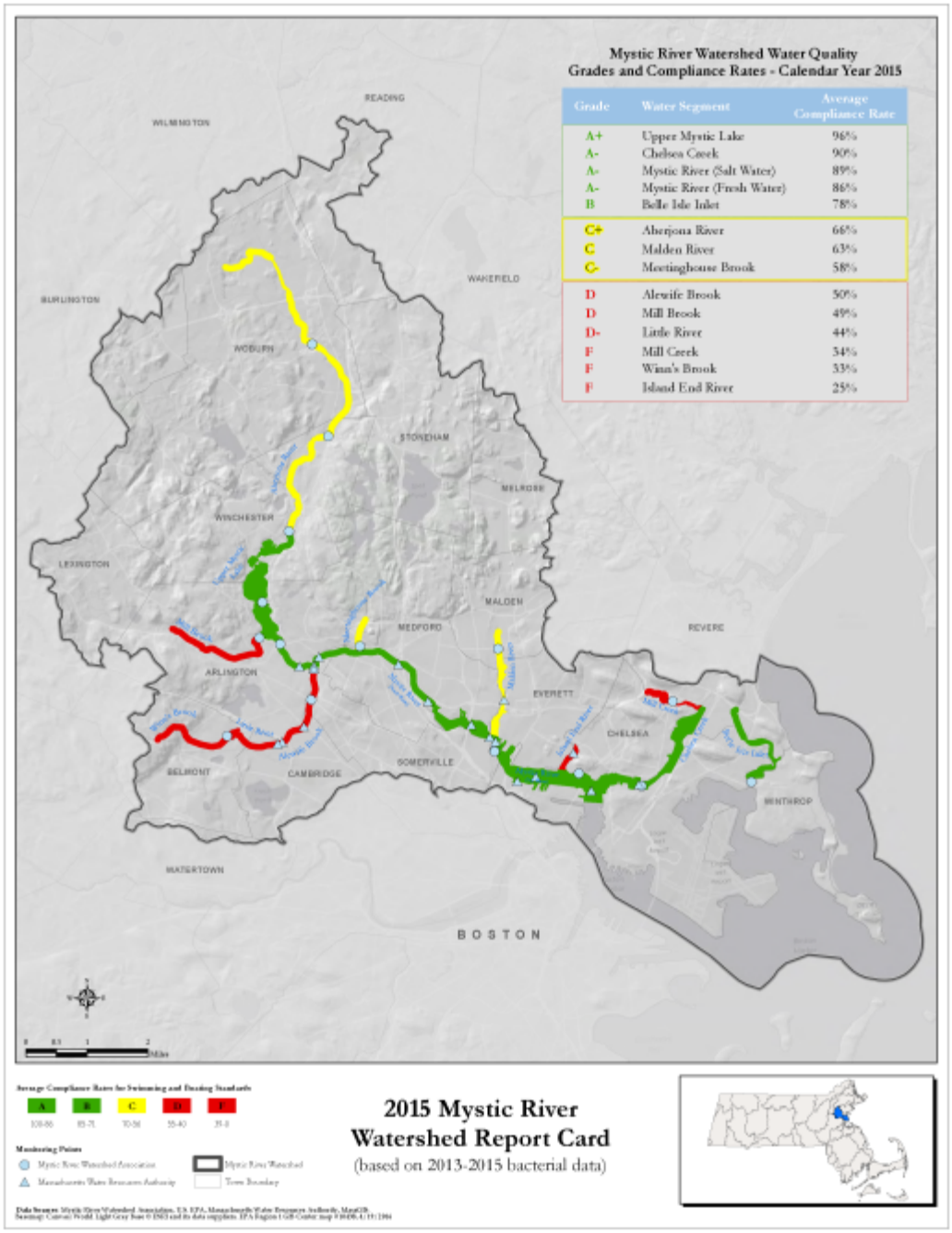
What Is Water Quality Like *TODAY*?

