2021 Western Lake Erie Harmful Algal Bloom (HAB) Forecast

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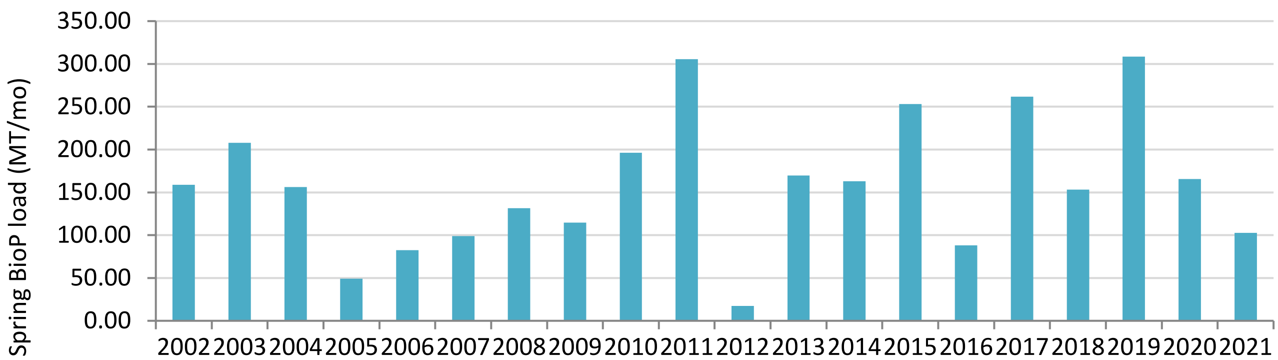
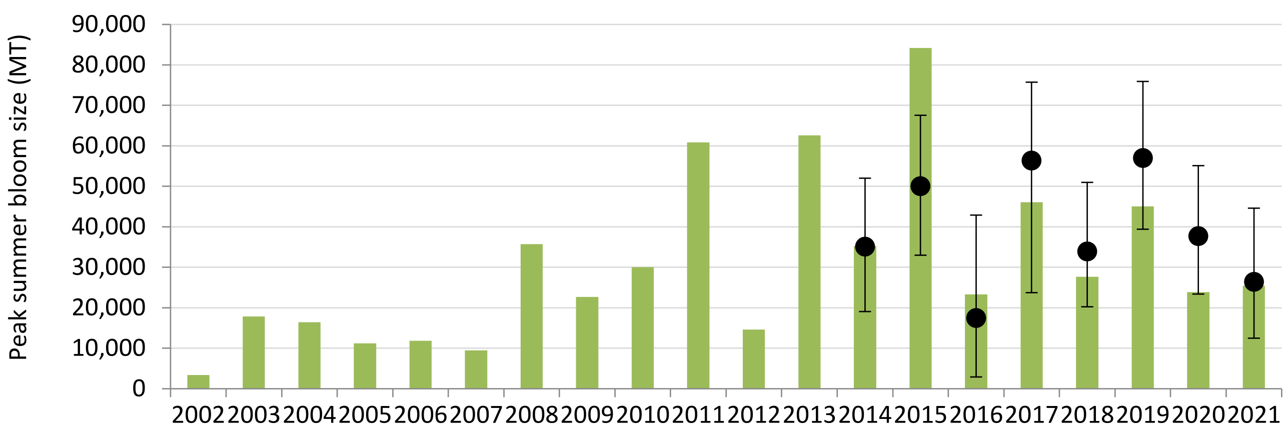
Forecast summary: A Harmful Algal Bloom of 26,423 metric tons (MT) is predicted for the western basin of Lake Erie in 2021, with a 95% predictive interval of 12,491 to 44,613 MT. This forecast is 14% lower than the 2002-2020 average, and less than half of the 2015 maximum. This forecast is a contribution to NOAA's ensemble bloom prediction. Observed extent in 2021 was 25,444 MT

This year's forecast is based on a new model that builds on the Bertani et al. (2016) model that included a "time term" to account for the apparent increase in HAB sensitivity to phosphorus loads. In this new version, the "time" term is replaced with the cumulative DRP load from the previous 10 years, similar to that used by Ho and Michalak (2015). The model, calibrated with three independent estimates of the 2002-2020 HAB observations and loading of bioavailable phosphorus, explained 72% of the interannual variability. It also explained 60% of the interannual variability in a leave-one-out cross validation.

The spring bioavailable phosphorus loads and bloom forecasts compared to observed historical blooms are shown below:



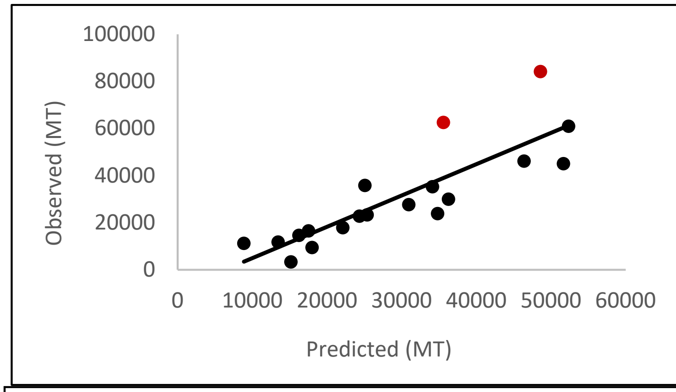


Spring phosphorus loads (top) and mean bloom observations with forecasts (bottom). Error bars represent 95% predictive intervals. The 2020 error bars represent the 95% confidence interval from a 5-model ensemble (See Scavia et al.2021.

Phosphorus loads: Daily TP and DRP loads were downloaded from Heidelberg University's National Center for Water Quality Research (https://ncwqr.org/monitoring/data/), and aggregated to monthly loads. Bioavailable P was estimated as DRP plus a fraction of particulate P (TP-DRP), where the faction (0.5) was determined during model calibration. The load time period included April-June plus a fraction of the end of March, where the fraction (0.16) was determined during model calibration.

HAB extent estimates: The HAB model was calibrated using three sets of HAB estimates for 2002-2020. HAB extent as dry weight biomass was derived from two satellite-derived estimates (Stumpf et al. 2016; Manning et al. 2019) and a geostatistical estimate based on *in situ* observations (Fang et al. 2019). The Stumpf cyanobacteria index is based on processing satellite image spectra specific for cyanobacteria, whereas the Manning biomass estimates are based on chlorophyll-specific spectra (Sayers et al. 2016) that give similar results for relatively high chlorophyll concentrations. Both are constrained to near-surface observations. The Fang estimates are based on *in situ* chlorophyll observations, which are relatively sparse, but provide full water-column estimates. Stumpf estimates are for the full lake, whereas the other two estimates only determine bloom size within the western basin. So, the Stumpf estimates were clipped to the western basin as described by Fang et al. (2019).

HAB model calibration:. Calibration was based on Bayesian inference using a Markov Chain Monte Carlo (MCMC) sampling algorithm implemented within WinBUGS interfaced with the R package, R2WinBUGS (Lunn et al., 2000; R Core Team, 2015; Sturtz et al., 2005). Detailed information on the MCMC algorithm settings, chain convergence evaluation, and parameter prior distributions can be found in Obenour et al. (2014) and Bertani et al. (2016). A new response curve was developed for the revised model based on parameter estimates and model-specific spring loads.



Results of the model calibration, showing predicted vs. observed HAB biomass while red dots are 2013 and 2015 outlier years; however all years were included in the calibration.

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