

PWD Delaware Estuary Observed Dissolved Oxygen Analysis

DRBC Water Quality Advisory Committee, 5/14/2019



PHILADELPHIA
WATER
— DEPARTMENT —



OVERVIEW

1. Background
2. Preliminary Dissolved Oxygen Analysis
3. PWD DO Partnership

Background – DRBC Water Quality Issues

- DRBC Designated Use Review in Zones 3 to 5
 - Evaluate DO and fish “maintenance” vs. fish “propagation”
- Endangered Atlantic sturgeon may be species of concern for DO
- Ammonia Toxicity Criteria
 - 2013 EPA recommended update based on sensitivity of freshwater mussels



Water Quality Overview – Ammonia & DO

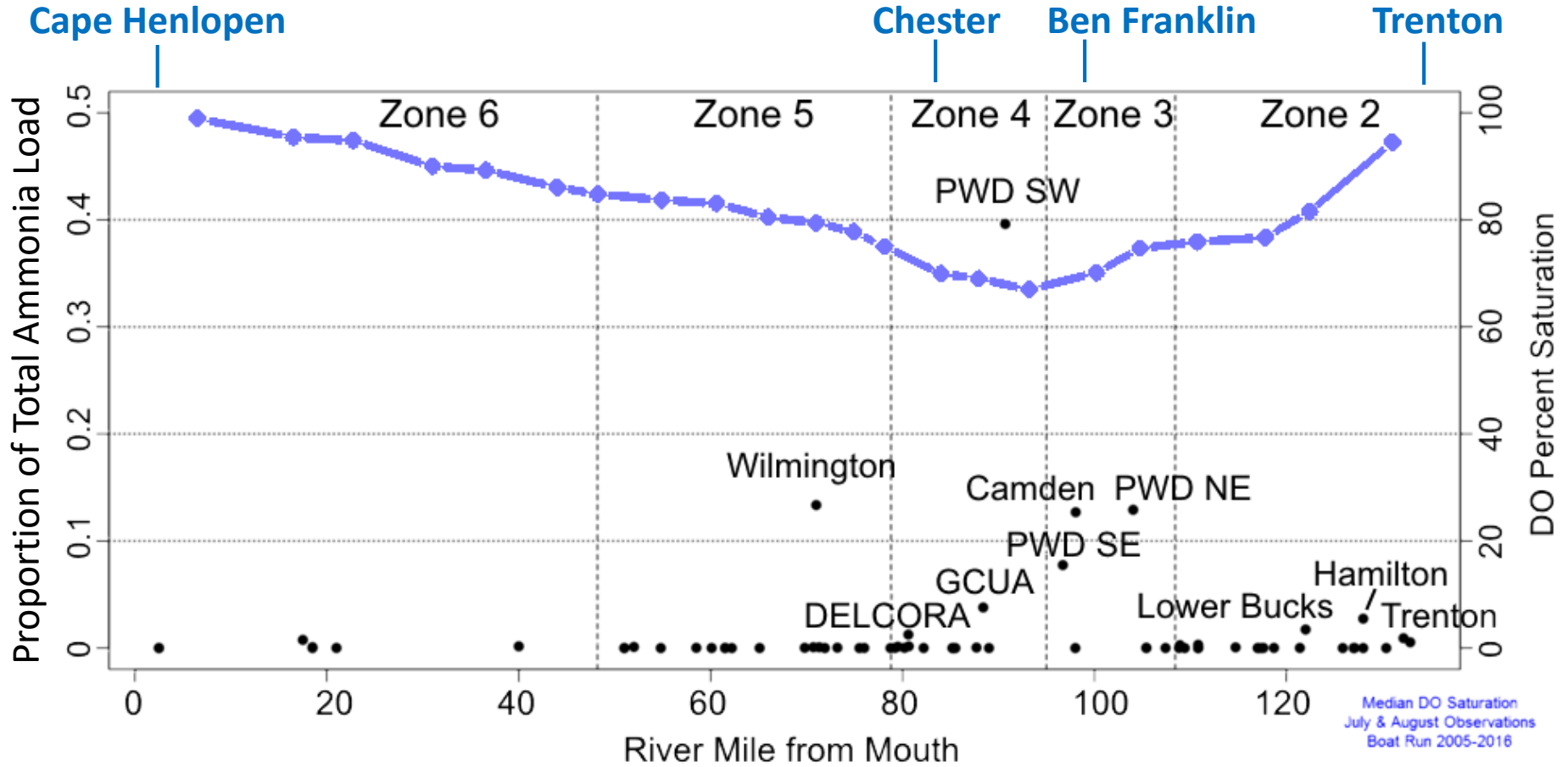
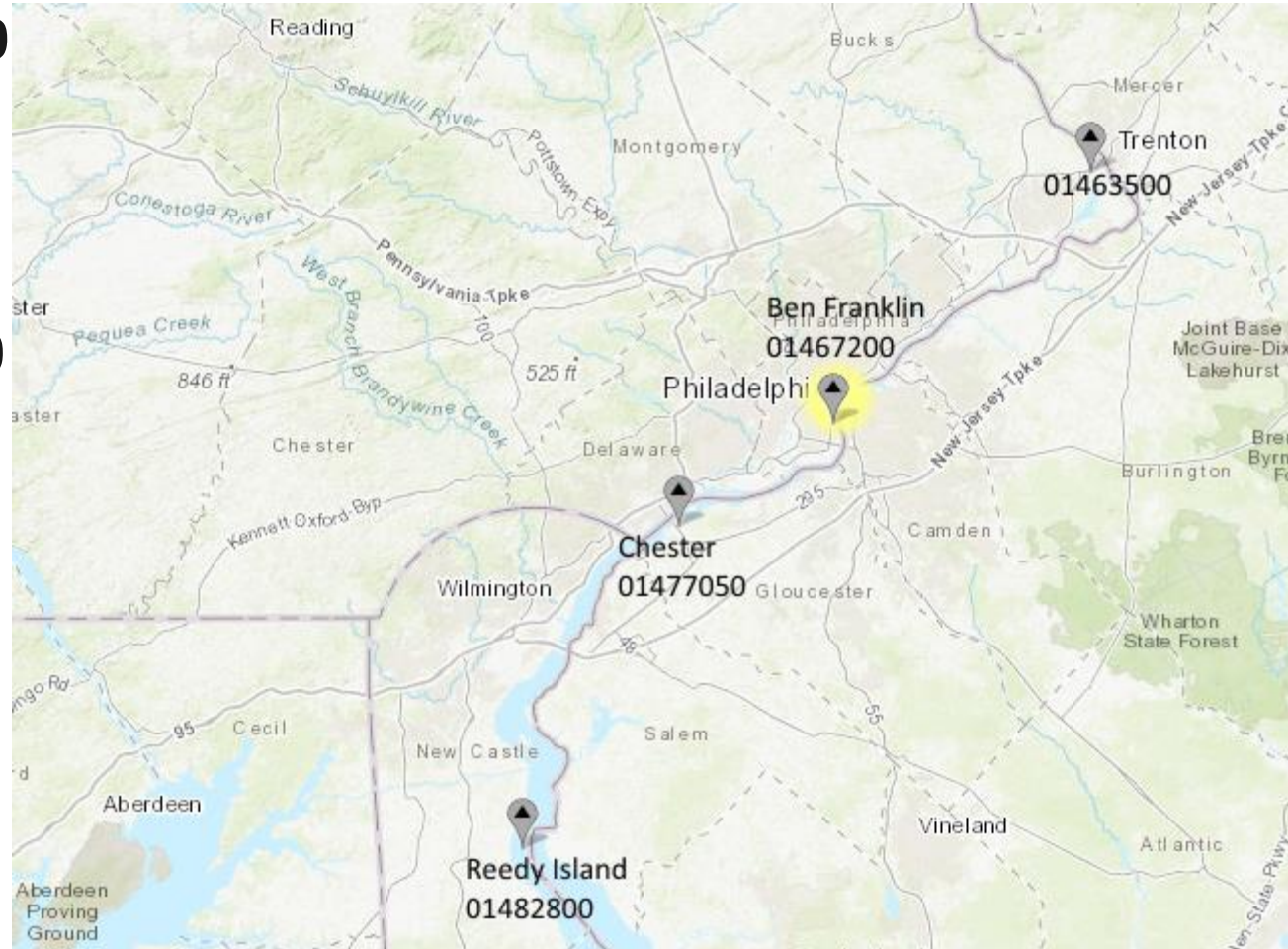


