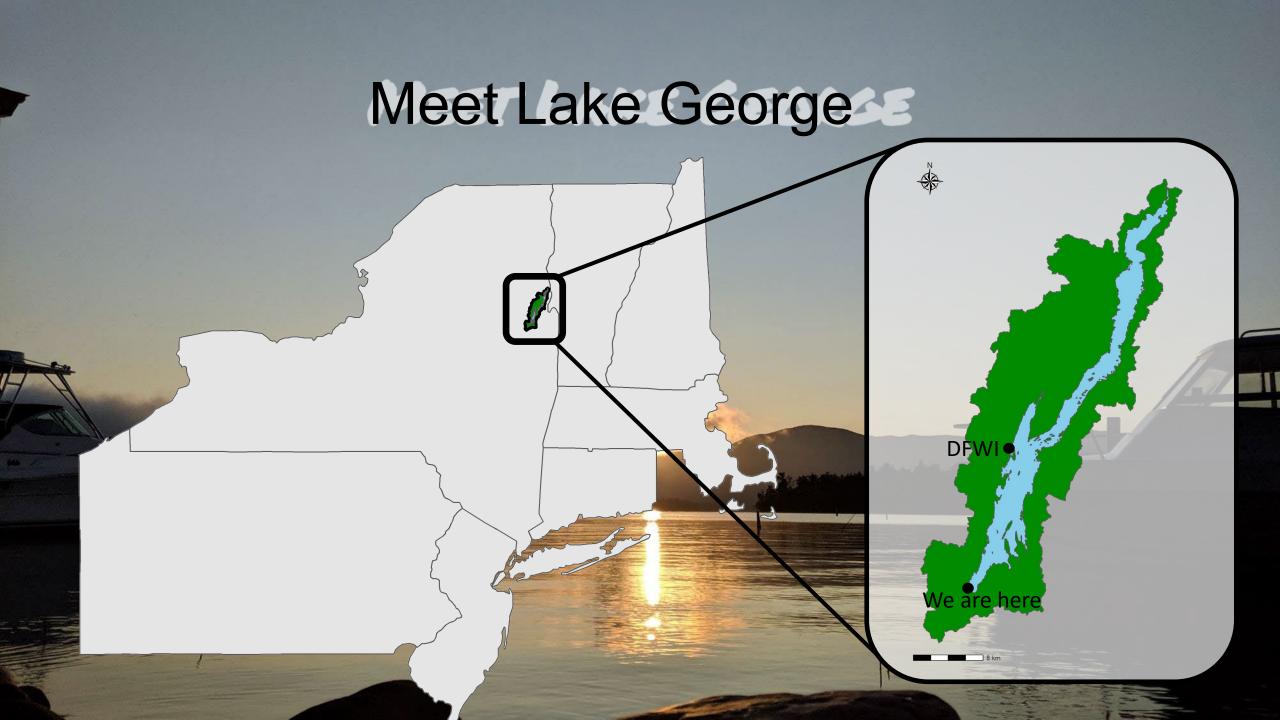
HABHAZARD

Predicting risk of harmful algal blooms in lake george



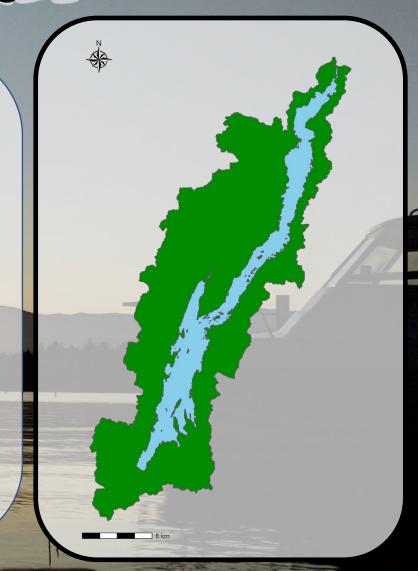


Meet Lake George

Oligotrophic

50 km long, 2 km wide

18 m depth on average 58 m max depth



A step back in time to 1922 22

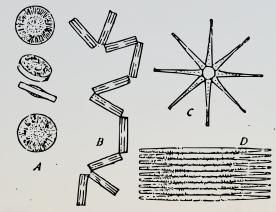


Figure 12. Lake Diatoms, highly magnified. A, Cyclotella; B, Tabellaria; C, Asterionella; D, Fragilaria.

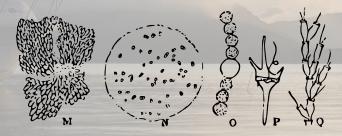


Figure 13. A few of the commoner microscopic plants of the open water in Lake George. M. Botryococcus; N. Aphanocapsa; O. Anabaena; P. Ceratium; Q. Dinobryon. All highly magnified.

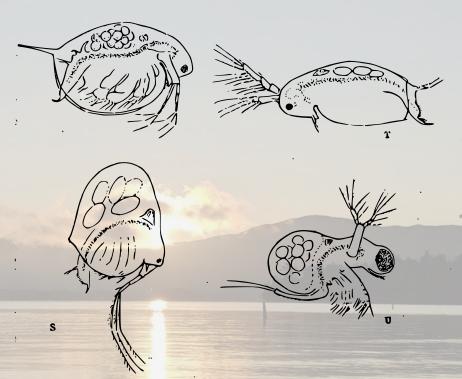


Figure 14. Waterfleas. R. Daphne; S. Holopedium; T. Sida; U. Polyphemus; from open water.

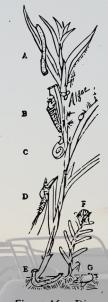
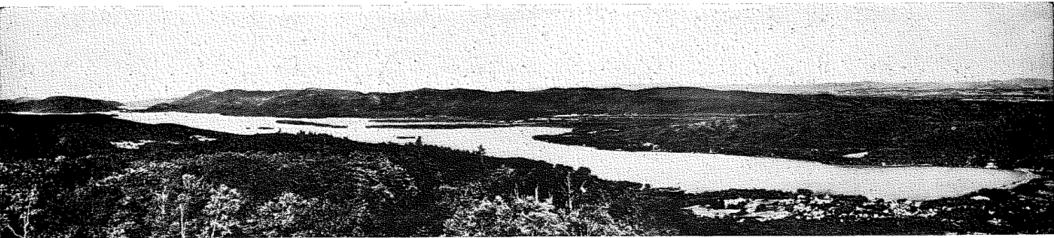


Figure 16. Diagram illustrating the local adjustment of the principal fish food animals of the lake. A, tube of a midge larva attached to a pondweed leaf; B, a caddisworm in its case; C, a snail; D, the young ("nymph") of a may fly; E, a "bloodworn" tube (tube of a midge larva) buried in the bottom silt; F, a scud ("fresh-water shrimp"); G, a little white clam of the bottom ooze layer.

Fast forward to the 70s

NEWS and VIEWS



OFFICERS

PRESIDENT
Lysle W. Morton

IST VICE PRESIDENT
Robert F. Stutz

2ND VICE PRESIDENT
George C. Singer

COUNSEL, Charles H. Tuttle
ASS'T. COUNSEL
Gordon Hemmett, Jr.

SECRETARY, Ralph Schoenherr

TREASURER, Arthur S. Knight

EXECUTIVE VICE PRES.
Cyrus H. Woodbury

Lake George from Top of Prospect Mountain Veterans' Memorial Toll Highway

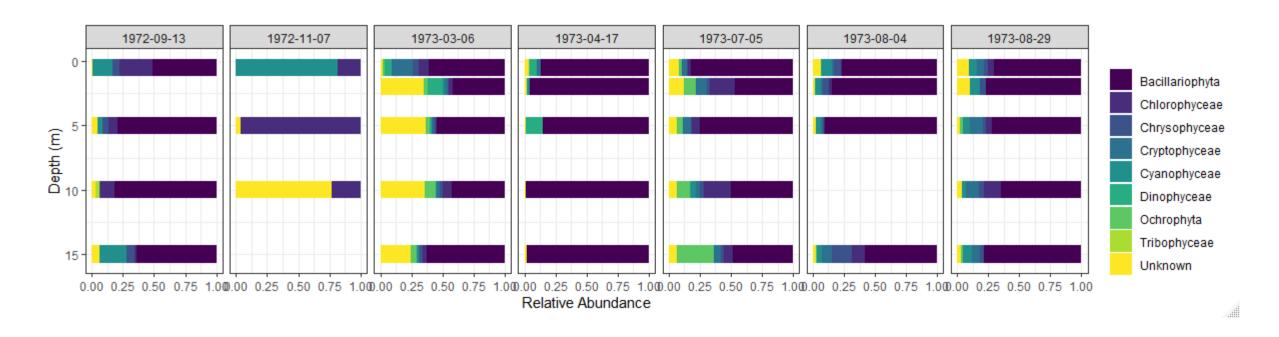
The Cake George Association

(Incorporated in 1885)

The Object of The Association Shall Be To Preserve, Protect and Promote the Welfare of Lake George and Its Area COMMITTEE CHAIRMEN
FISH AND GAME, Richard E. Bolton
FORESTRY, Russell Mulvey
NAVIGATION, James L. Roberts
EDUCATION, William C. Busch Jr.
SANITATION, Edmund Morette
LAW E'F'M'T., Sheriff Wm. Carboy
LEGISLATIVE, Lawrence E. Corbett, Jr.
WATER LEVELS, Charles H. Tuttle
ADVISORY, Herbert F. Reilly
MEMBERSHIP, Gordon Hemmett, Jr.
NOMINATIONS, Paul Hillman
LIAISON REP. I. B. P., Dr. C. G. Suits

Phytoplankton in Lake George

1972 1973: Diatoms are most abundant throughout the season



Cyanobacteria are a relatively small part of the community

A community shift in the 70s705

TASTE AND ODOR NUISANCE AT LAKE GEORGE

Donald B. Aulenbach, Ph.D. Environmental Engineering Division Rensselaer Polytechnic Institute

In the recent past there have ion, the lake will sooner or later been some incidences of tastes and have impaired quality. The quesodors in the water in the Lake tion of tastes and odors is a very George Basin. These tastes and difficult one and the water inordors have been attributed to a dustry has been dealing with the number of factors but at the mo- problem for many years. It is ment the most reasonable cause known that tastes and odors can appears to be a growth of some be derived from algae, a situation microscopic plants (algae) in the which has been reported by the water. As a natural life process, water industry. Therefore, it is these algae will grow and emit reasonable to expect that this by-products of metabolism much same situation may exhibit itself in the same way man produces under certain conditions at Lake by-products or wastes from his George. In the continuing pro-

An Air View of The LAKE GEORGE "ALGAE BLOOM"

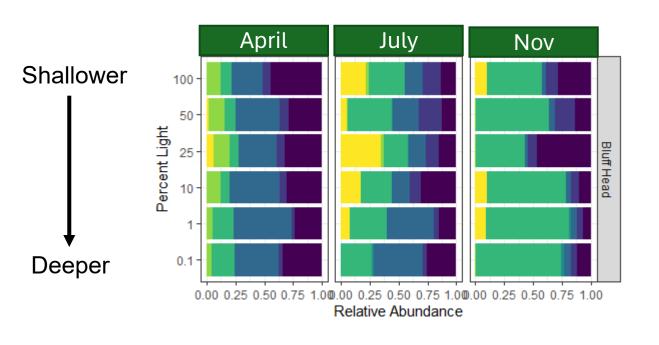
(May 21, 1972)

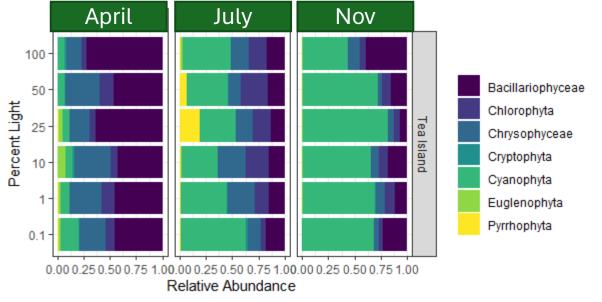
A Report by Dr. C. G. Suits As part of the investigation of the suspected algae growth phenomena which has made its appearance during the past week, Dr. Nicholas Clesceri, Director of the RPI Fresh Water Institute and I flew over Lake George on the above date. The phenomena has been characterized by a cloudy, brownish color in the water, accompanied by a marked fishy odor and taste.



Cyanobacteria in Lake George

1997: Diatoms bloom in spring, Cyanobacteria dominate in fall





What is a HAB?

Definition not always clear

Accumulation of cyanobacterianear the surface (usually)





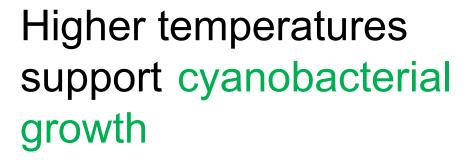
HABdoes not necessarily meantoxic



What conditions do habs like?



