

# What Is Water Quality Like *TODAY?*

## MyRWA's New Daily Boating Advisory System

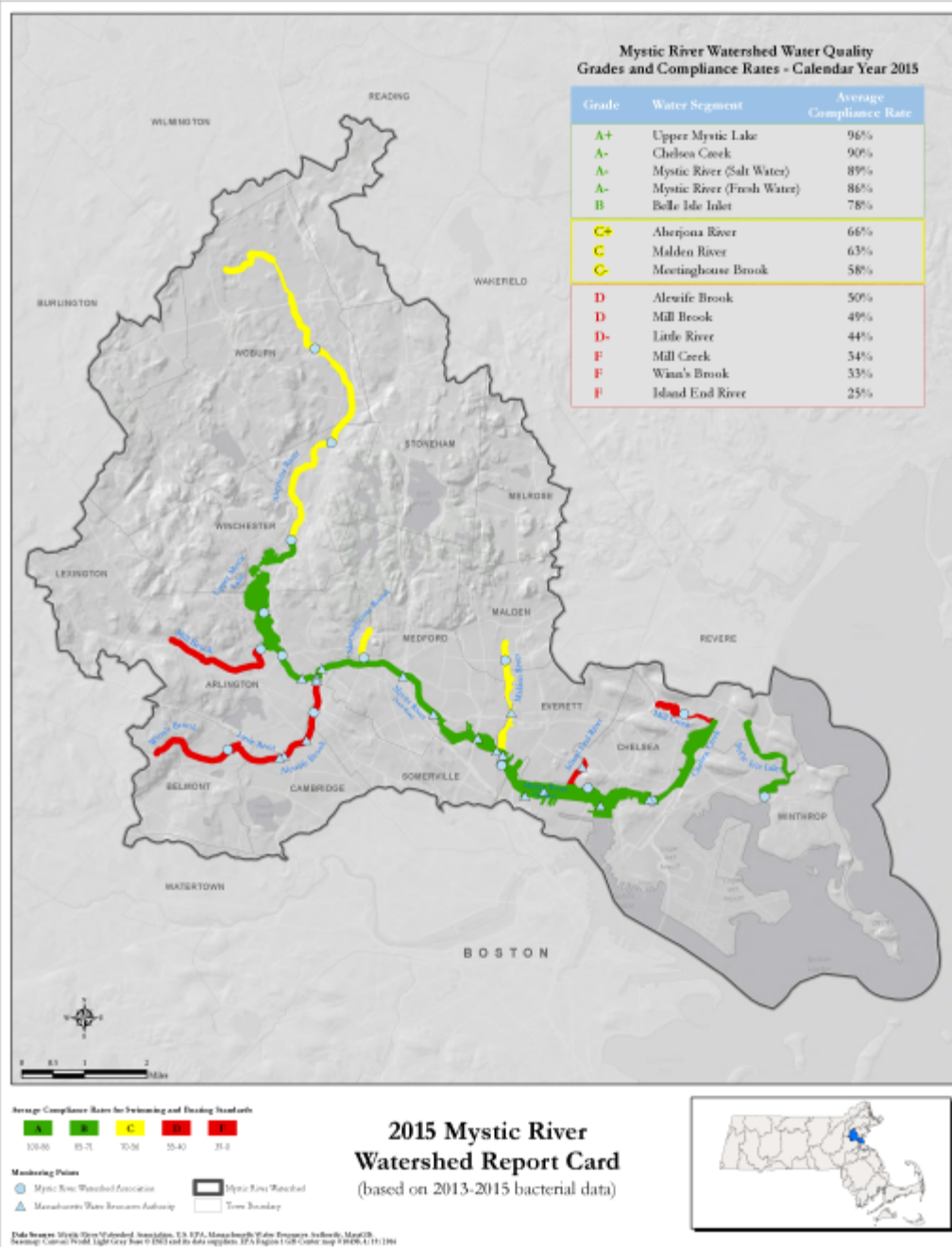
Andy Hrycyna  
Mystic Steering Committee  
April 14, 2018

Mystic River Watershed Water Quality  
Grades and Compliance Rates - Calendar Year 2015