FIGURE MODIFIED FROM DRBC

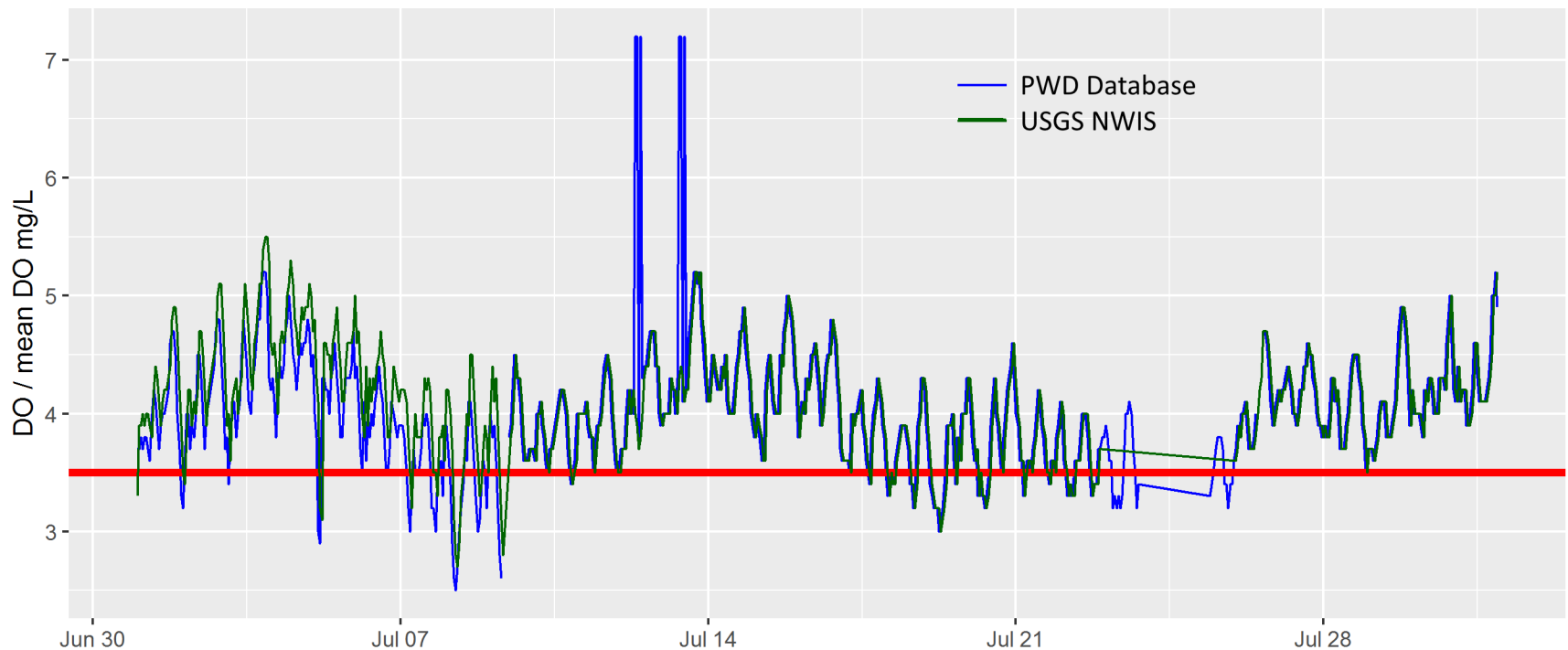
USGS DO Monitors Analyzed

- **Trenton 01463500**
- **Ben Franklin Br 01467200**
- **Chester 01477050**
- **Reedy Island 01482800**
- **2000 - 2018 data analyzed (when available)**
- **“Provisional” vs. “Approved” data**