Warm





Sunny

Higher light triggers movemento the surface



Low wind

Lower windreduces mixing back into the water column

First confirmed HABs in Lake George

October 23, 2020

November 7, 2020

We have continued to see at least one each year since

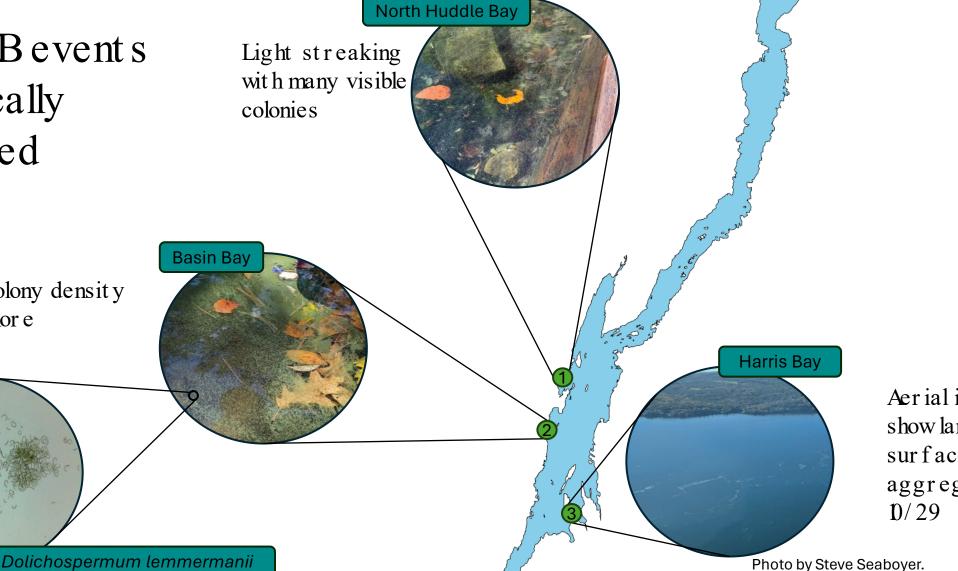
October 10, 2021 November 9, 2021

October 6, 2021 November 8, 2021

These HAB events are typically short-lived

near shor e

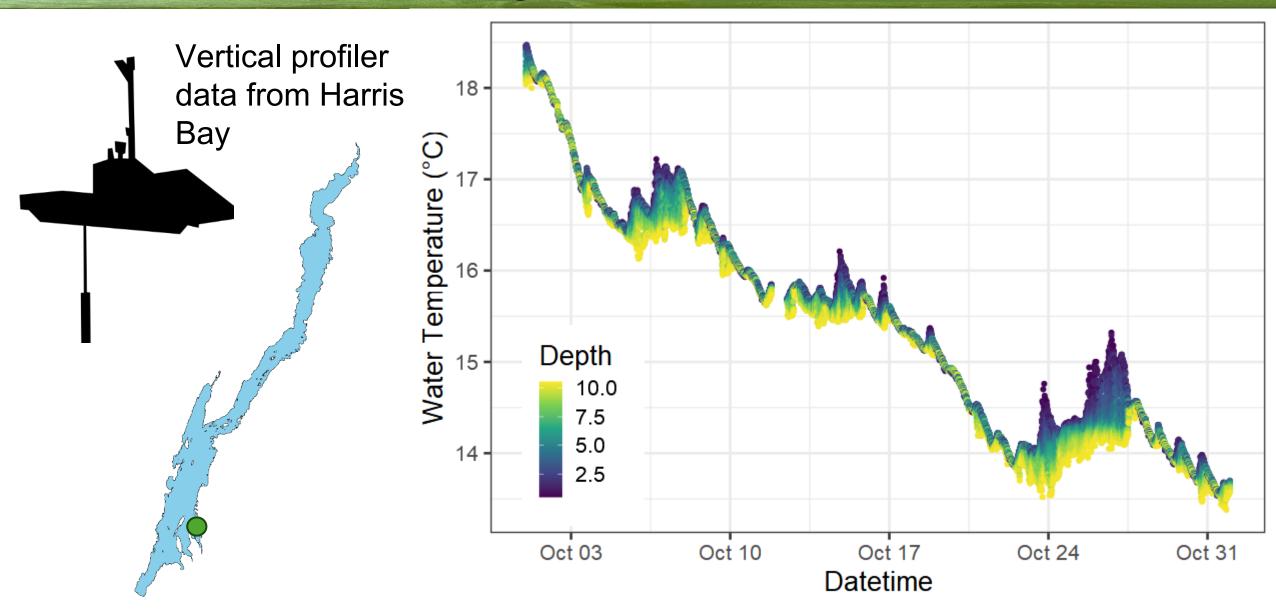
High colony density

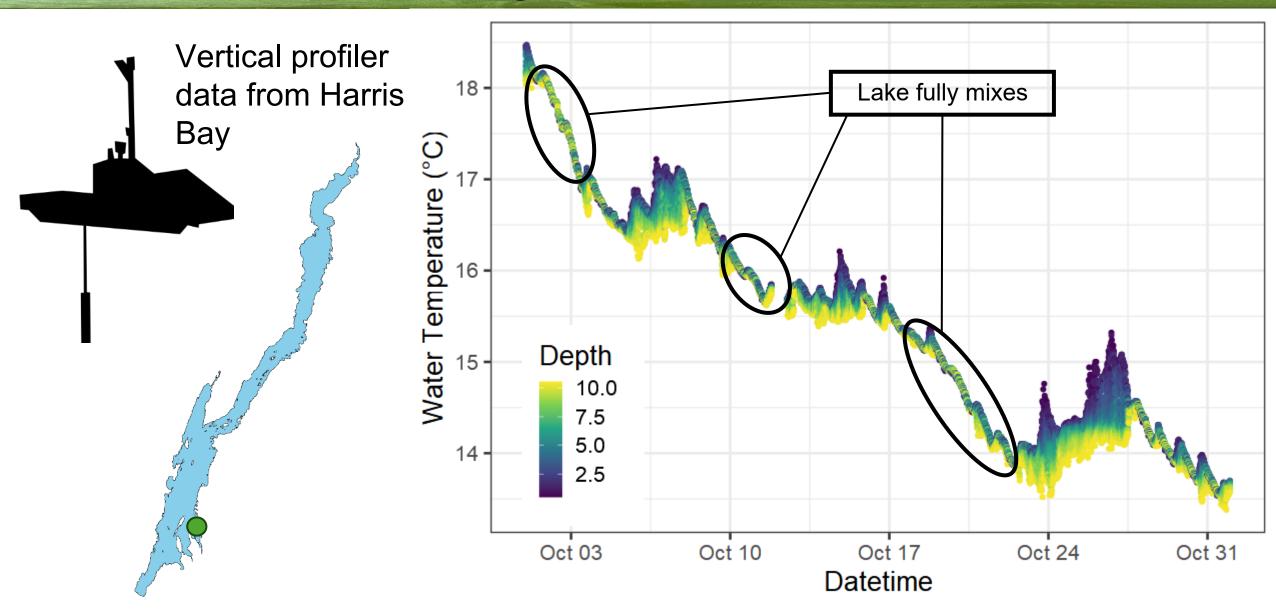


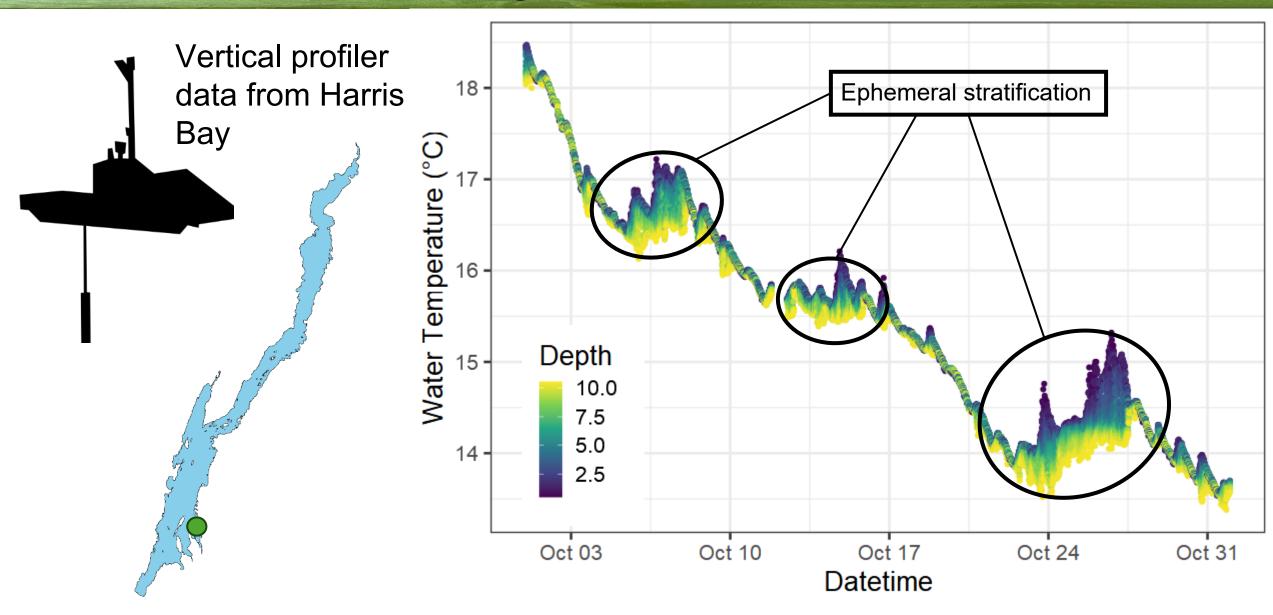
Aerial images show lar ge sur face aggregations

Photo by Steve Seaboyer.

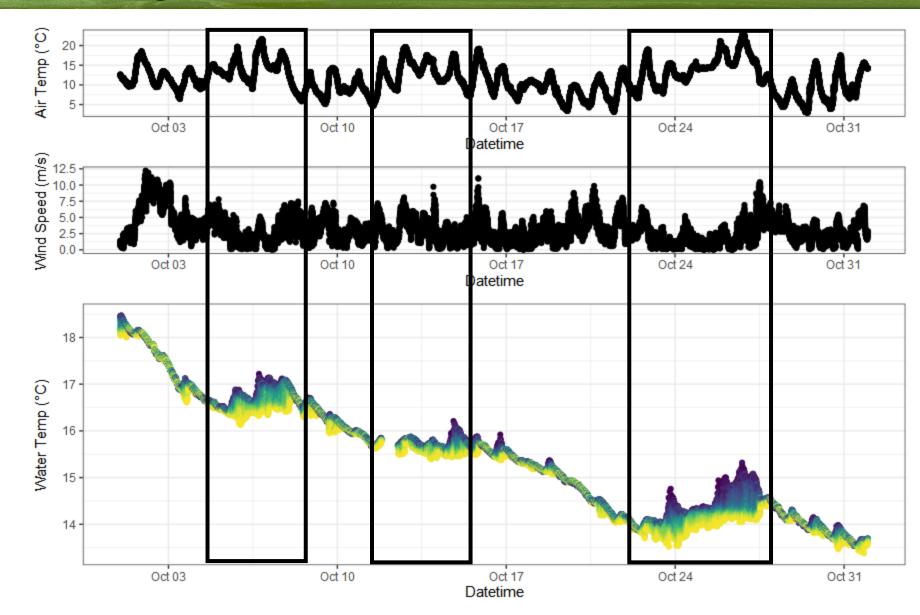
What was going on in the lake just before the HAB was detected?



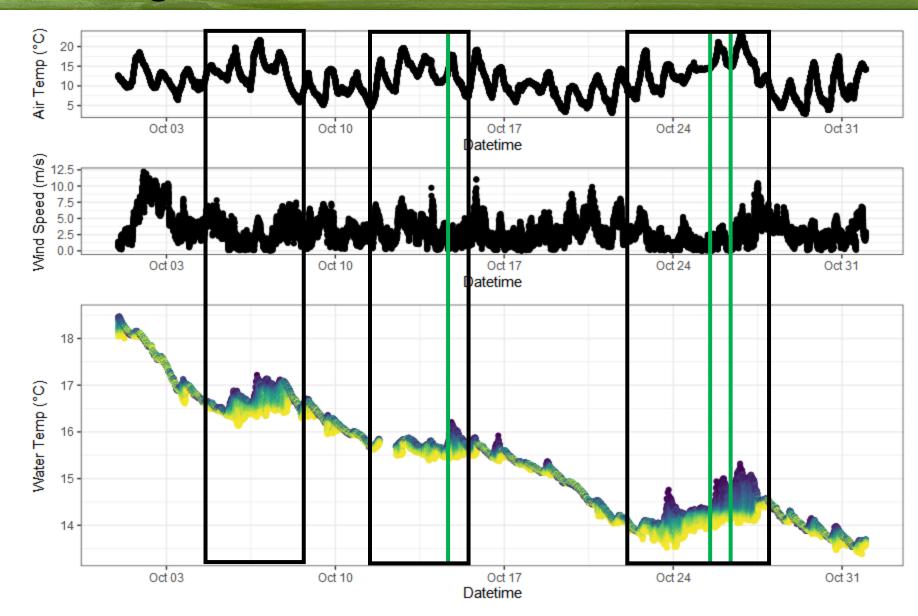




Ephemeral stratification is associated with periods of elevated air temperature and low wind speed



3 HAB events observed during these periods of ephemeral stratification



What conditions do habs like?