Grade	Water Segment	Average Compliance Rate
A+	Upper Mystic Lake	96%
A-	Chelsea Creek	90%
A-	Mystic River (Salt Water)	89%
A-	Mystic River (Fresh Water)	86%
B	Belle Isle Inlet	78%
C+	Aberjona River	66%
C	Malden River	63%
C-	Meetinghouse Brook	58%
D	Alexis Brook	50%
D	Mill Brook	49%
D-	Little River	44%
F	Mill Creek	34%
F	Winn's Brook	33%
F	Island End River	25%

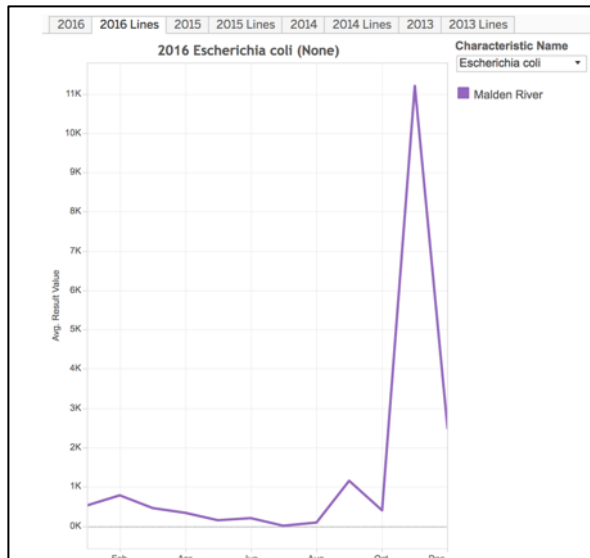