MyRWA's New Daily Boating Advisory System

Andy Hrycyna
Mystic Steering Committee
April 14, 2018

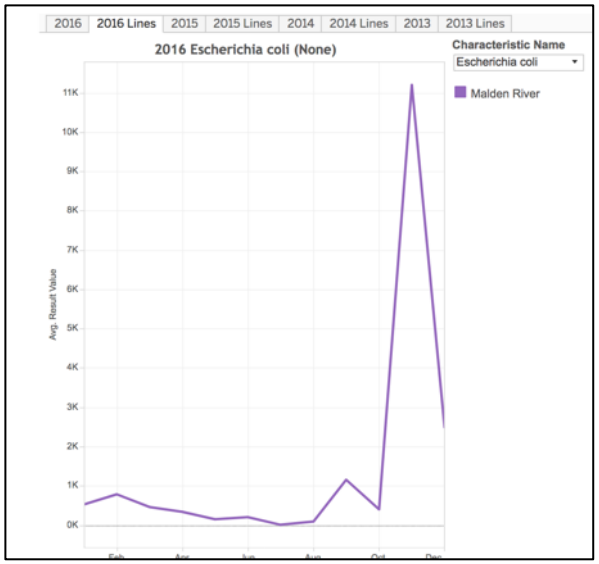


EPA water quality report card

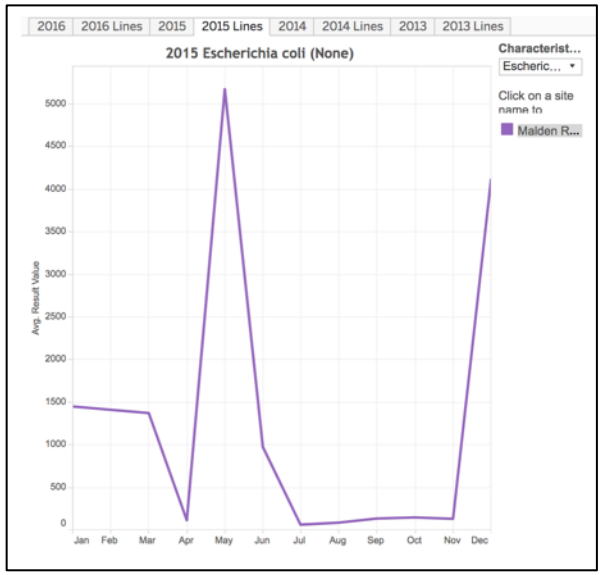
- MyRWA does analysis
- MyRWA + MWRA data sets
- Relatively simple calculations of %'s
- Even simpler, intuitive grading system
- Power of maps