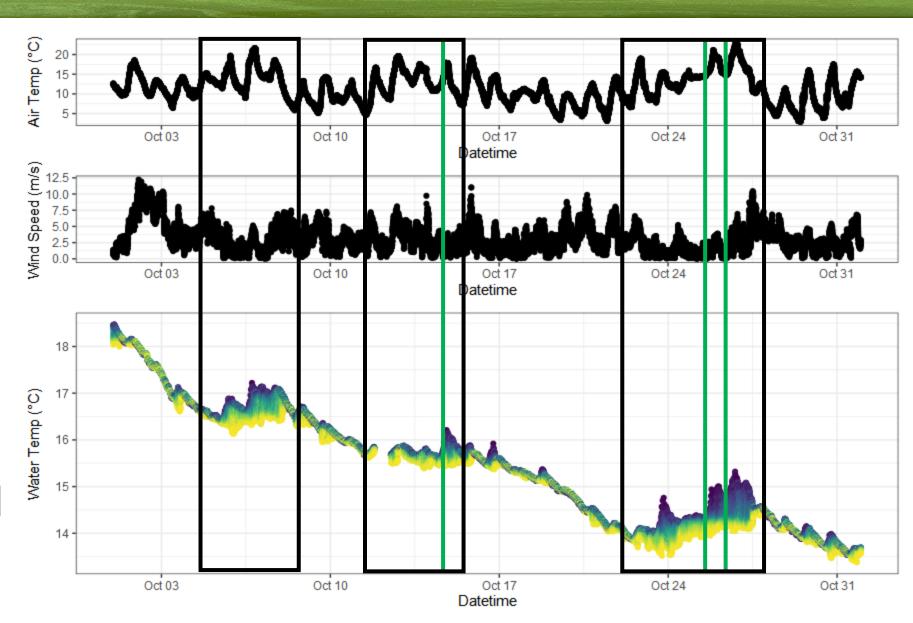
Warm



Sunny



Low wind

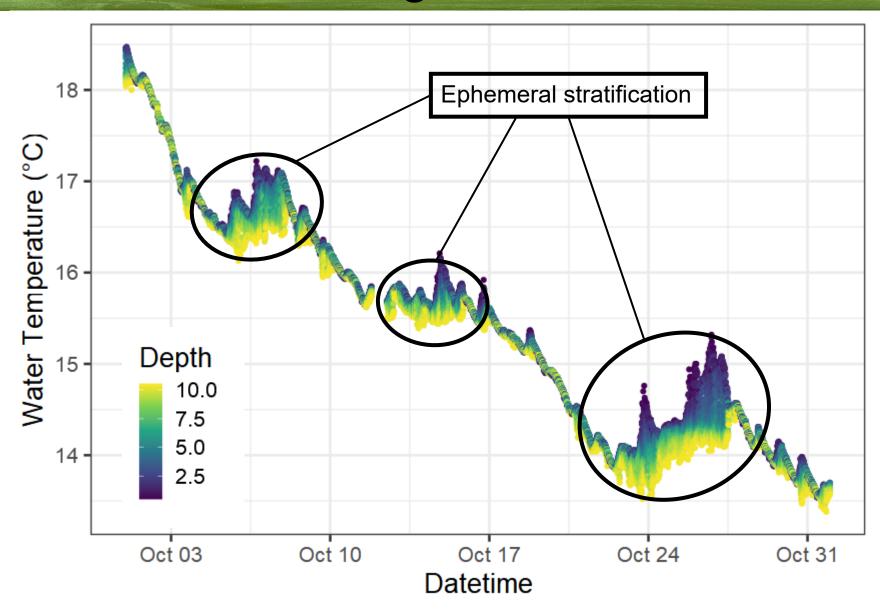


A measure of stratification strength

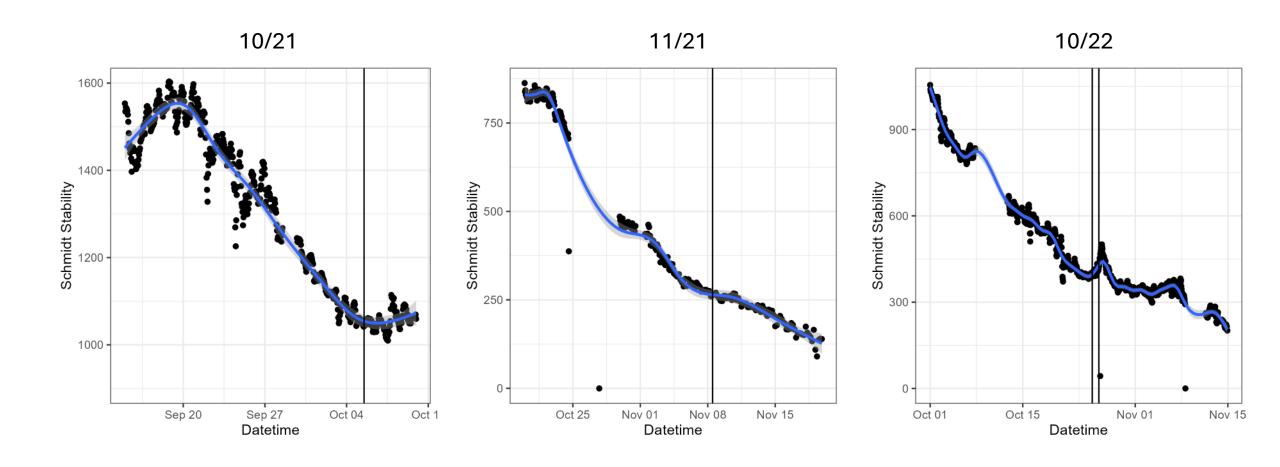
Schmidt stability

How muc**energy** does it take to **fully mix** the water column

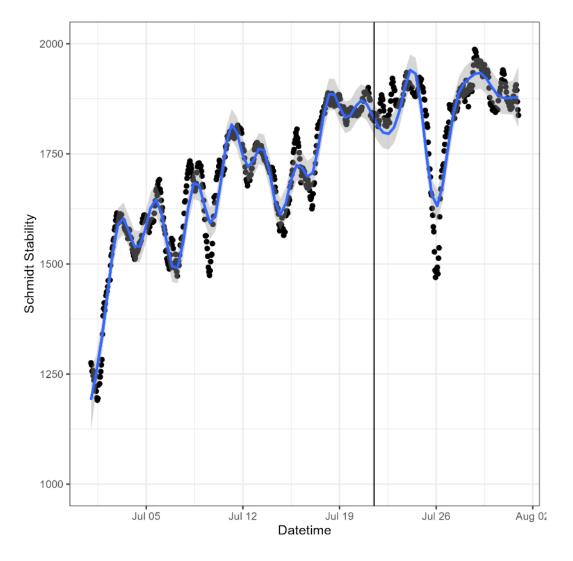
Declinesin the fall, but increases during periods of ephemeral stratification



Schmidt stability across 3 HAB events



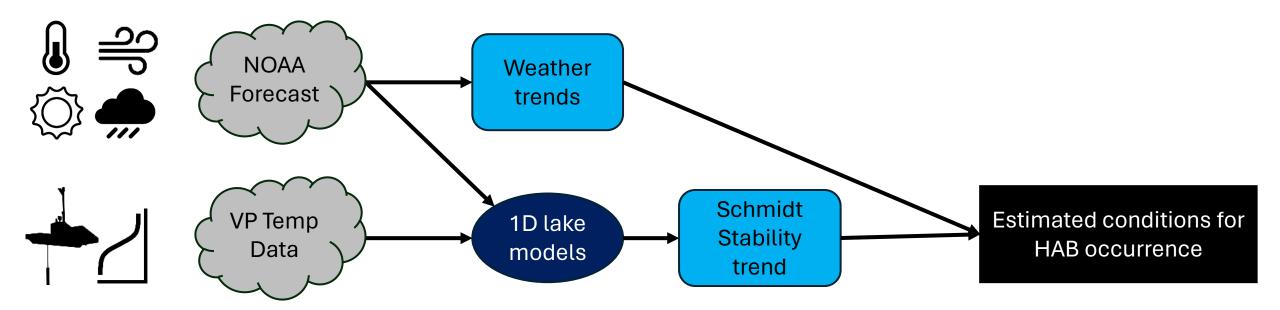
Summer blooms look different



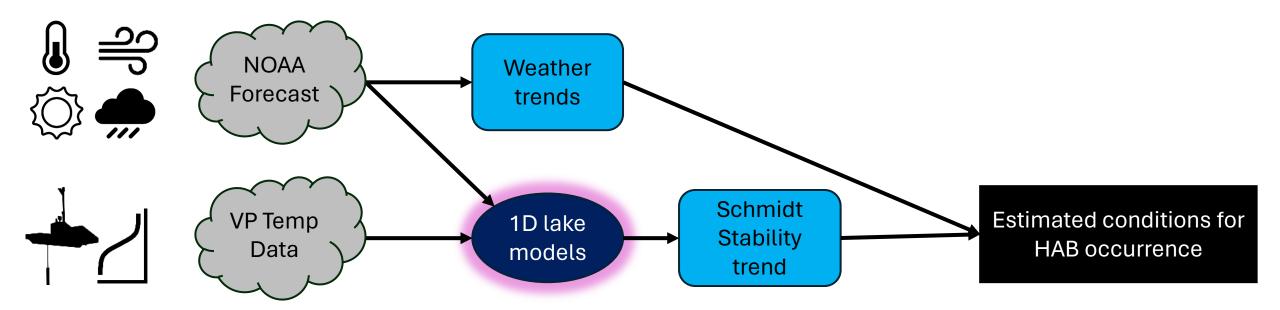
There may be different drivers of summervs fall HAB events

Understanding the causes of HABs in Lake George requires sampling in advance of their detection near the shore