## EPA water quality report card

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

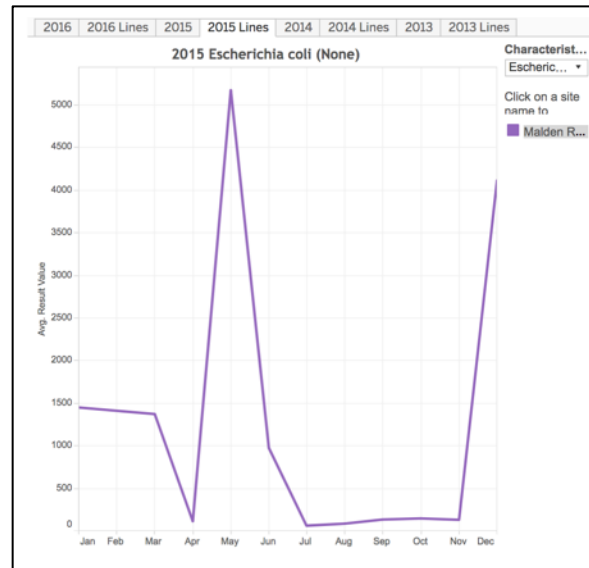


# Challenge: Variability of data

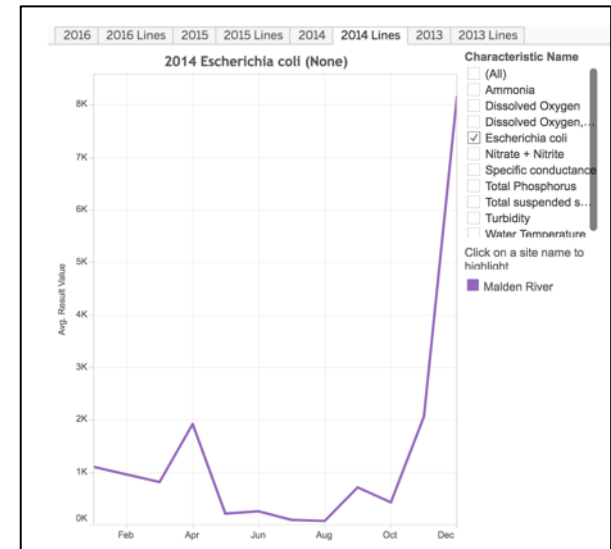
2016



2015

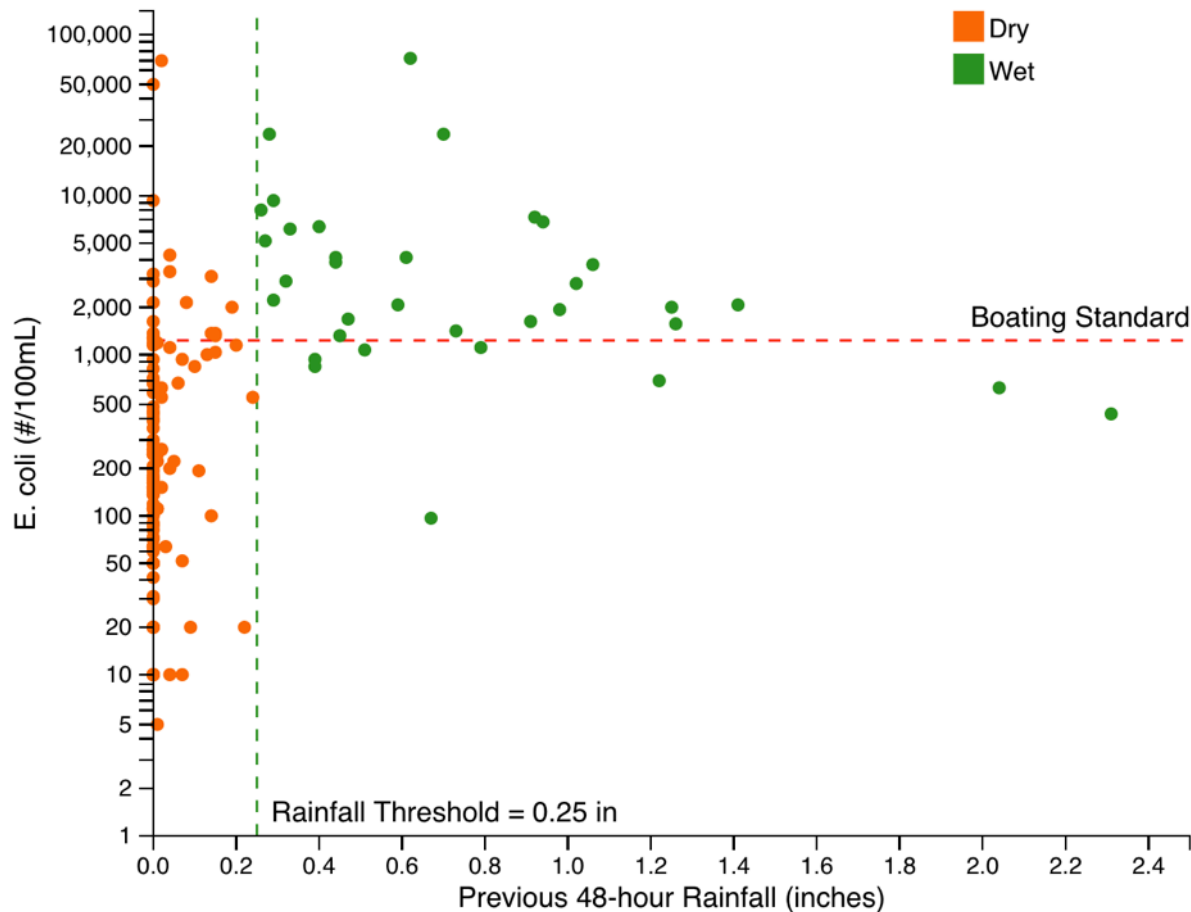


2014

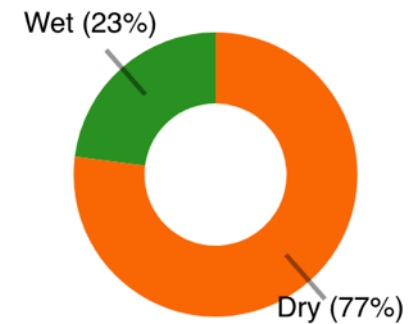


# Relationship between *E. coli* levels and antecedent rainfall: Malden River

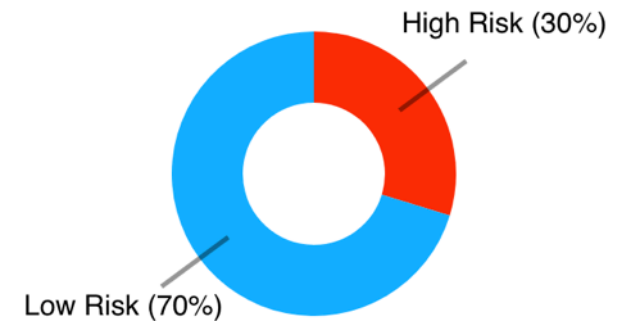
***E. coli* Samples vs. Previous 48-hour Rainfall**