Challenge: Variability of data

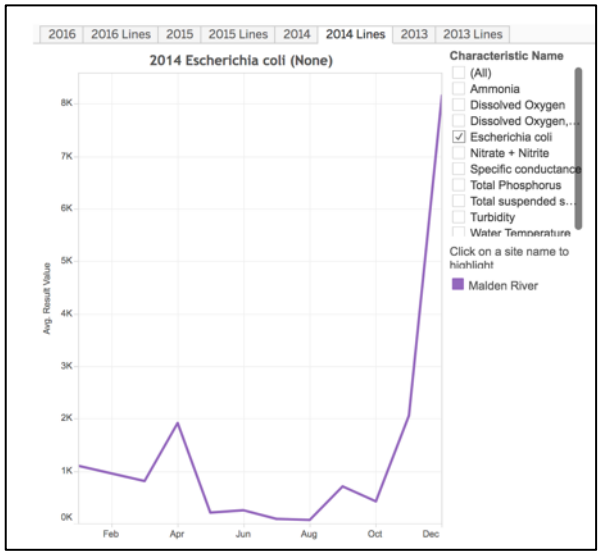
2016



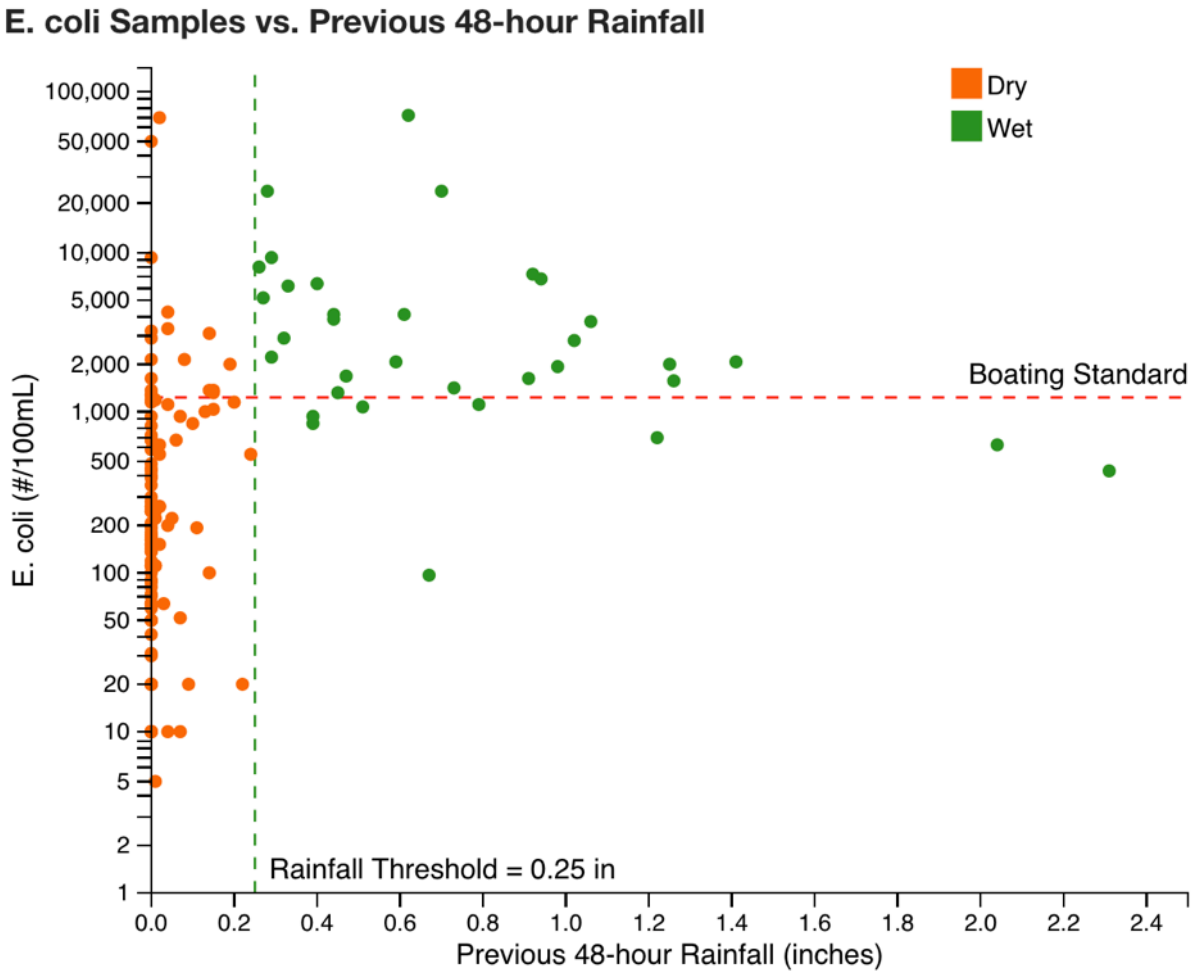
2015

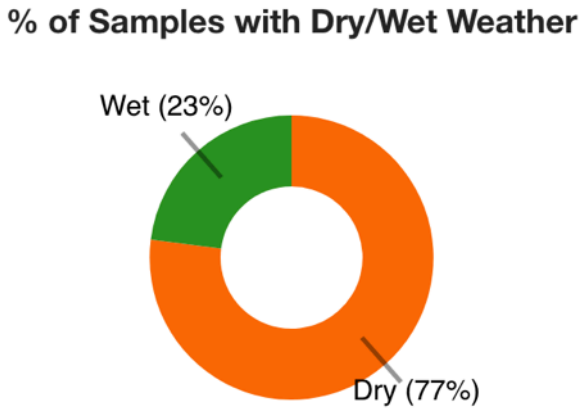


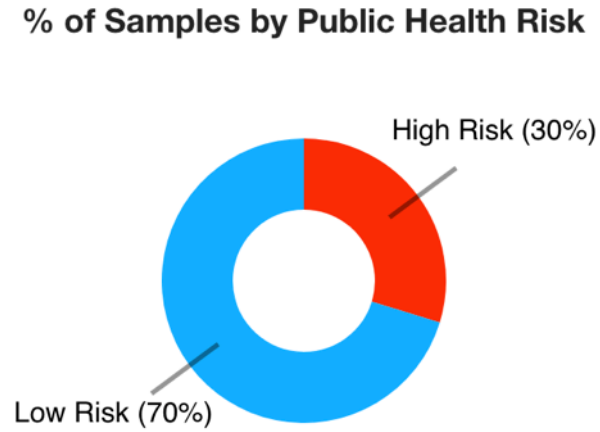
2014