A framework for forecasting

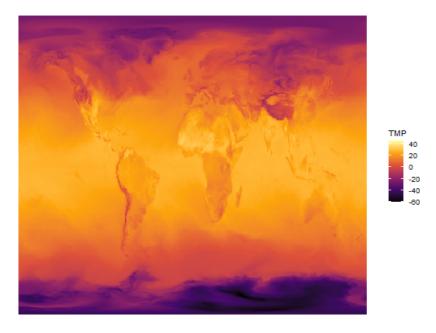


A framework for forecasting



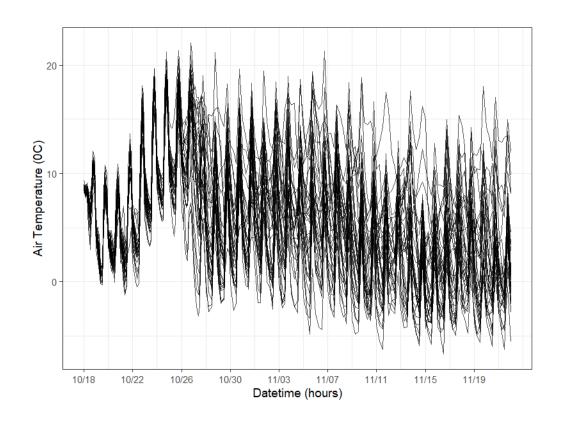
Global Ensemble Forecasting System

Datetime: 2023-04-18 20:00:00

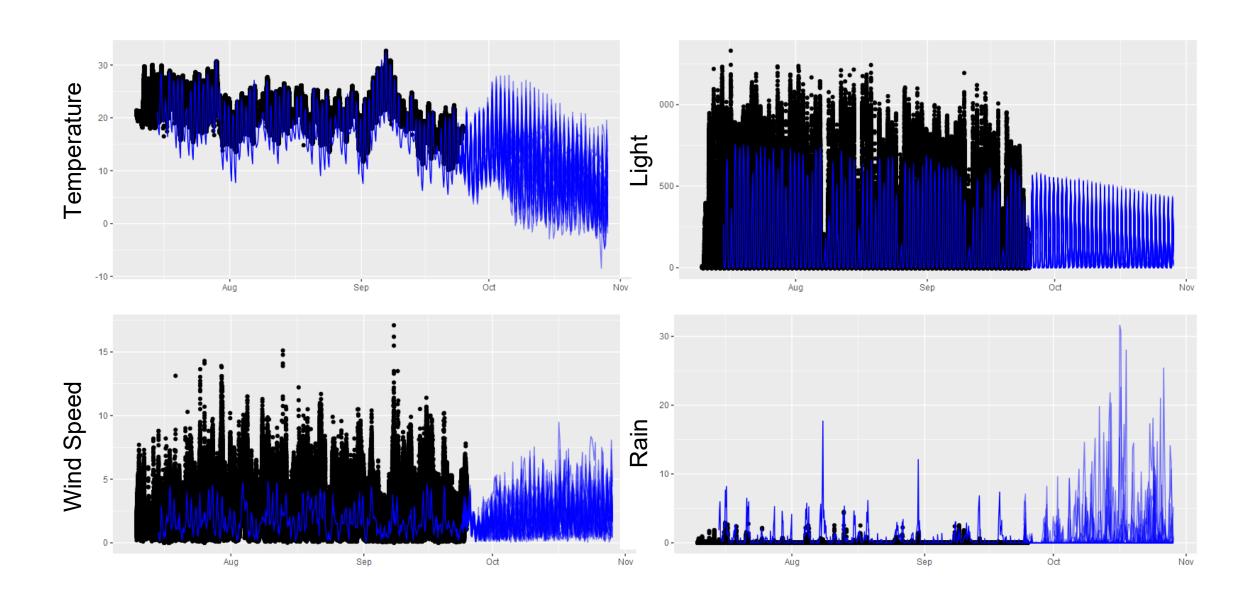


Ensemble of 30 for ecasts

35 - day time hor izon

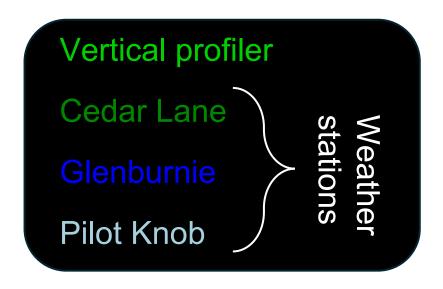


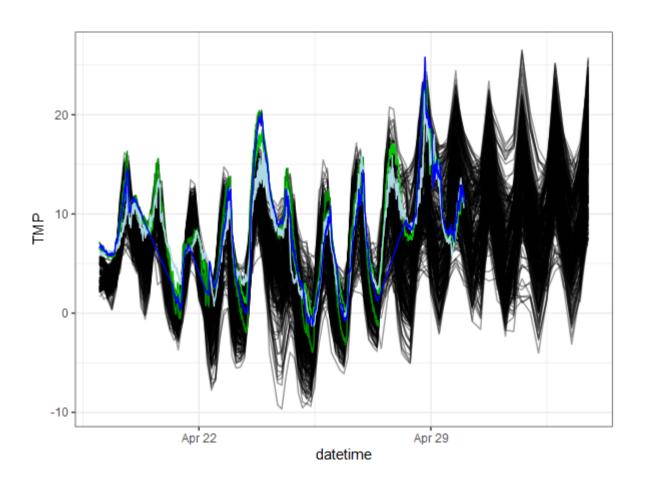
NOAA forecast vs Observed weather



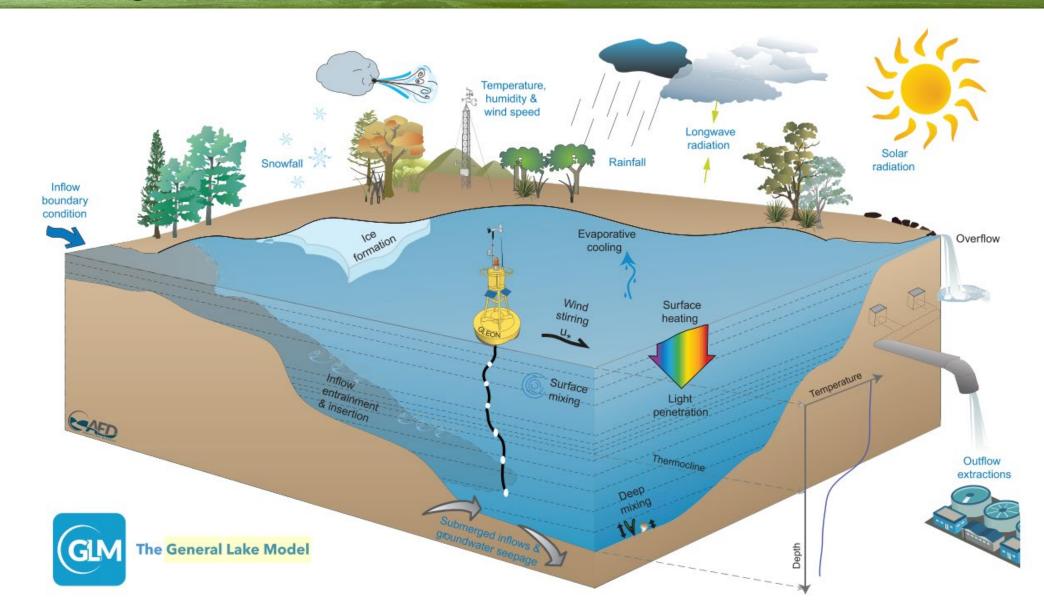
NOAA forecast vs Observed weather

Forecast from 2 weeks ago





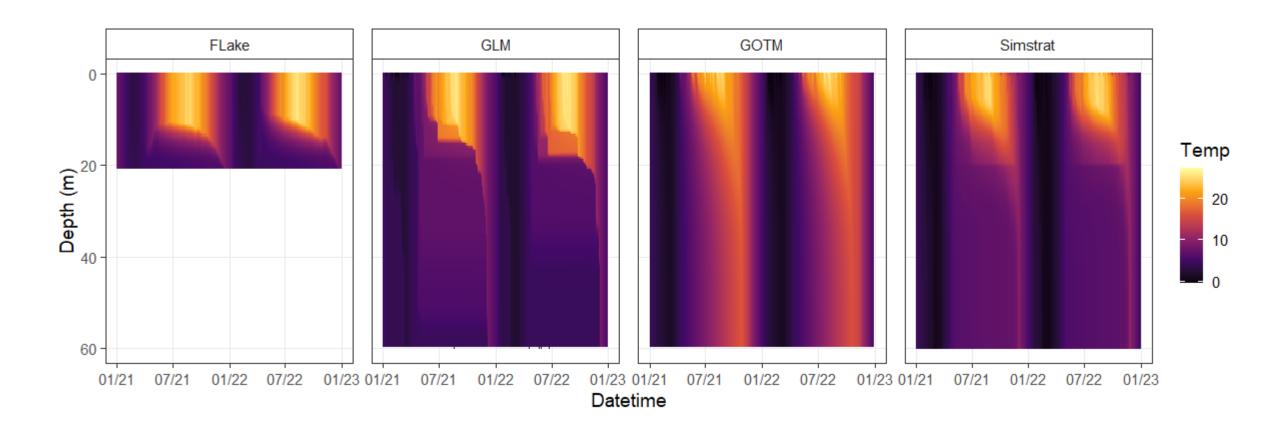
Modelling lake water temperature



Modelling lake water temperature



LakeEnsemblR – 1D lake modelling



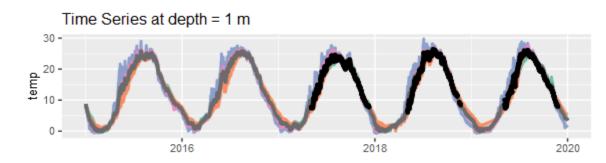
A model for Lake George

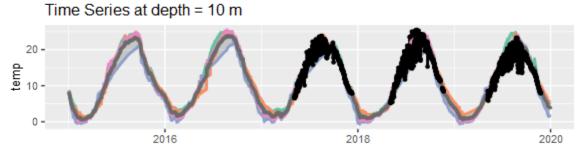


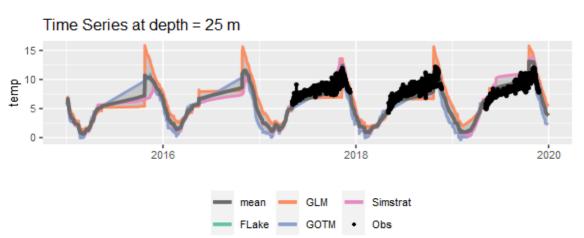
Used 3 years of vertical profiler data to calibrate model ensemble



RMSE = 1.26 for ensemble mean

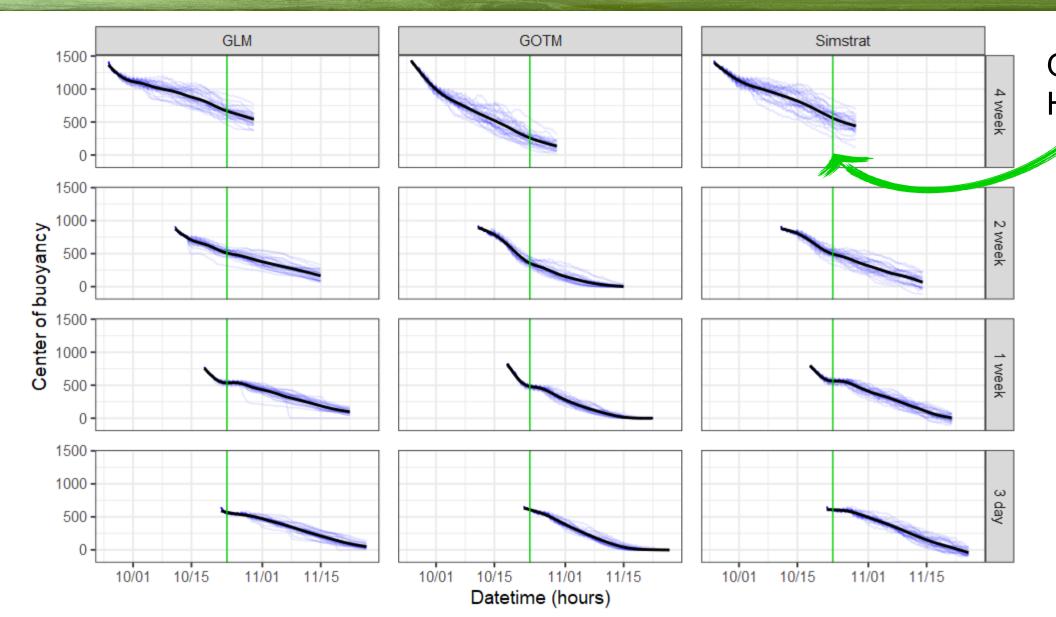






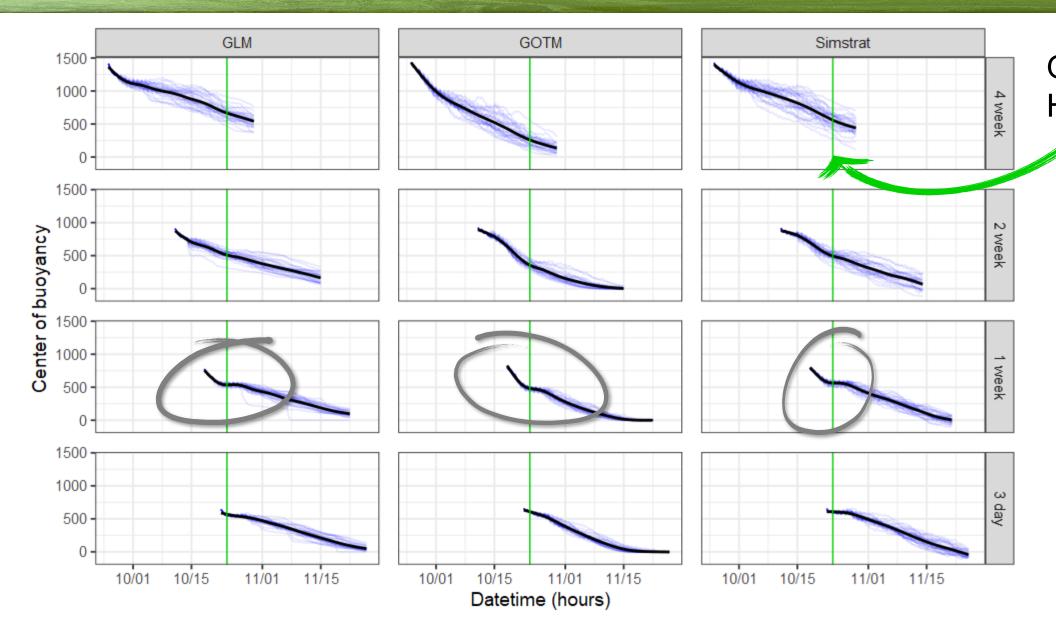
One-dimensional models are quick to run, comput at ionally efficient, and offer a longer time-horizon than mor e complex models