**% of Samples with Dry/Wet Weather**

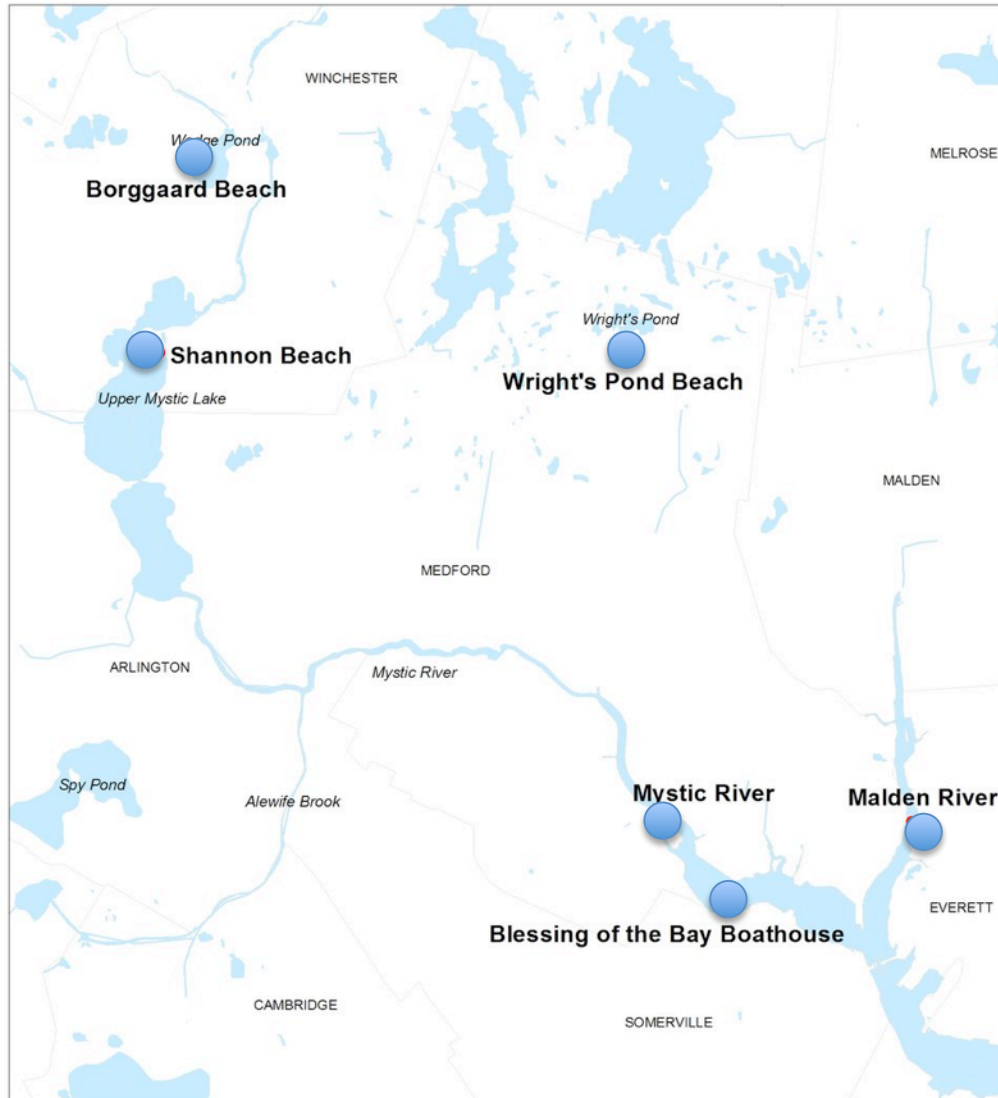


**% of Samples by Public Health Risk**





## Mystic Recreational Flagging Program



• Sampling locations



0 0.5 1 2 Miles



June 2015

Funded by:



MASSACHUSETTS  
ENVIRONMENTAL  
TRUST

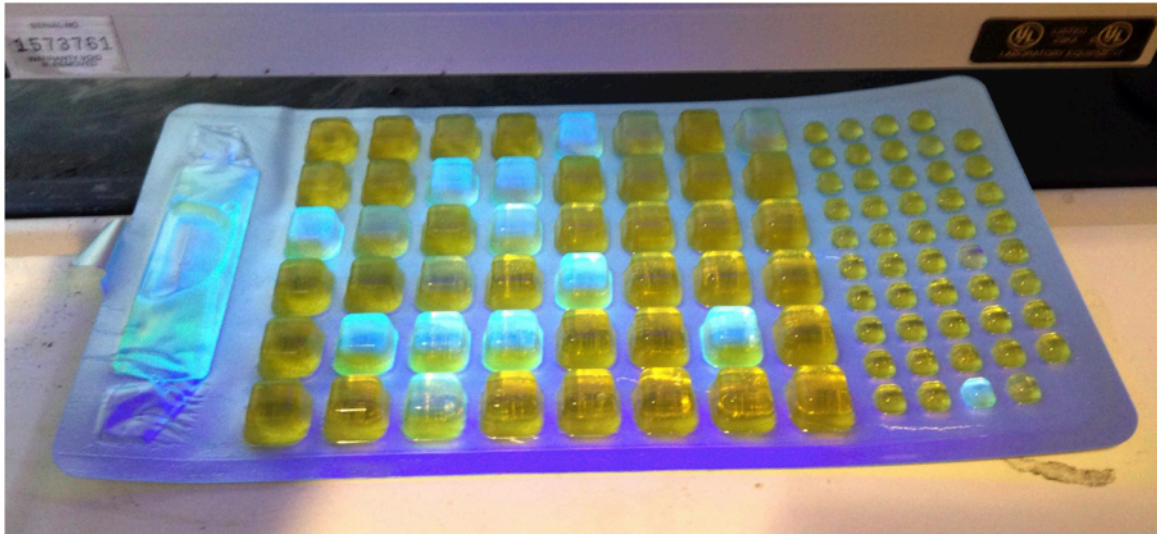


#### SAMPLING RESULTS

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.

## 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



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.

# Data August 2016

## Measured *E. Coli* Levels

Station	Date							
	August 25, 2016	August 24, 2016	August 23, 2016	August 22, 2016	August 17, 2016	August 16, 2016	August 15, 2016	August 9, 2016
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	Date							
	August 25, 2016	August 24, 2016	August 23, 2016	August 22, 2016	August 17, 2016	August 16, 2016	August 15, 2016	August 9, 2016
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

## 1 Overview

### 1.1 Methodology

### 1.2 Performance Metrics

## 2 Mystic River at Rt 16 Bridge (E. coli)

### 2.1 Dataset

### 2.2 Prediction Model

### 2.3 ROC Curves

### 2.4 Cutoff Optimization

### 2.5 Confusion Matrix

### 2.6 Cross-Validation

## 3 Lower Malden River at Rt 16 Bridge (E. coli)

### 3.1 Dataset

### 3.2 Prediction Model

### 3.3 ROC Curves

### 3.4 Cutoff Optimization

### 3.5 Confusion Matrix

### 3.6 Cross-Validation

## 4 Shannon Beach at Upper Mystic

# 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:

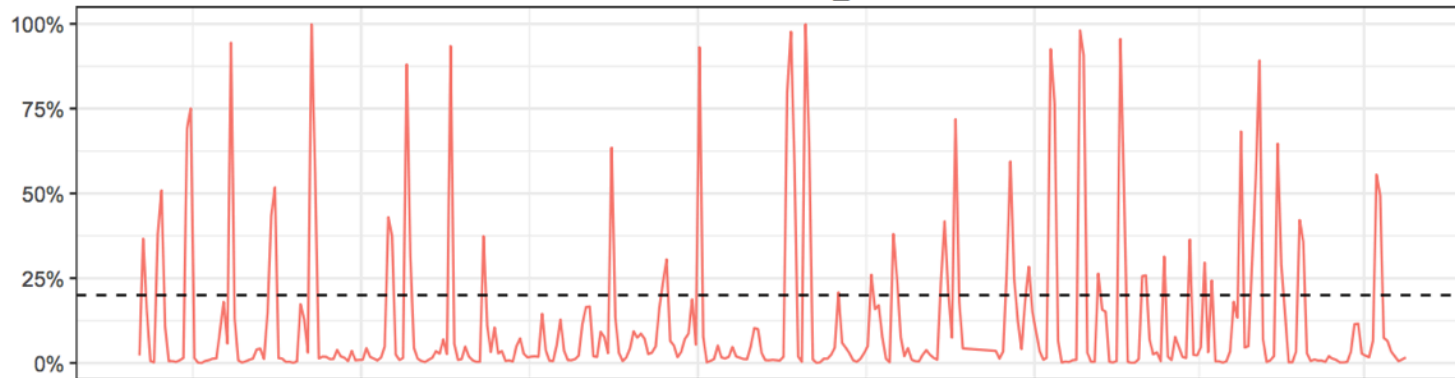
- **precip\_sum\_p24hr\_lag0hr**: total rainfall (inches) over 24 hours prior to sample timestamp
- **precip\_sum\_p24hr\_lag24hr**: total rainfall (inches) between 24 and 48 hours prior to sample timestamp
- **hours\_since\_100in\_precip\_event**: number of hours since last 1.0 inch rainfall event
- **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:

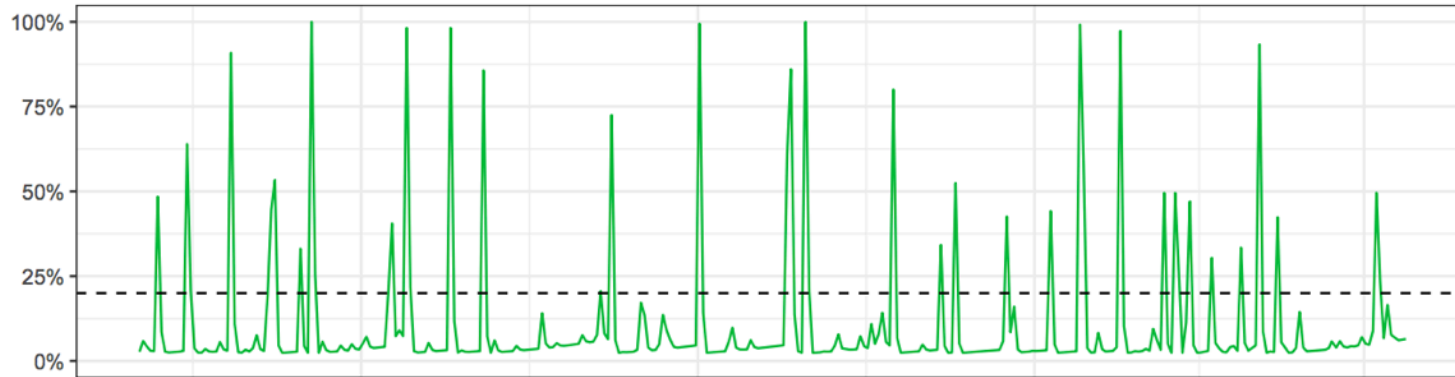
**aberjona\_logflow\_p1d**: daily mean streamflow (log-10 transformed) at Aberjona River gauge (Station ID: 01102500) on the day before sample was collected

# Exceedance Predictions – Year to Date

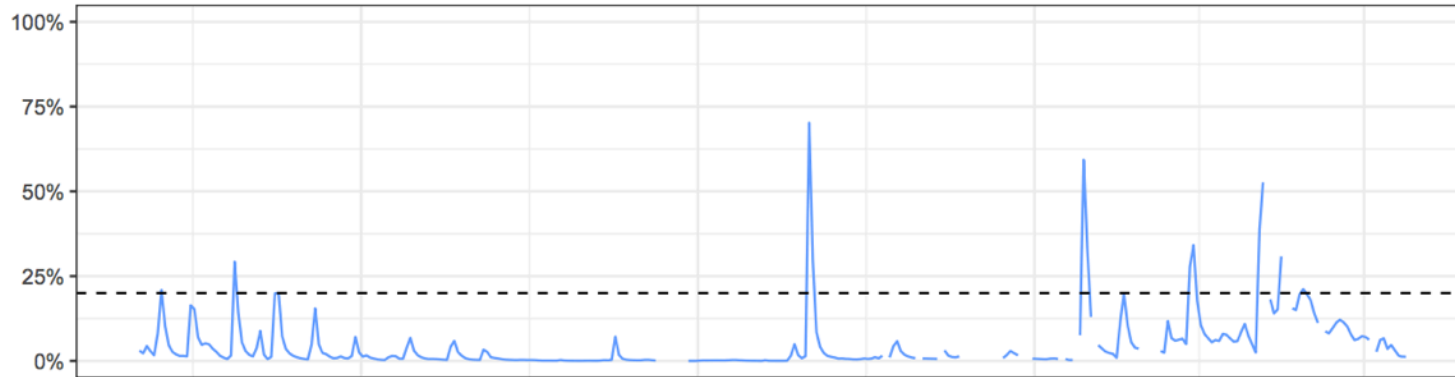
## MALDENLOWER\_ECOLI



## MYSTIC\_ECOLI



## SHANNON\_ENT



### Model

- MALDENLOWER\_ECOLI
- MYSTIC\_ECOLI
- SHANNON\_ENT

-- Cutoff

Predicted Probability of Exceedance

Date

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



## Mystic Boat Advisory

@SafeMystic

How safe is it to boat today? We'll provide daily predictions for water quality conditions in the Mystic & Malden Rivers & Upper Mystic Lake at Shannon Beach.