USGS DO Data Review & Approval

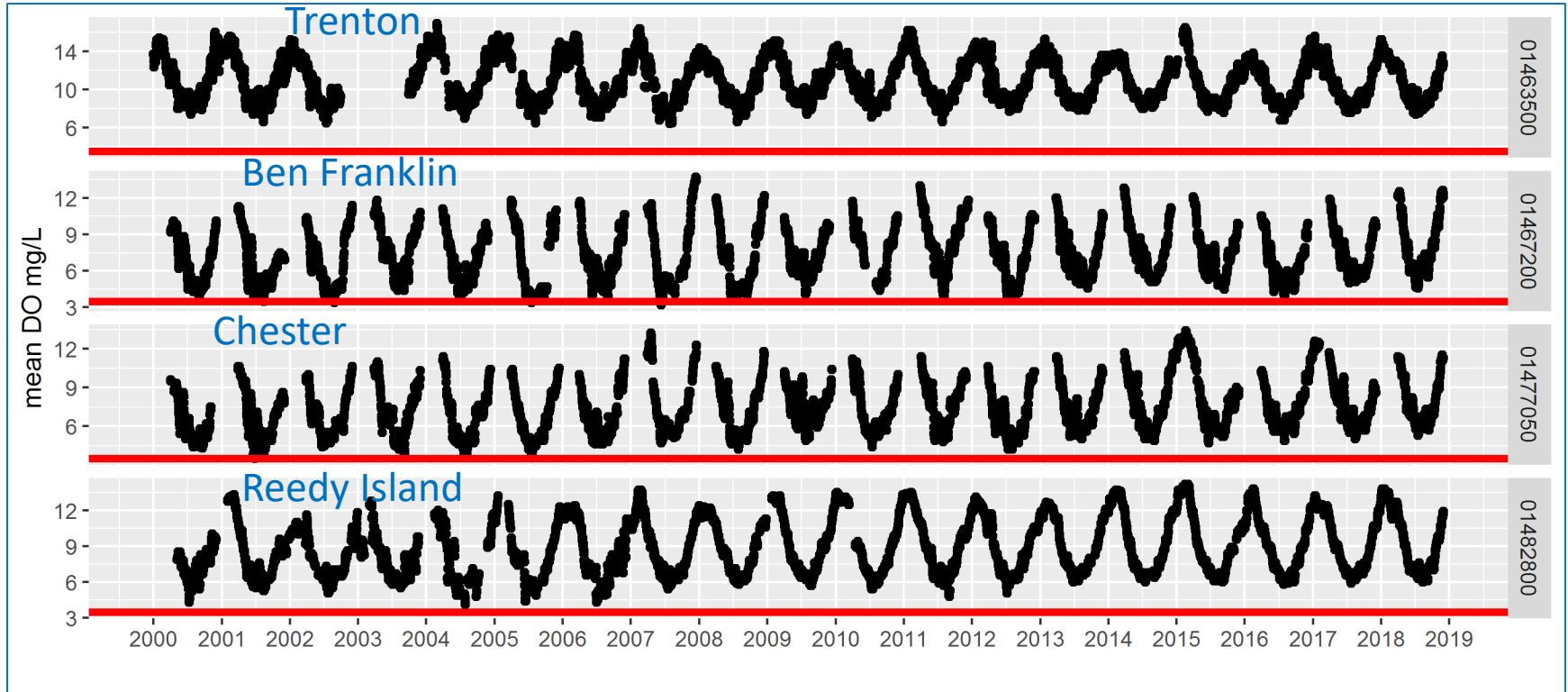
- Corrections and removal of erroneous data points are common
- Re-download data and check against approved data