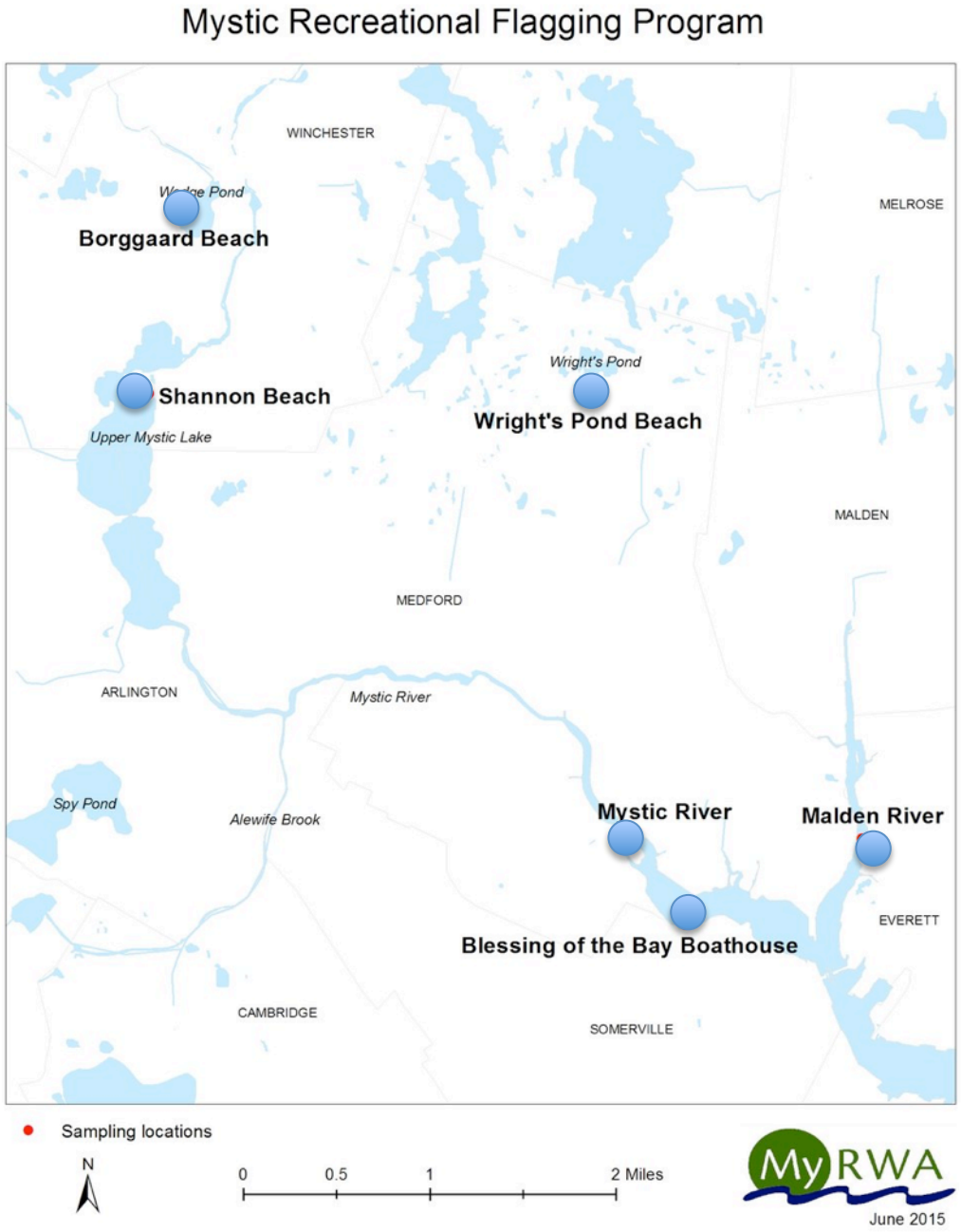


Relationship between *E. coli* levels and antecedent rainfall: Malden River









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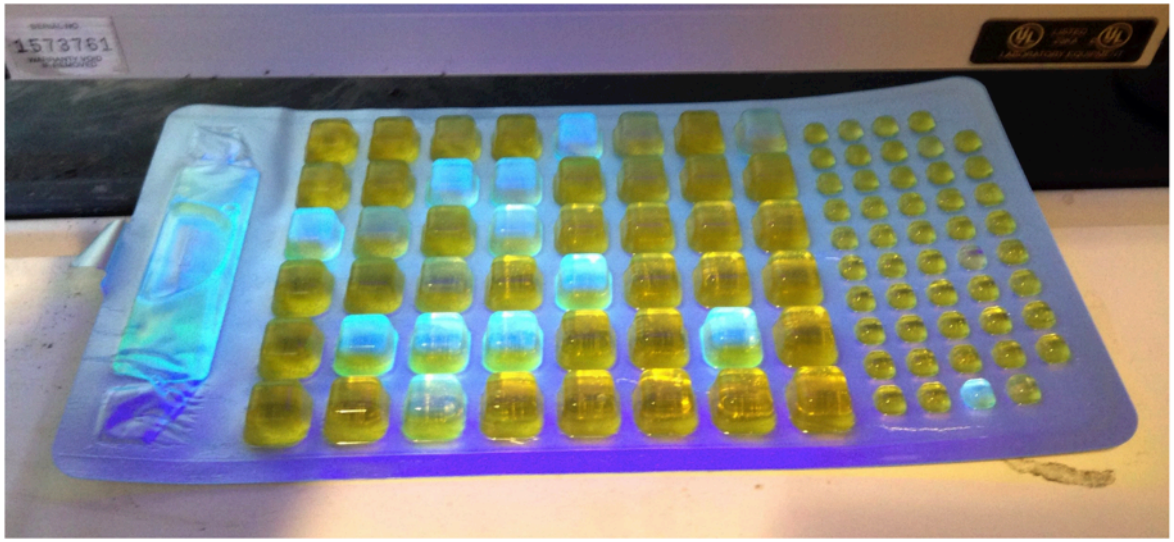
SAMPLING RESULTS