📍 Arlington, MA

🌐 [mysticriver.org](http://mysticriver.org)

📅 Joined October 2017

[Tweet to Mystic Boat Advisory](#)

👤 2 Followers you know



Tweets  
**10**

Following  
**2**

Followers  
**3**

Following

### Tweets Tweets & replies



**Mystic Boat Advisory** @SafeMystic · 10h

Malden River: Advisory  
Mystic River: Advisory  
Upper Mystic Lake @ Shannon Beach: Good

More Info:



#### recreationadvisory

How safe it is to boat today? Using a sophisticated model we predict water quality conditions for the Malden River, Mystic River and Upper Mystic Lake a Shannon ...  
[mysticriver.org](http://mysticriver.org)



**Mystic Boat Advisory** @SafeMystic · Oct 24

Malden River: Good

### Who to follow · Refresh · View all

👤 Followed by [MysticRiverWatershed](#)  
**PaddleBoston** @PaddleB... ×  
[Follow](#)

👤 Followed by [Mike Cooper](#) and others  
**Patrick Gabridge** @patric... ×  
[Follow](#)

👤 Followed by [Jeff Walker](#)  
**timelyportfolio** @timelypo... ×  
[Follow](#)

✉ **Find people you know**  
Import your contacts from Gmail

[Connect other address books](#)