Forecast for October 2022



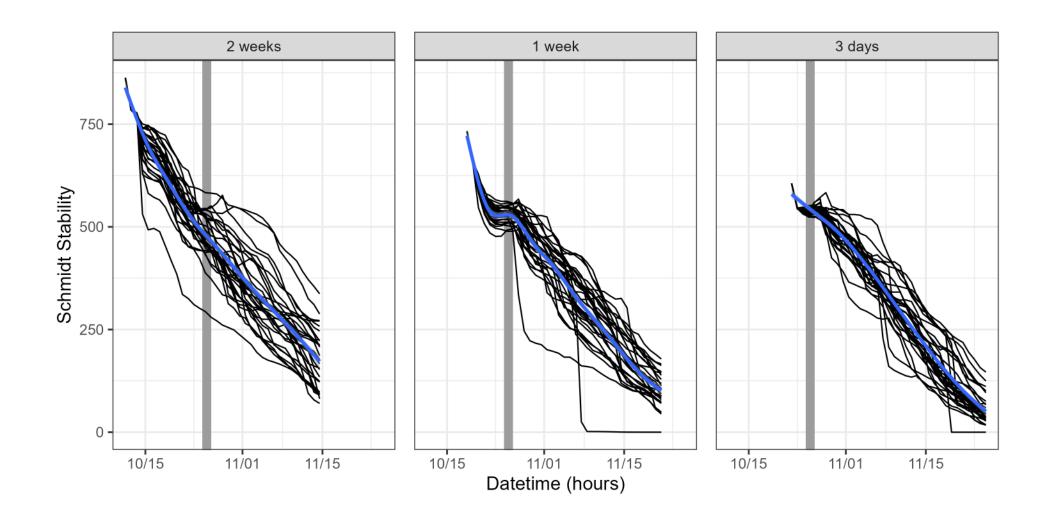
October 25th HAB event

Forecast for October 2022

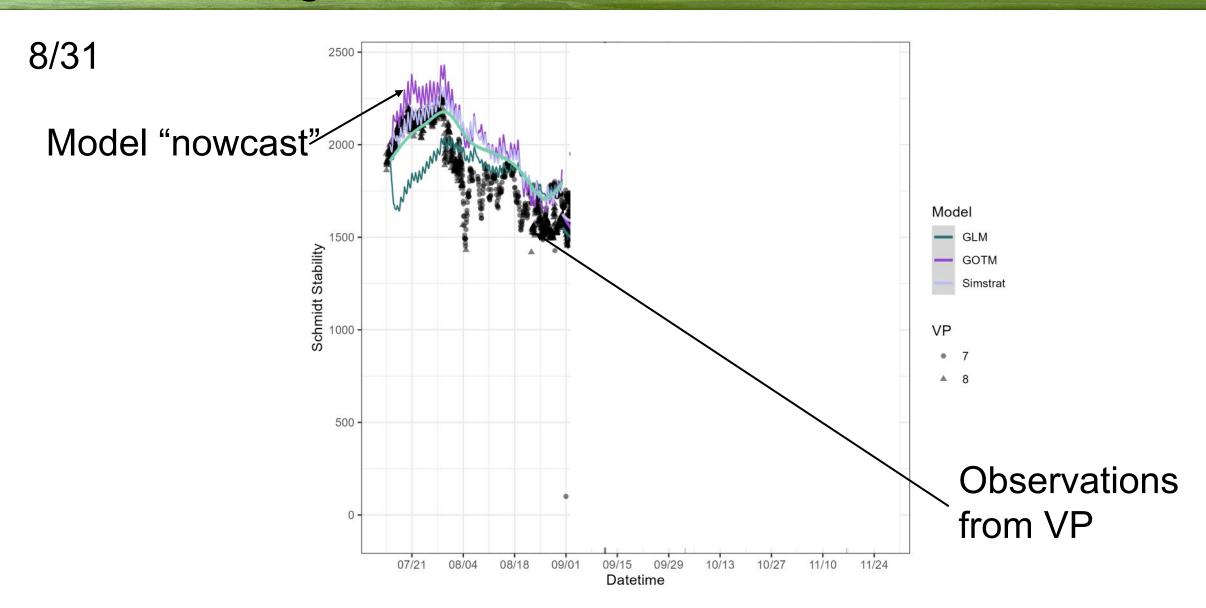


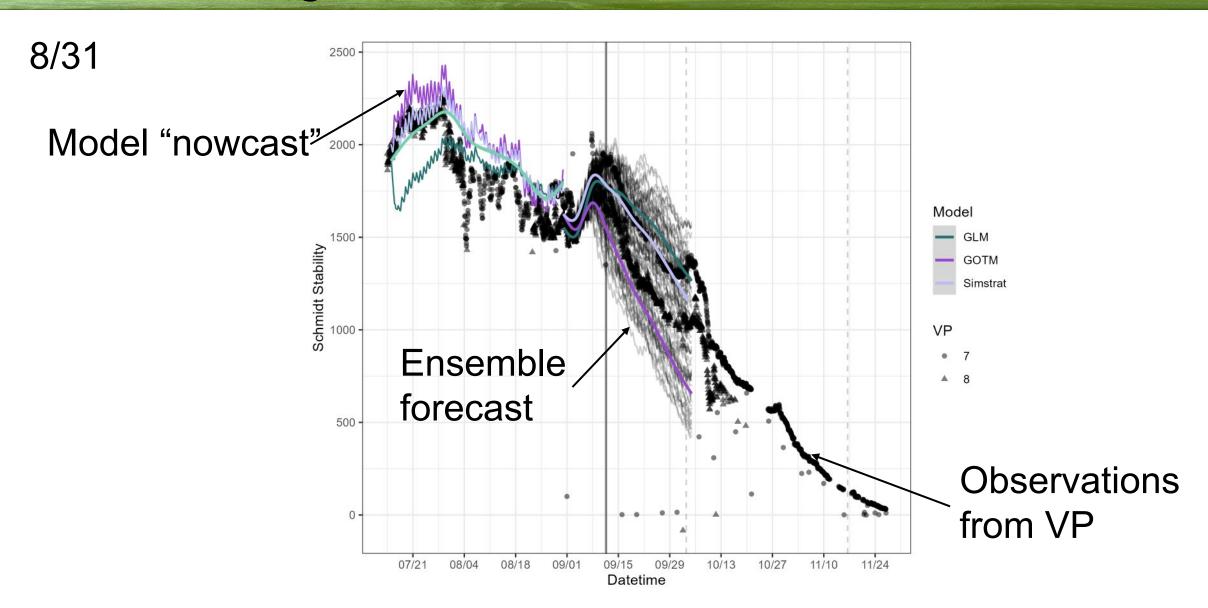
October 25th HAB event

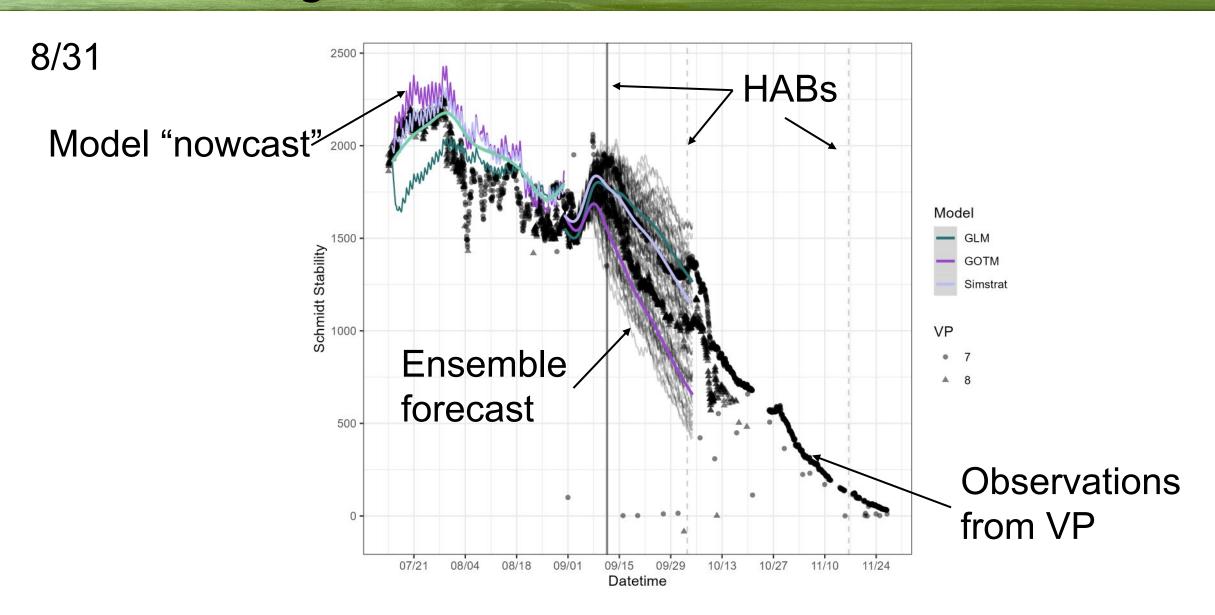
Forecast for October 2022

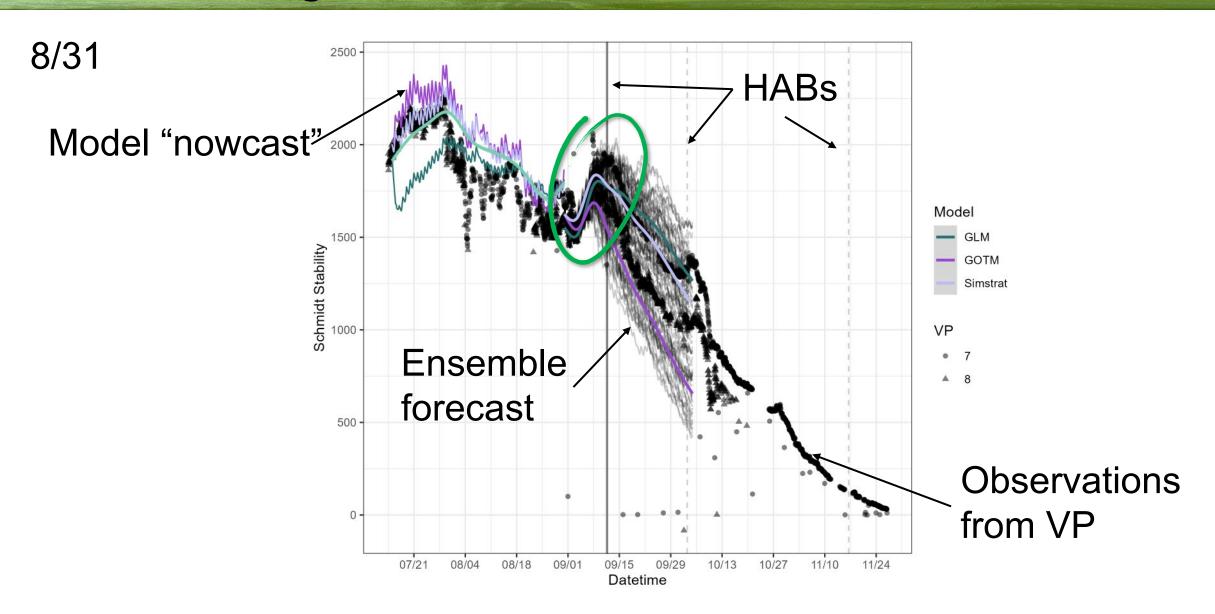


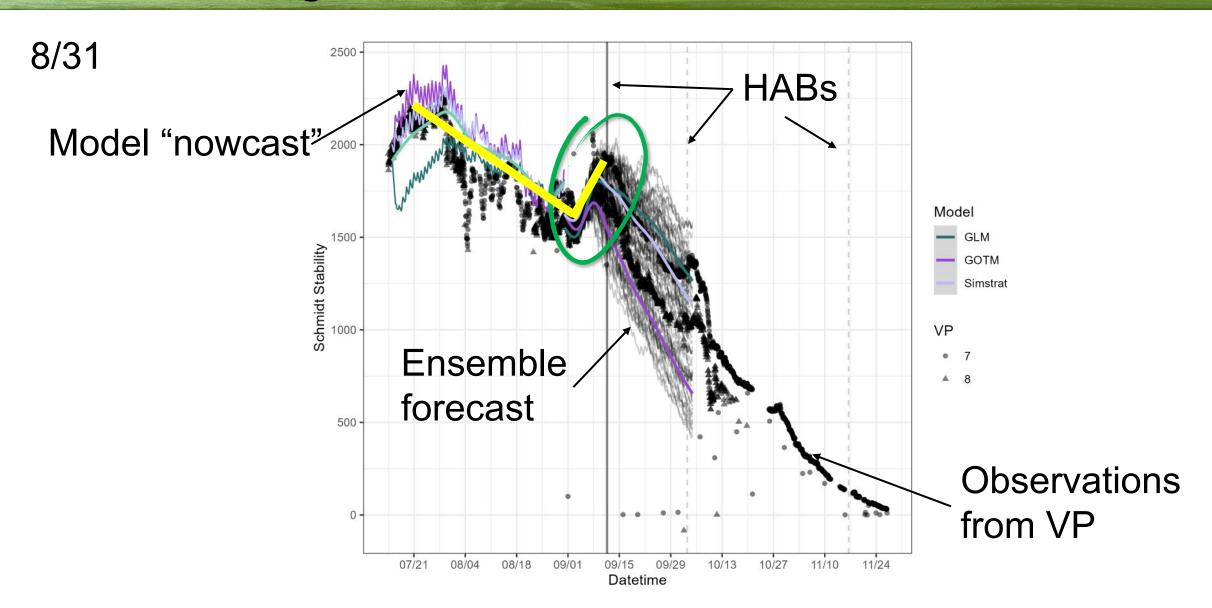
In 2023 we tested the predictive ability of the forecast