During the 2015 sampling season (38 sampling days), 483 samples were collected by 14 samplers (staff, trained volunteers and interns) and analyzed at Tufts or MyRWA for bacteria (*Enterococcus* or *Escherichia Coli*) or turbidity.



Implementation of the IDEXX method to analyze bacteria concentrations in the water quality samples. After 24 hours in the incubator, the number of large and small fluorescent wells in the tray determines the bacteria concentration in that sample. Photo by Jessica Haitz.

Sampling and Data Work

- 2 seasons of sampling
- 80 sampling events
- 6 recreational sites
- Modeling by Jeff Walker and Nathan Sanders
- Lab collaboration with Professor John Durant, Tufts University

Data August 2016

Measured *E. Coli* Levels

Station	August 25, 2016	August 24, 2016	August 23, 2016	August 22, 2016	August 17, 2016	August 16, 2016	August 15, 2016	August 9, 2016
	Date							
Alewife Brook	609	450	720	4040	556	689	1220	650
Blessing of the Bay Boathouse	52	10	<100	520	97	10	<100	146
Malden River and Rt. 16	26.2	19.7	122	1730	48	20	199	47.9
Mystic River and Rt. 16	24.3	73.3	272	1100	29.5	<10	185	19863
Wedge Pond / Borgaard Beach	66.3	235.9	20	51	>2419.6	20		30.9
Wright's Pond Beach	<1	1	3	8.5	2	5.2	1	1

Measured *Enterococcus* Levels

Station	August 25, 2016	August 24, 2016	August 23, 2016	August 22, 2016	August 17, 2016	August 16, 2016	August 15, 2016	August 9, 2016
	Date							
Alewife Brook	134	74	200	2850		146	200	350
Blessing of the Bay Boathouse	9.4	4.1	10	144	>2419.6	>2419.6	20	13.4
Upper Mystic Lake / Shannon Beach	<1	2	<1	<10	<1	2		15.8

Mystic Recreational Flagging Project - Model Development

Jeffrey D Walker, PhD

24 October, 2017

1 Overview

This document summarizes bacteria exceedance prediction models for the Mystic River Recreational Flagging project.

1.1 Methodology

A logistic regression model was fit to each of three locations (Mystic River @ Rt 16 Bridge, Lower Malden River @ Rt 16 Bridge, Shannon Beach @ Upper Mystic Lake). Robust models could not be fit to the other potential locations (Blessing of the Bay Boathouse, Wedge Pond) either because there were not good climatic and hydrologic predictor variables, or because the exceedance frequency was too low.

At each location, the data were split into training (75%) and testing (25%) subsets using stratified random sampling (i.e. each subset contains approximately the same percent of exceedances). The training subsets were then fed into multiple classification models including logistic regression (using all variables, and step-wise feature selection based on AIC), elastic net regression, random forest, gradient boosting, and support vector machine. Using the `caret` package, each type of model was optimized over its tuning parameters. The variable importance functions of each model were then used to identify which predictors were most common among the different types of models. In general, the step-wise logistic regression model to minimize AIC performed very well, and resulted in the set of strongest predictors at each site. Various combinations of these predictors were then fit to a standard logistic regression model using 10-fold cross validation repeated 3 times. The final model was then based on the set of predictors that performed best.