# Electronic Signage

## TODAY'S WATER QUALITY CONDITIONS

**Mystic River: Advisory**

**Malden River: Advisory**

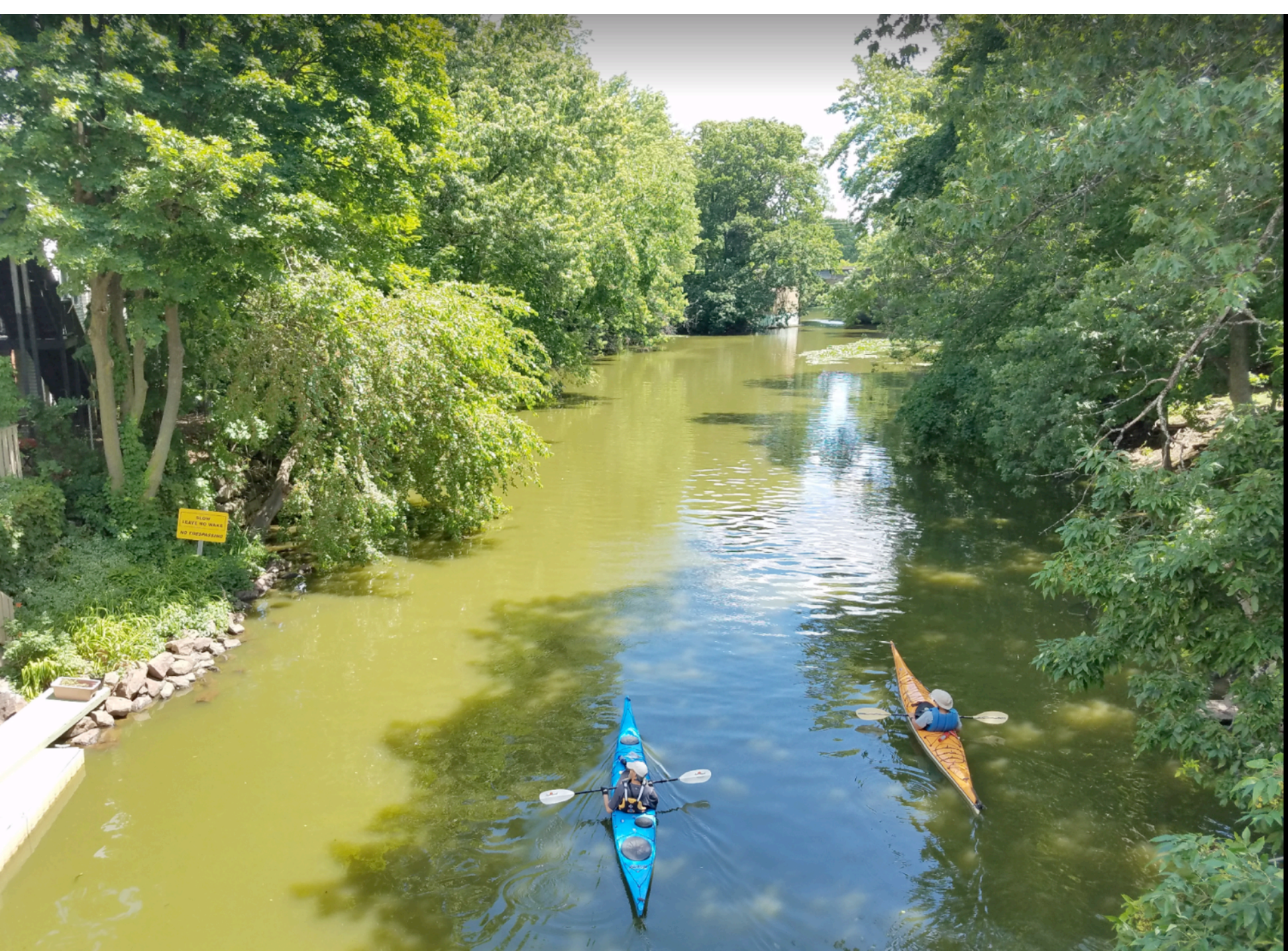
**Shannon Beach: Good**

*Updated: Oct 25 2017 6:00 am EDT*

**Mystic River Watershed Association**  
<https://mysticriver.org/recreationadvisory>  
Twitter: @SafeMystic







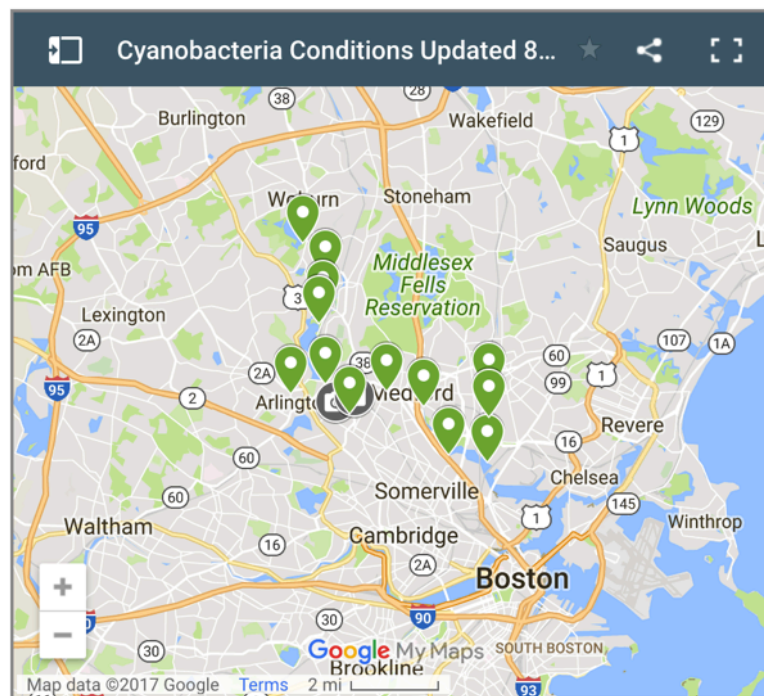


# MyRWA Cyanobacteria reporting 2017

## 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	Green	Green	Green	Green	Green	Green	Green
Wedge Pond	Green	Green	Green	Green	Green	Green	Green
Upper Mystic Forebay	Green	Green	Green	Green	Green	Green	Green
Upper Mystic Lake	Yellow	Red	Red	Green	Green	Green	Green
Mystic River Upstream	Yellow	Yellow	Green	Green	Green	Green	Green
Mystic River Somerville	Red	Red	Red	Green	Green	Green	Green
Malden River	Green	Green	Green	Yellow	White	Green	Green

Legend	
Green	No signs of cyanobacteria bloom
Yellow	Unconfirmed signs of cyanobacteria bloom
Red	Confirmed cyanobacteria bloom by DPH
White	No sample collected

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