Water Quality Overview - DO

DRBC Standard (3.5 mg/L daily avg.) usually met in Zones 3 & 4

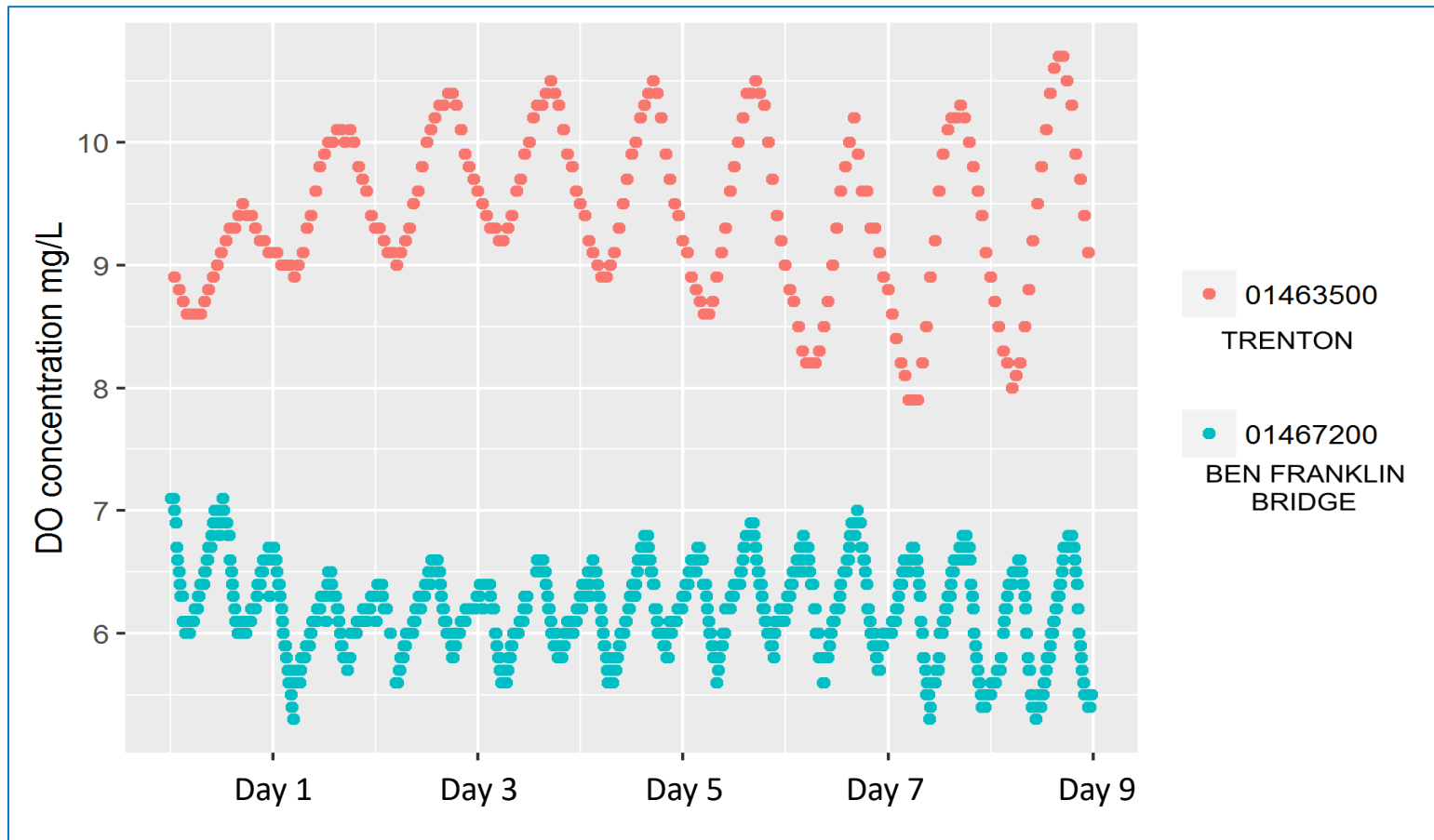
- Large summer DO variability, likely due to flow & temperature
- Seasonal and intra-daily variability