Following the guidance by Francy et al (2013), model acceptance was based on the following goals:

Accuracy > 0.80
Sensitivity > 0.5
Specificity > 0.85

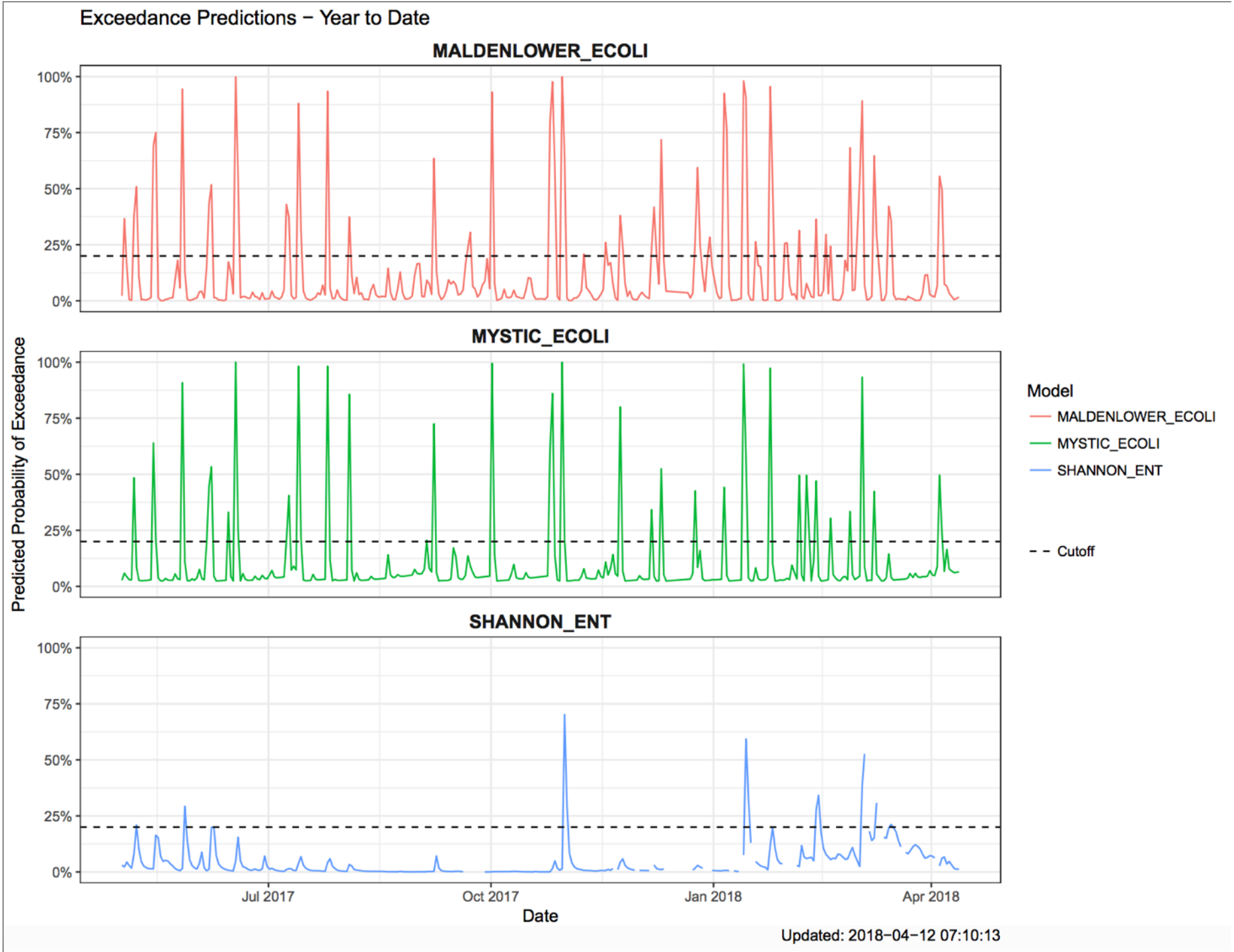
Predictor variables

The logistic regression model for the **Malden River** is based on 5 predictors:

- **precip_sum_p24hr_lag0hr**: total rainfall (inches) over 24 hours prior to sample timestamp
- **precip_sum_p24hr_lag24hr**: total rainfall (inches) between 24 and 48 hours prior to sample timestamp
- **hours_since_100in_precip_event**: number of hours since last 1.0 inch rainfall event
- **pressure_change_p72hr**: change in barometric pressure (inHg) from 72 hours prior to sample timestamp (when negative, indicates storms moving in)
- **temp_change_p72hr**: change in air temperature (degF) from 72 hours prior to sample timestamp

The logistic regression model for the **Upper Mystic Lake/ Shannon Beach** is based on 1 predictor:

aberjona_logflow_p1d: daily mean streamflow (log-10 transformed) at Aberjona River gauge (Station ID: 01102500) on the day before sample was collected


Exceedance Predictions − Year to Date
MALDENLOWER_ECOLI
MYSTIC_ECOLI
SHANNON_ENT
100%
75%
50%
25%
0%
Predicted Probability of Exceedance
Jul 2017
Oct 2017
Jan 2018
Apr 2018
Date
Model
MALDENLOWER_ECOLI
MYSTIC_ECOLI
SHANNON_ENT
Cutoff
Updated: 2018−04−12 07:10:13

What do the categories mean?