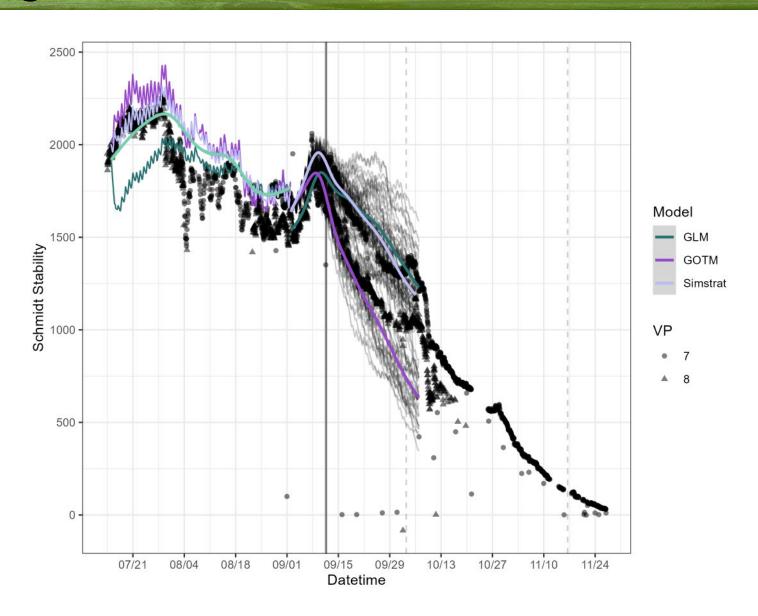


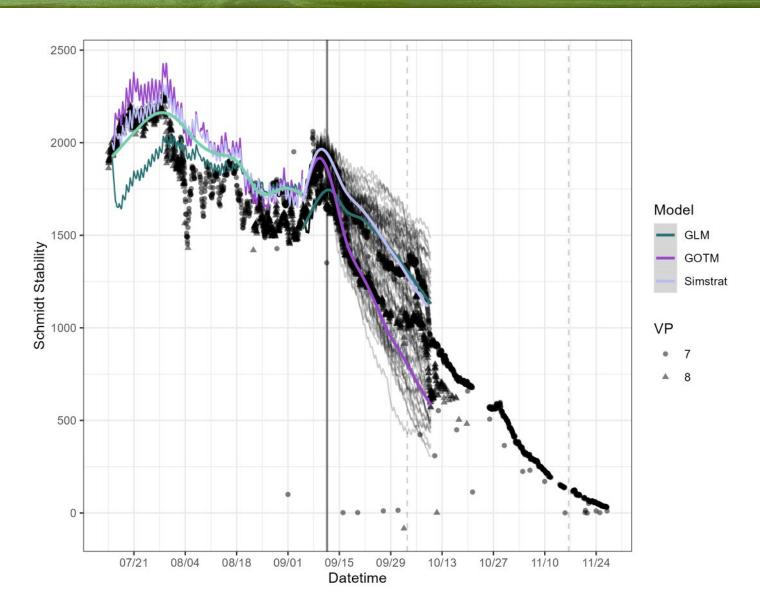


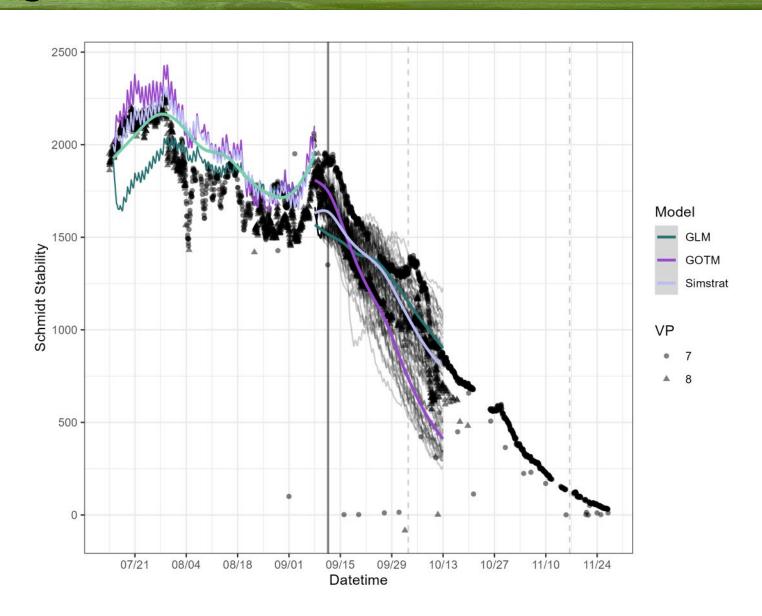


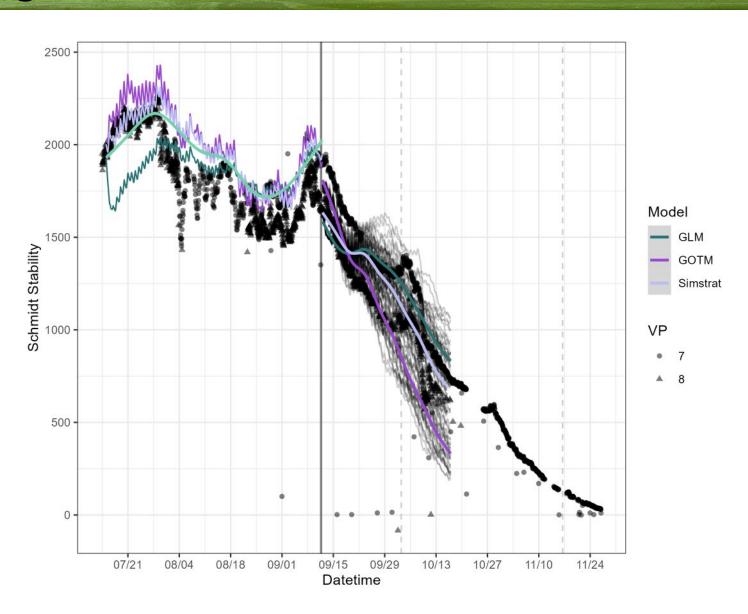


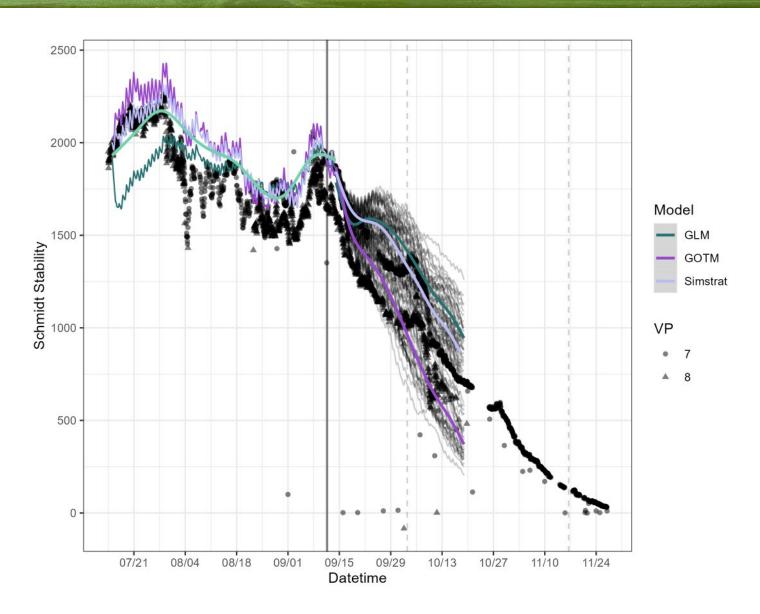


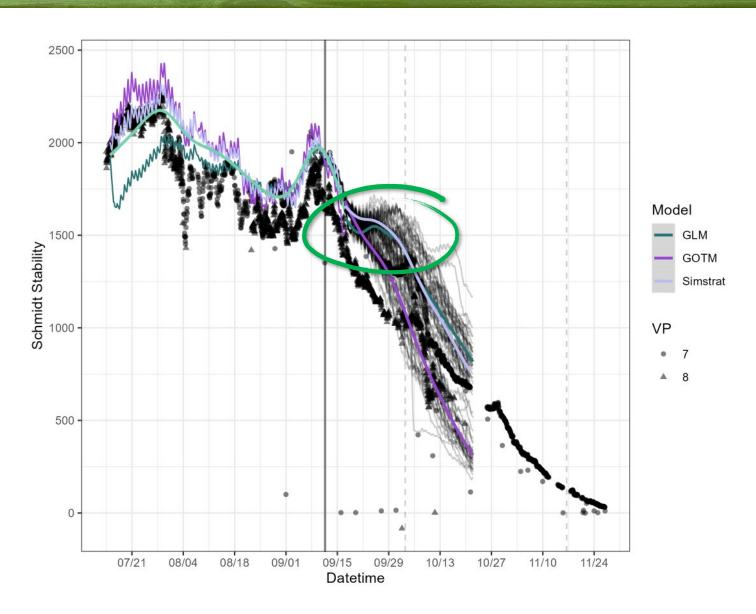


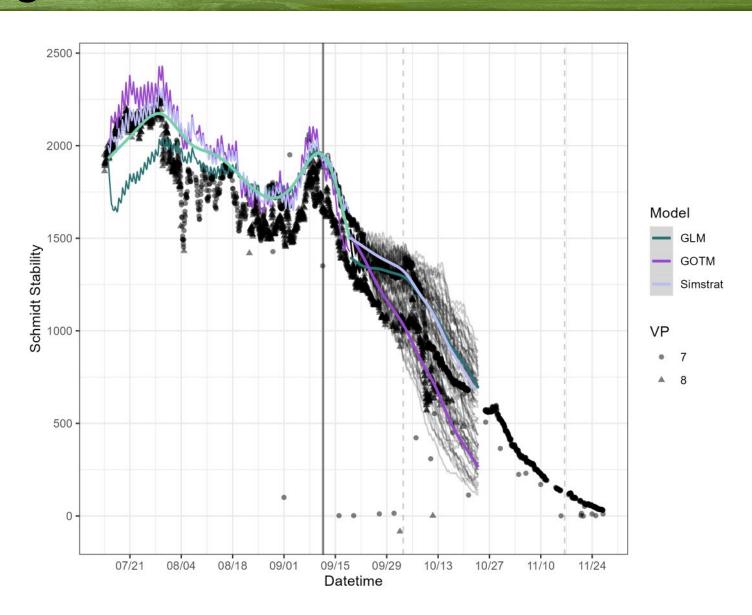


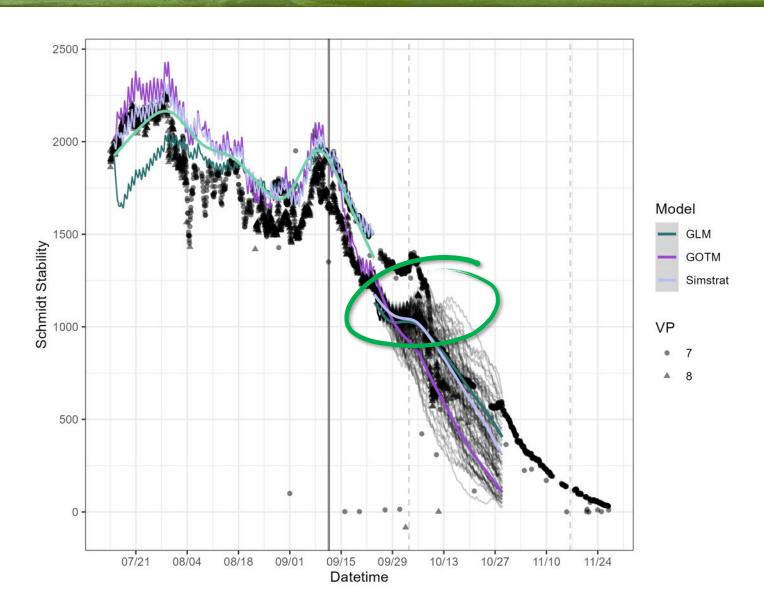


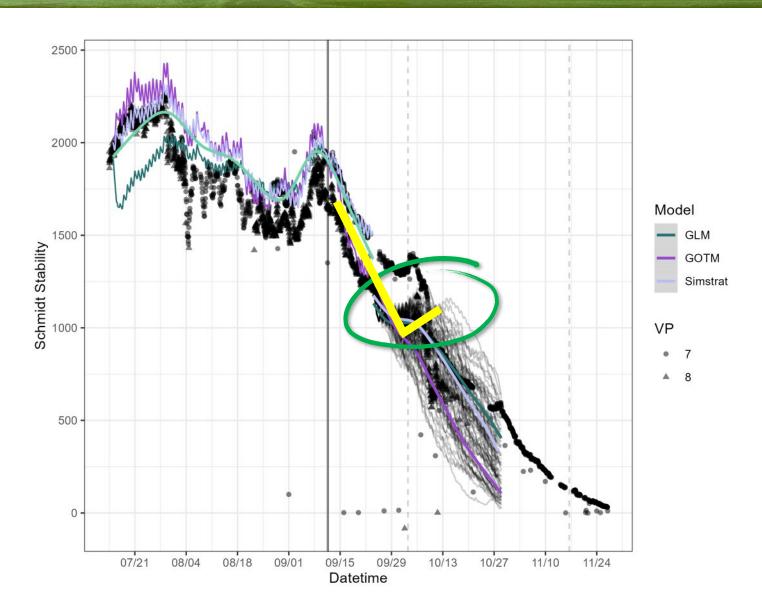


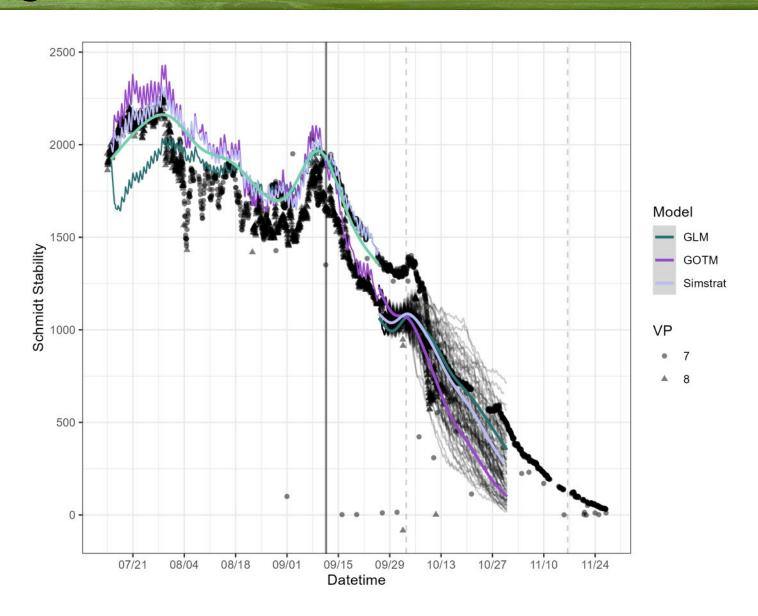


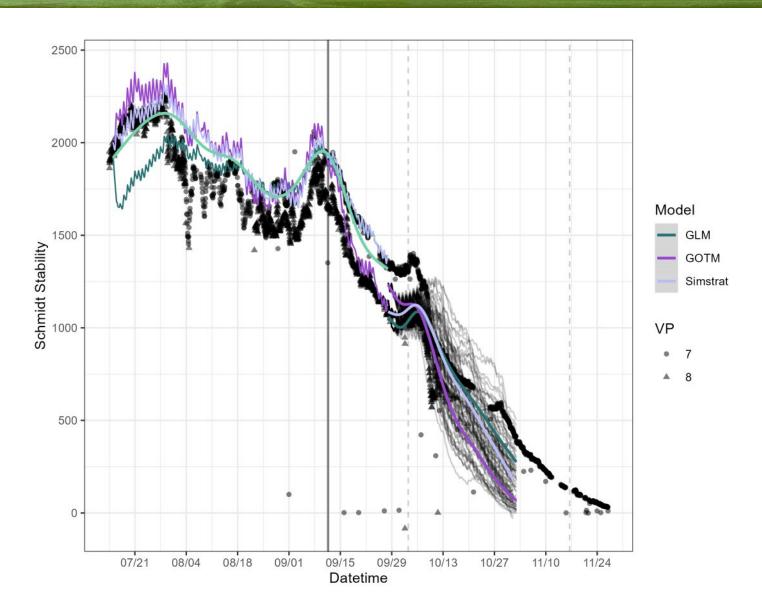


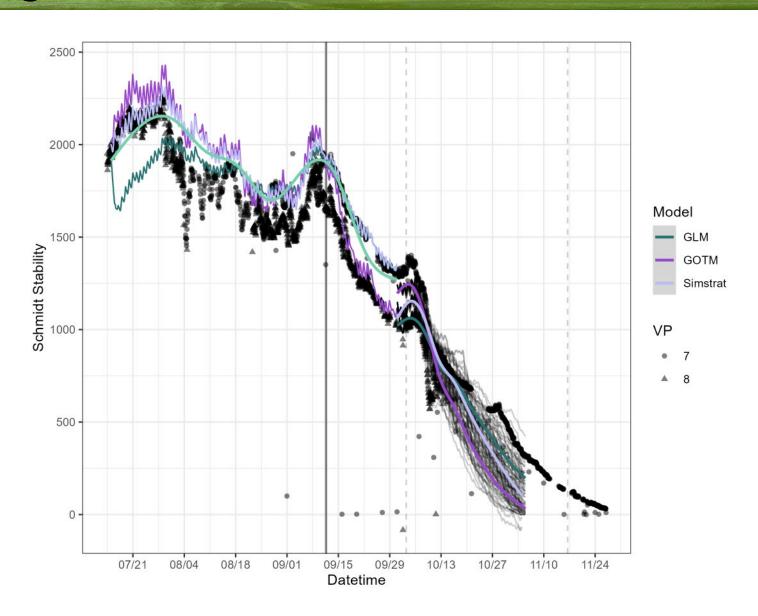


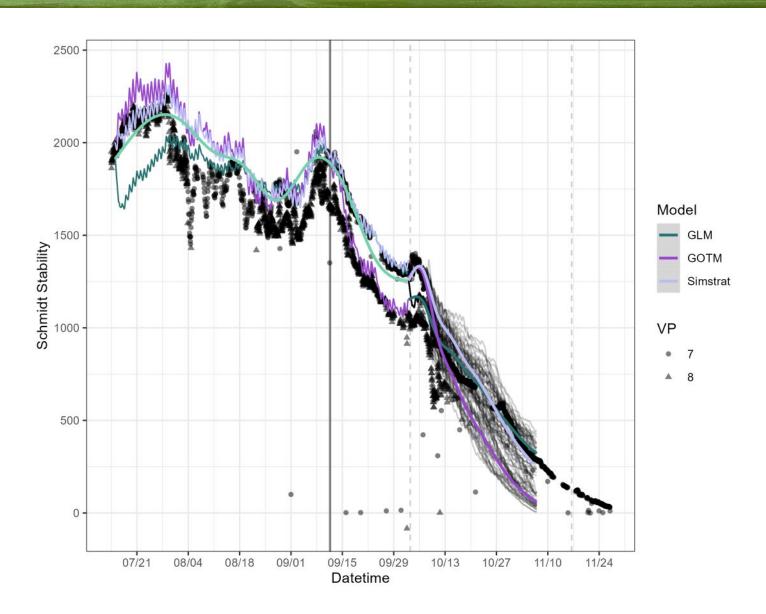


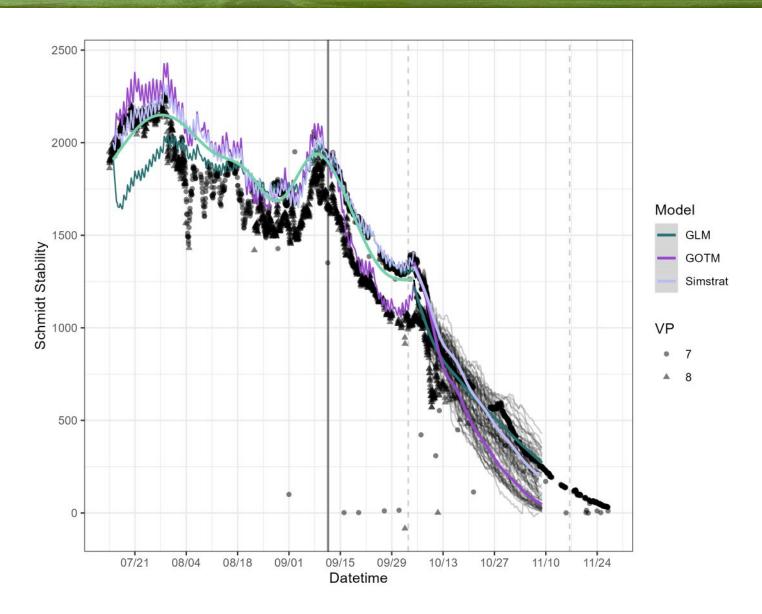


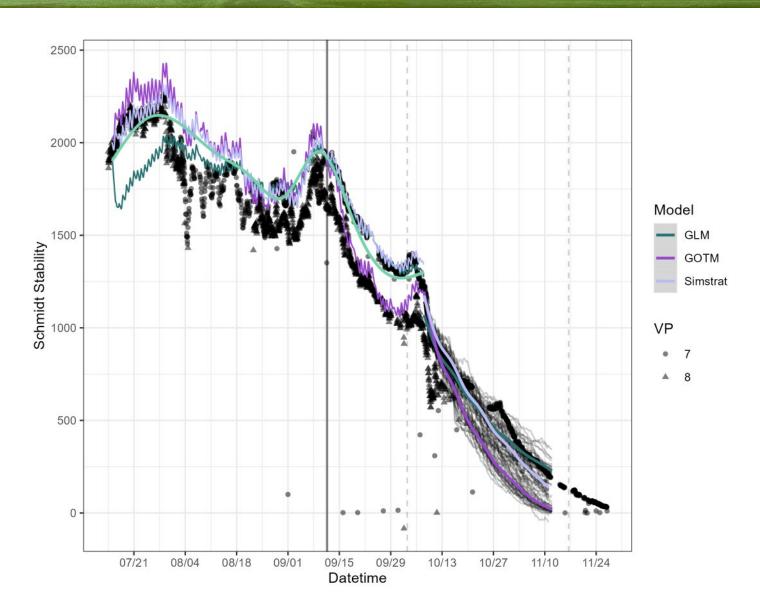


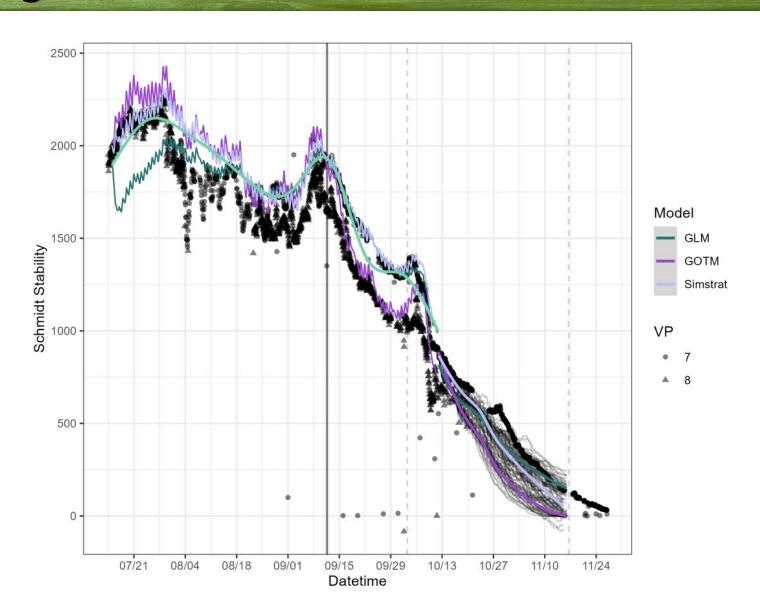