GOOD

Boating is probably safe! The chances that *E. coli* bacteria levels exceed state recreational standards are low, and there is no evidence of a cyanobacteria bloom.

ADVISORY

The chances that E. coli bacteria levels exceed state recreational standards are high, or there is evidence of a cyanobacteria bloom with concentrations exceeding state safety guidelines.

UNCERTAIN

There is no evidence of elevated bacteria levels, but screening values indicate a possible cyanobacteria bloom.

NOT AVAILABLE

Current predictions are not currently available due to missing data or other system error.

MYSTIC DAILY BOATING ADVISORY

HOW SAFE IS IT TO BOAT TODAY?

These estimates of water quality conditions are generated by an automated bacteria prediction model and by additional cyanobacteria testing during boating season. For more on what the estimates mean and how they are arrived at, see the questions below.

Mystic River

MYSTIC VALLEY PARKWAY (RT 16)

Status: Good

Low probability of elevated bacteria levels.

Malden River

REVERE BEACH PARKWAY (RT 16)

Status: Good

Low probability of elevated bacteria levels.

Upper Mystic Lake

SHANNON BEACH

Status: Good

Low probability of elevated bacteria levels.

Saturday, March 3, 2018

MYSTIC DAILY BOATING ADVISORY

ATTENTION: WINTER IS HERE! THE DAILY BOATING ADVISORY SYSTEM WILL BE *OFFLINE* DURING THE WINTER MONTHS. WE WILL BACK UP AND RUNNING IN MAY 2018, SEE YOU THEN!

HOW SAFE IS IT TO BOAT TODAY?

These estimates of water quality conditions are generated by an automated bacteria prediction model and by additional cyanobacteria testing during boating season. For more on what the estimates mean and how they are arrived at, see the questions below.

Mystic River

MYSTIC VALLEY PARKWAY (RT 16)

Status: Advisory

High probability of elevated bacteria levels.

Malden River

REVERE BEACH PARKWAY (RT 16)

Status: Advisory

High probability of elevated bacteria levels.