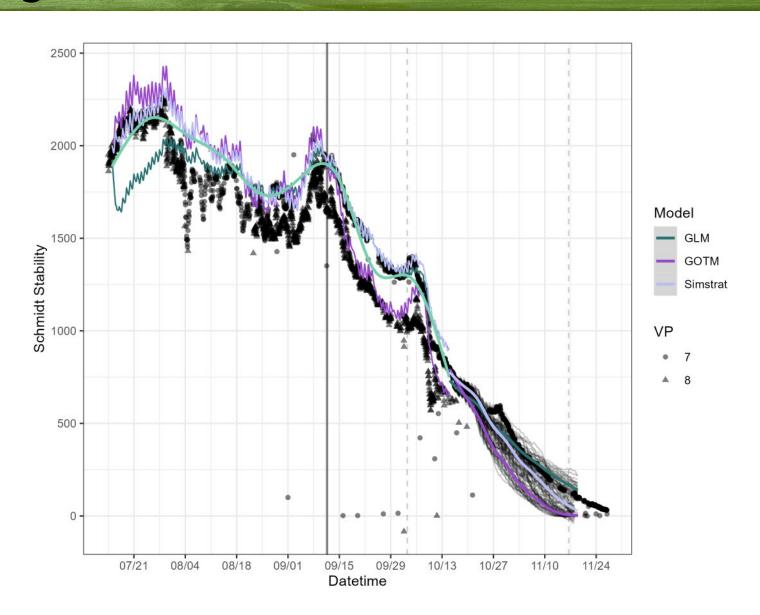


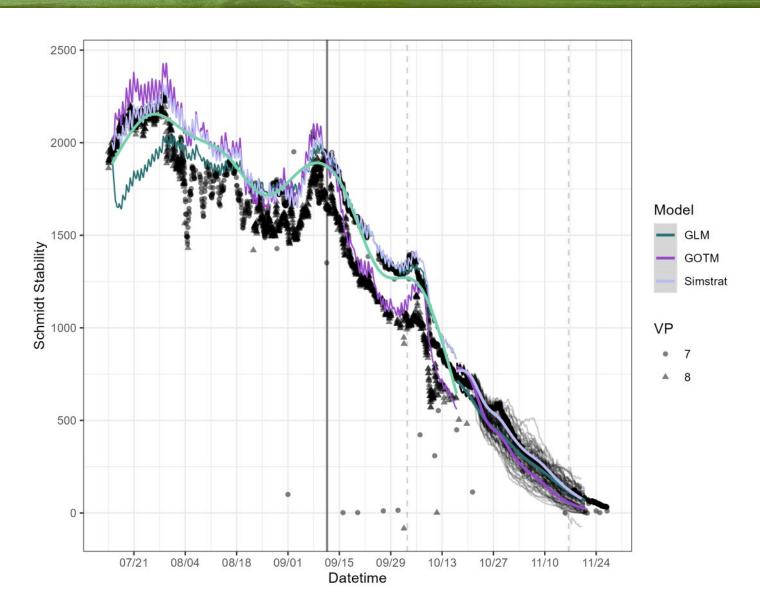


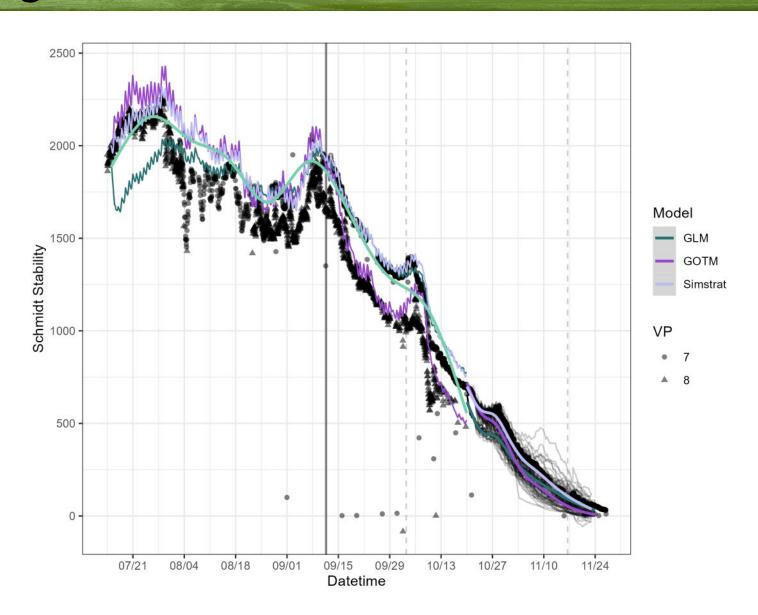




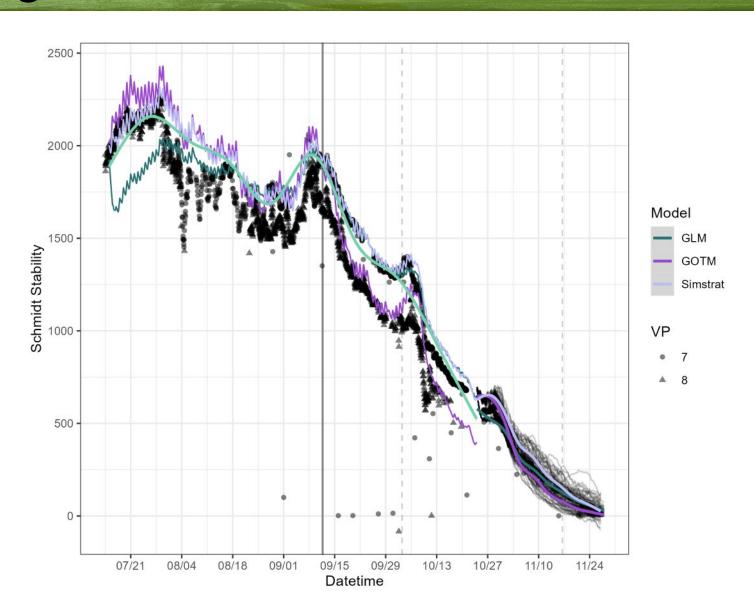


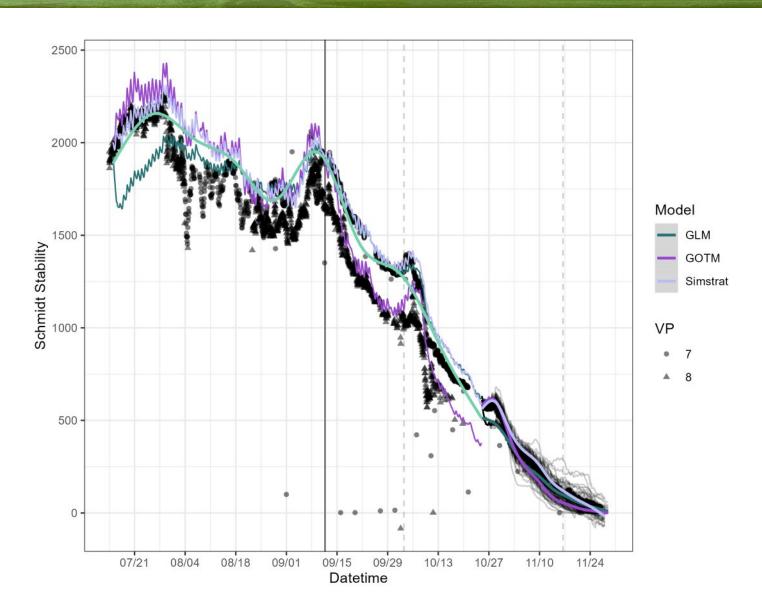


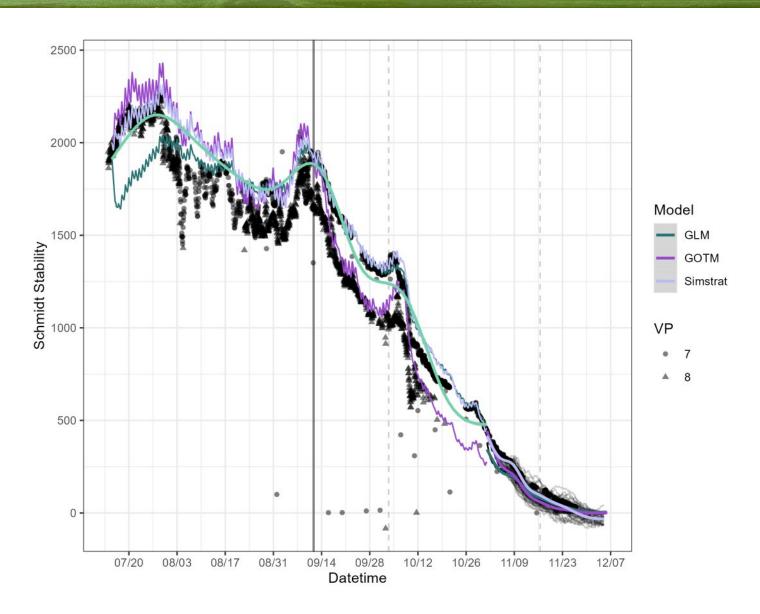


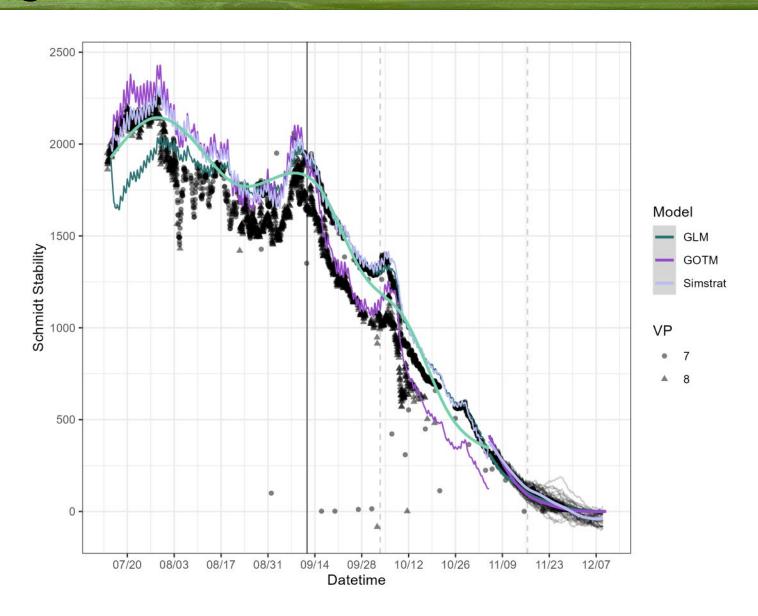


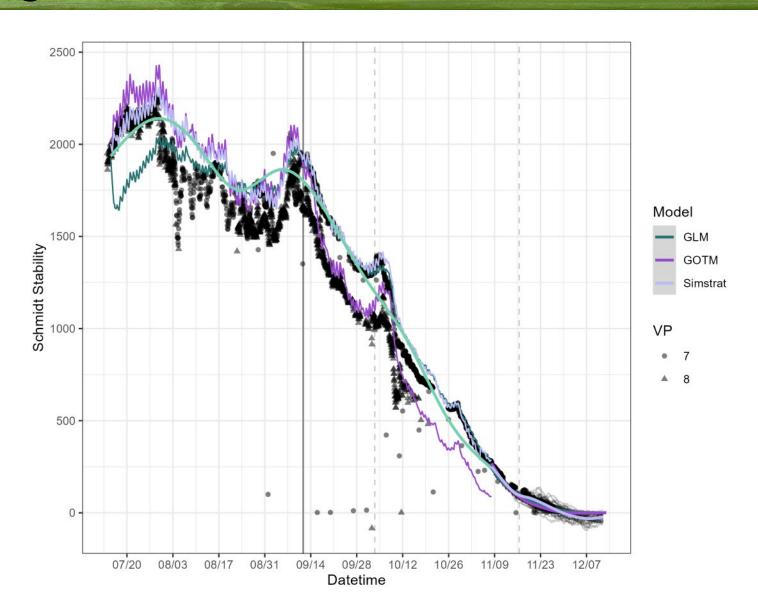


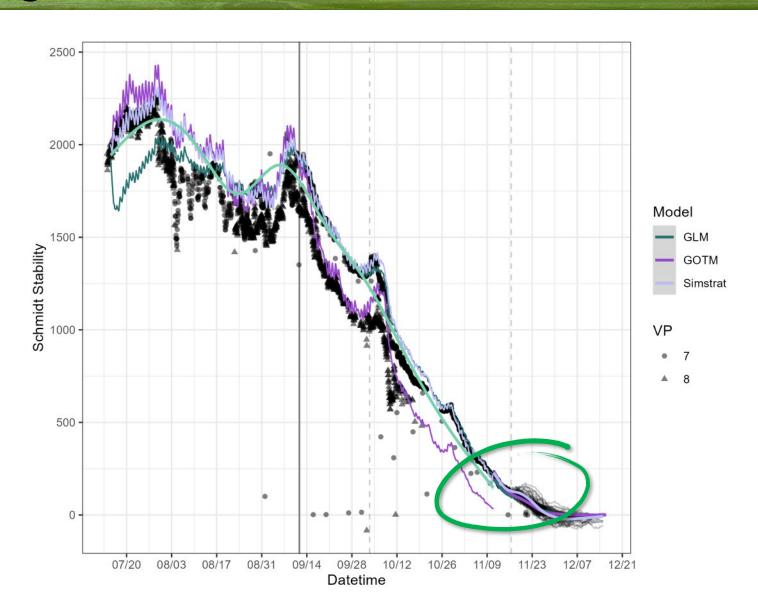


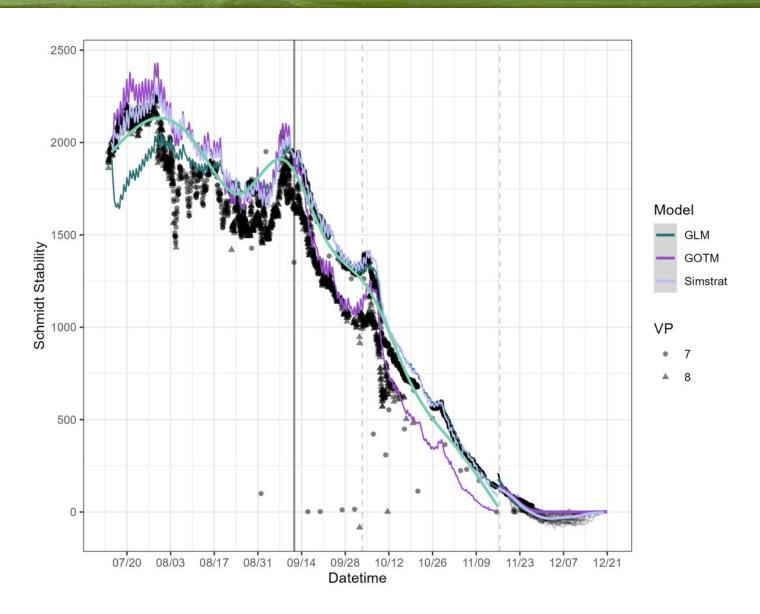


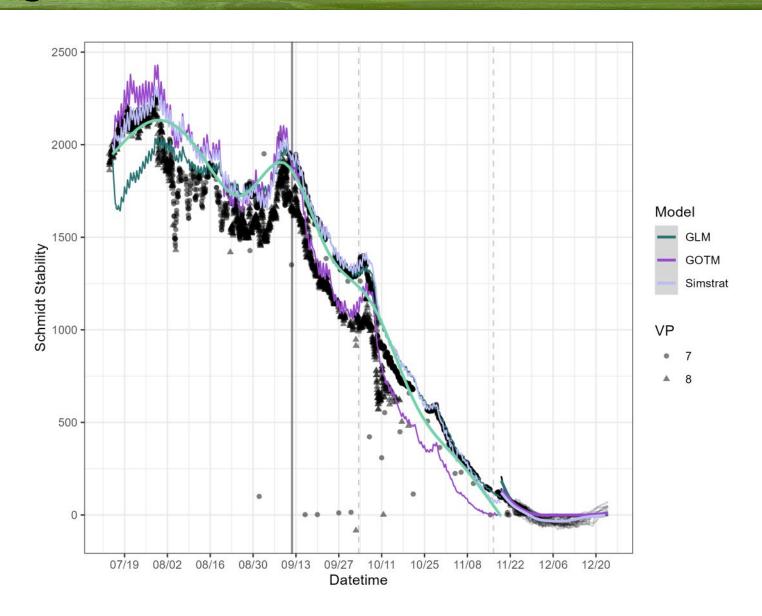




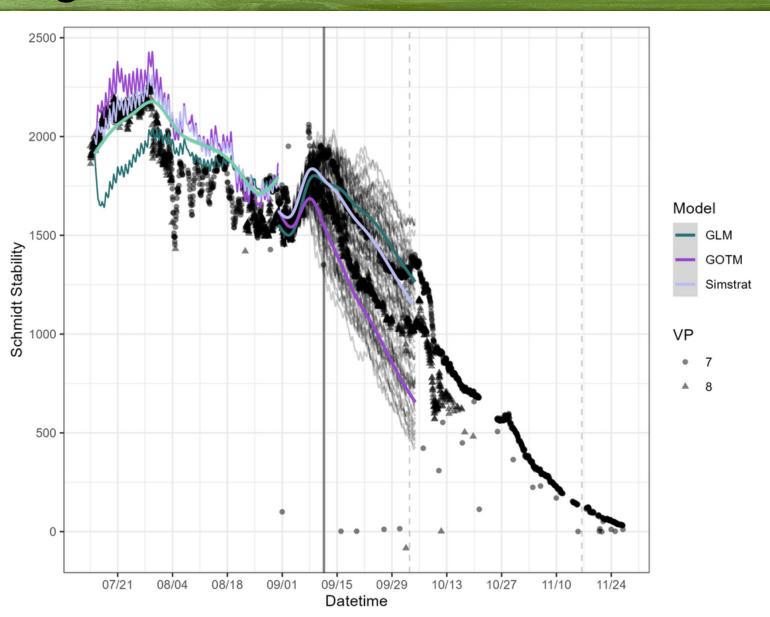




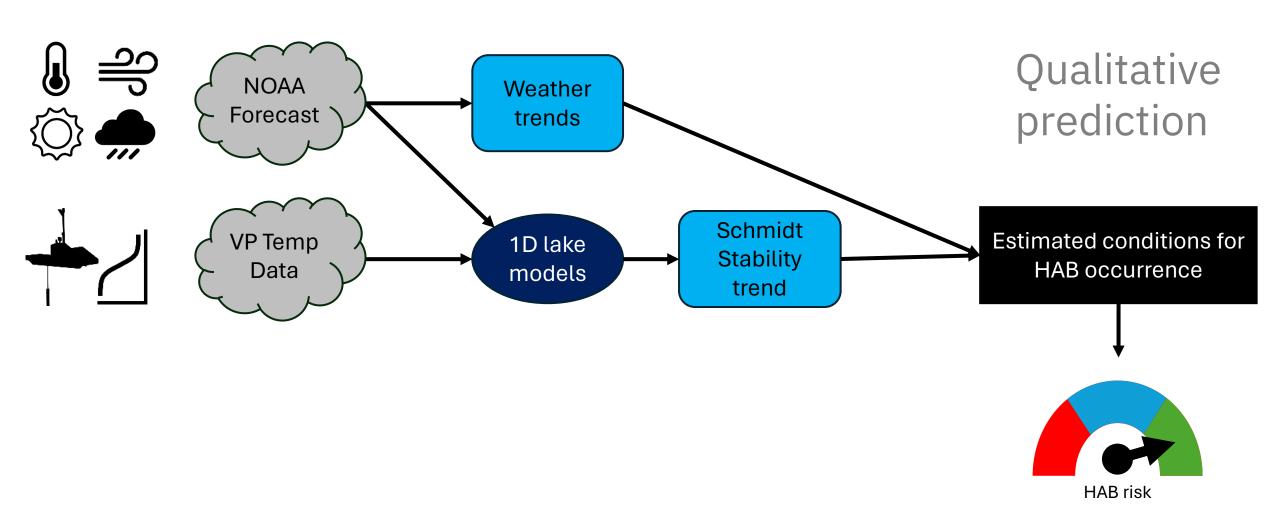




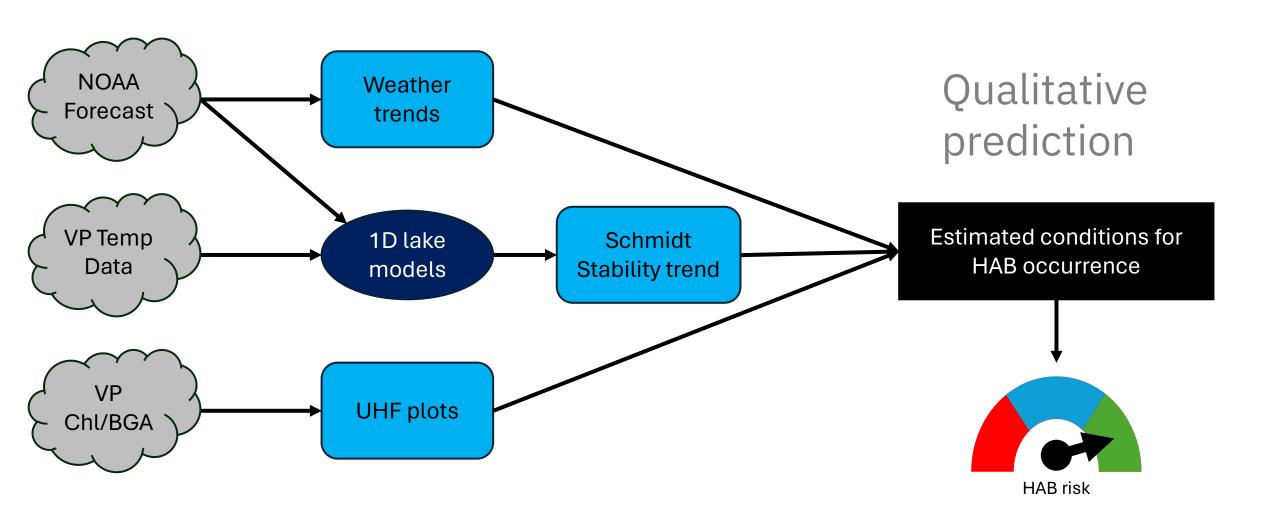
Changing predictions over time



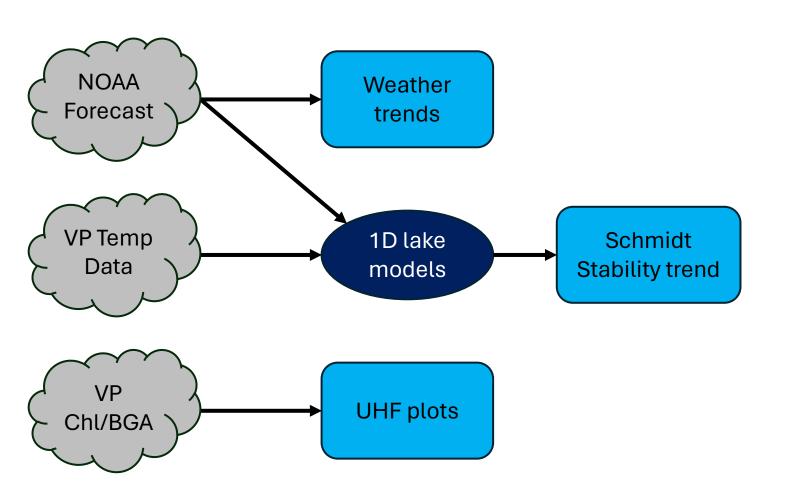
A framework for forecasting

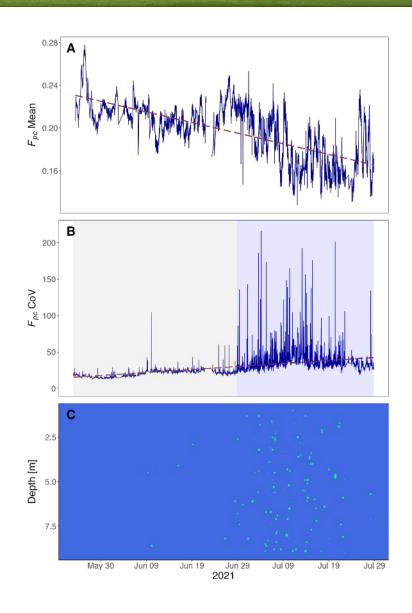


Incorporating ultra high frequency sensor data

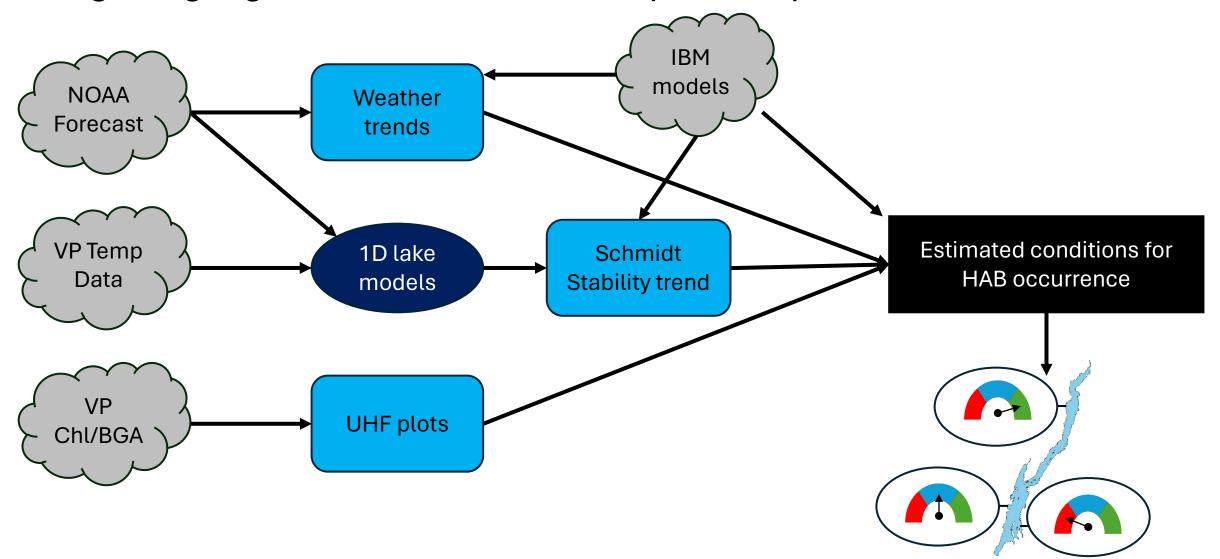


Incorporating ultra high frequency sensor data





Integrating high-resolution models to predict spatial variation in risk



What can we do with this information?



Adaptive sampling

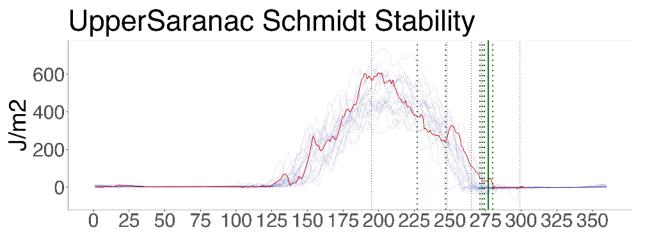
Targeted periods of intensive sampling prior to bloom events



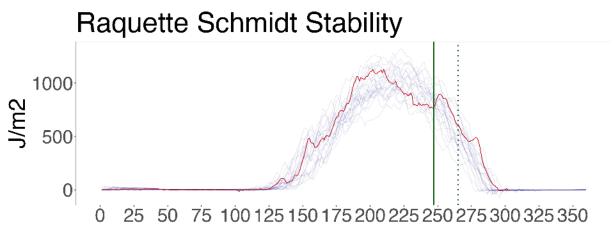
More eyes on the lake

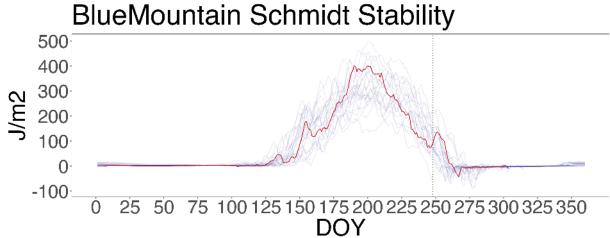
Telling people when to be on the lookout can help improve model accuracy

Beyond Lake George



Re stratification is associated with blooms in other lakes





Thank you!



Any questions?