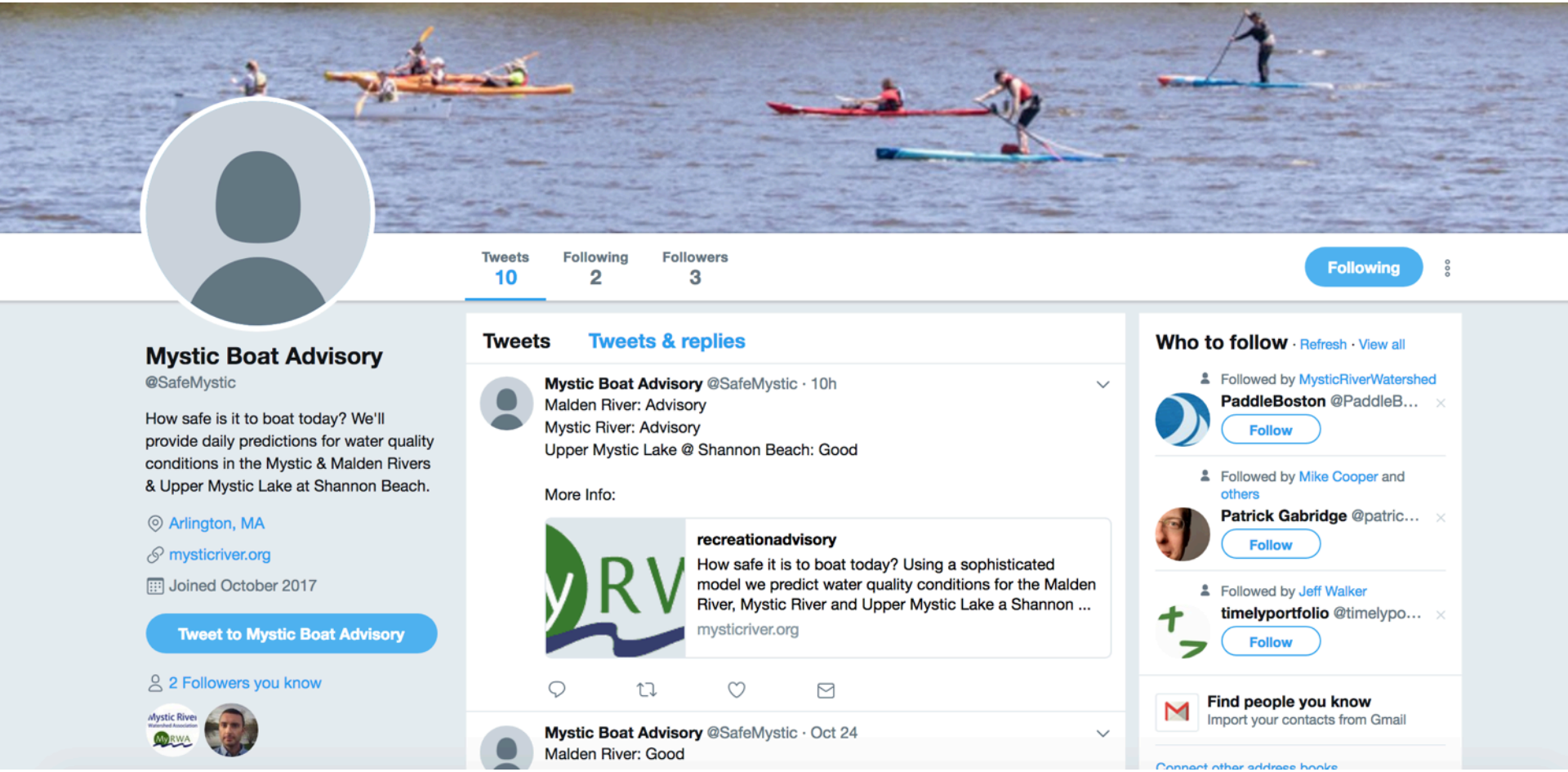
Upper Mystic Lake

SHANNON BEACH

Status: Advisory

High probability of elevated bacteria levels.

Twitter feed



Electronic Signage

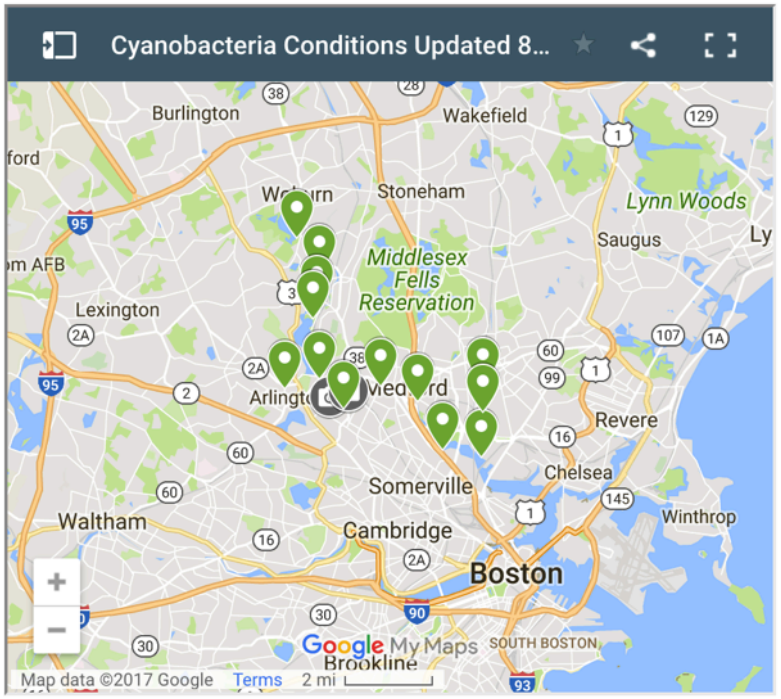

SLOW
I HAVE NO WAKE
NO TRESPASSING

MyRWA Cyanobacteria reporting 2017

CURRENT CONDITIONS - UPDATED 8/15/17

On August 15th, MyRWA staff collected samples at 6 locations along the Mystic River to test for phyocyanin, the photocynthetic compound indicative of cyanobacteria blooms. The results of the tests showed that none of the sites have any indication of a cyanobacteria bloom.

Recent testing by the Massachusetts Department of Public Health (DPH) on July 26th confirmed that there are no longer cyanobacteria cell counts above state thresholds in the Mystic River near Blessing of the Bay in Somerville and in Upper Mystic Lake. Shannon Beach on Upper Mystic Lake is now open and both of these sites now have had their cyanobacteria advisories rescinded. See the DPH website for more information.



Site	6/30/2017	7/5/2017	7/11/2017	7/18/2017	7/21/2017	8/1/2017	8/15/2017
Horn Pond							
Wedge Pond							
Upper Mystic Forebay							
Upper Mystic Lake							
Mystic River Upstream							
Mystic River Somerville							
Malden River							

Legend	
	No signs of cyanobacteria bloom
	Unconfirmed signs of cyanobacteria bloom
	Confirmed cyanobacteria bloom by DPH
	No sample collected

Results are based on MyRWA testing and do not reflect DPH advisories. See above for more information.