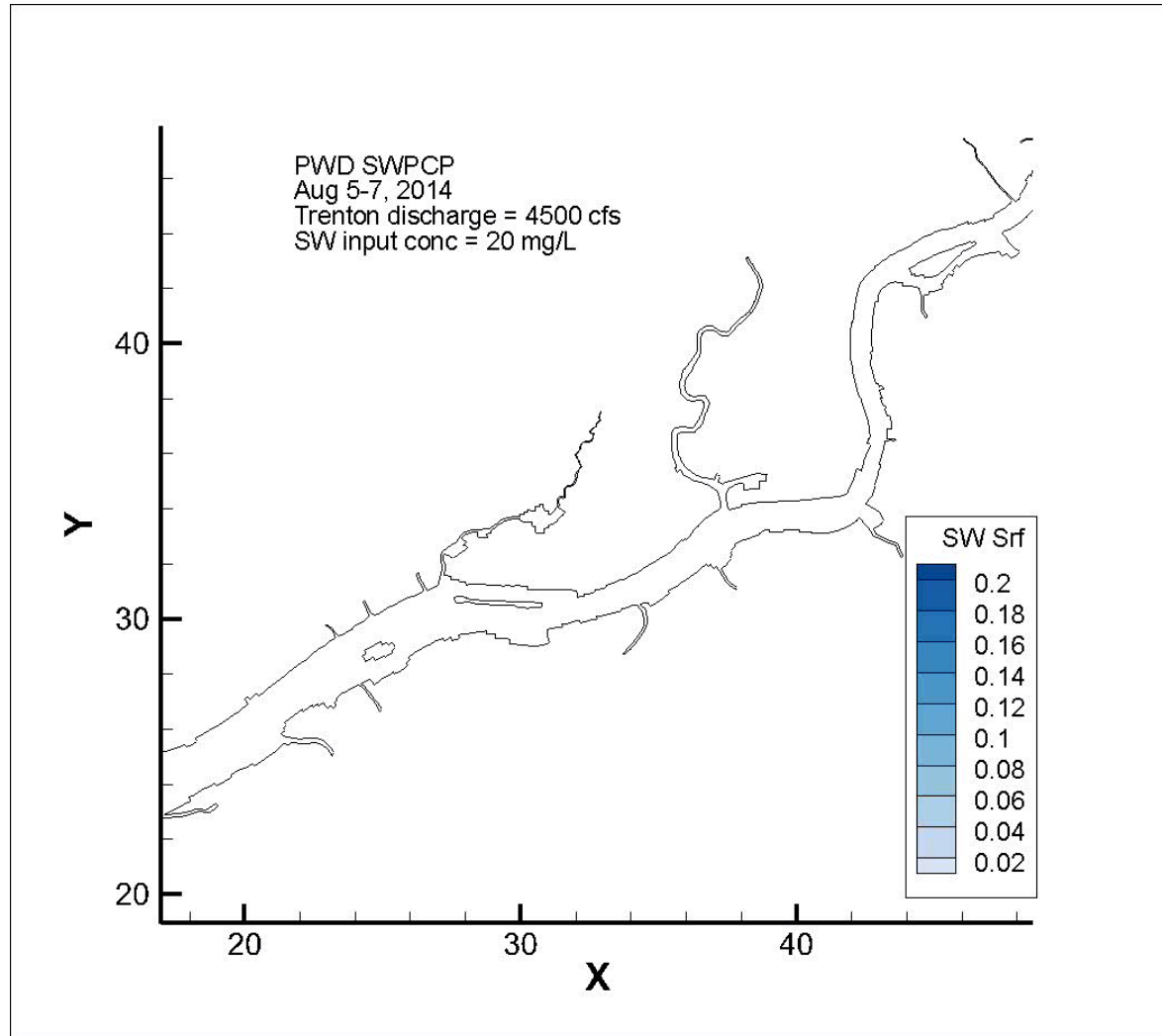
Water Quality Overview

Delaware River DO Fluctuations

DO Fluctuation “Heartbeat” at Tidal Frequency, not Daily



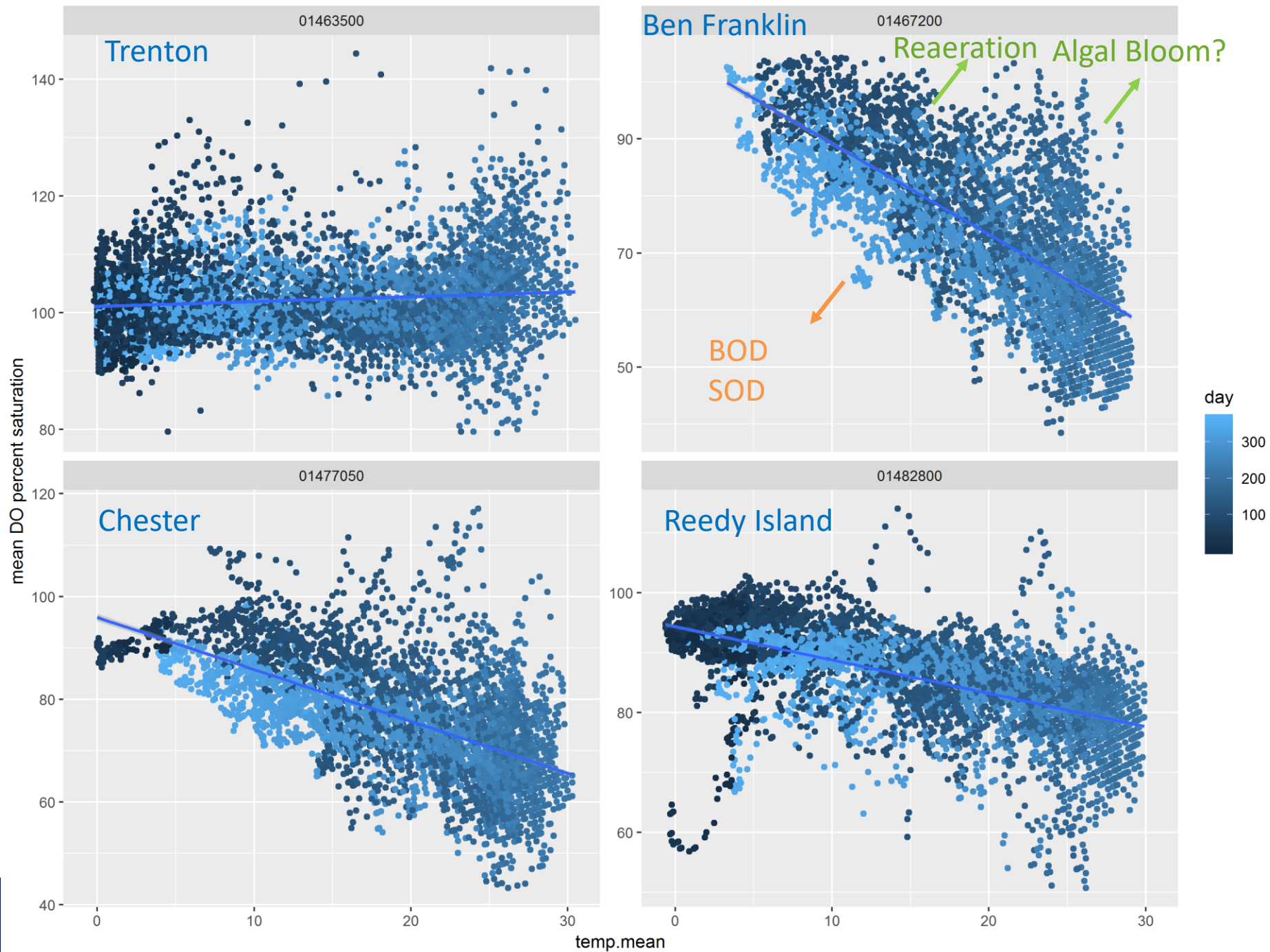
Delaware River Dye Simulation



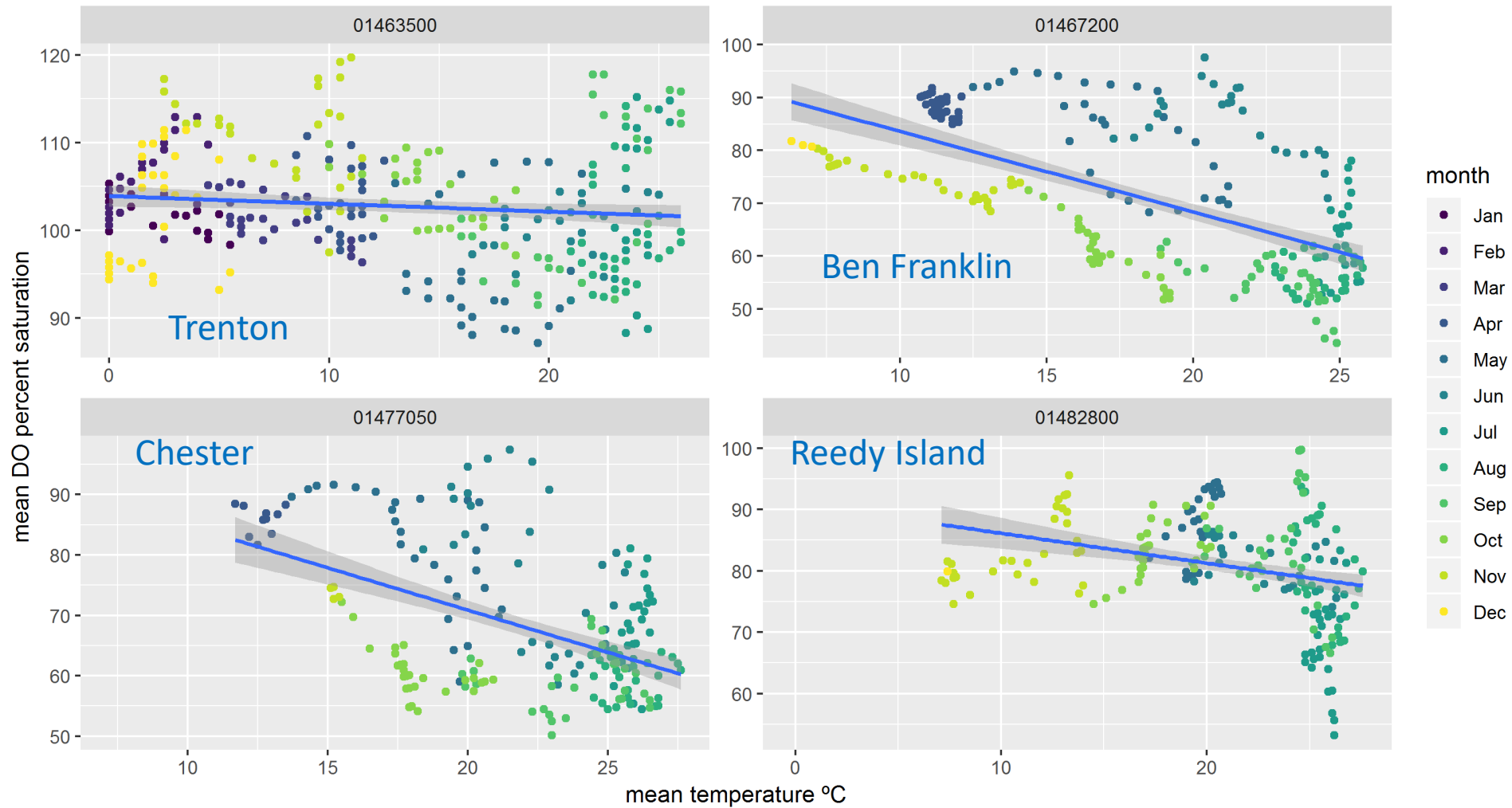
Delaware Estuary Existing Criteria Attainment

Year	01463500 min.	1463500 mean	1467200	1477050	1482800
2000	100	100	100	100	90.4
2001	100	100	100	100	93.2
2002	100	100	99.7	100	92.6
2003	100	100	100	100	93.2
2004	100	100	100	100	90.7
2005	100	100	99.7	100	86.8
2006	100	100	100	100	83.3
2007	100	100	98.6	100	96.2
2008	100	100	100	100	97.8
2009	100	100	100	100	97.3
2010	100	100	100	100	94.5
2011	100	100	100	100	96.2
2012	100	100	100	100	96.4
2013	100	100	100	100	100
2014	100	100	100	100	100
2015	100	100	100	100	100
2016	100	100	100	100	98.4
2017	100	100	100	100	99.5
2018	100	100	100	100	100

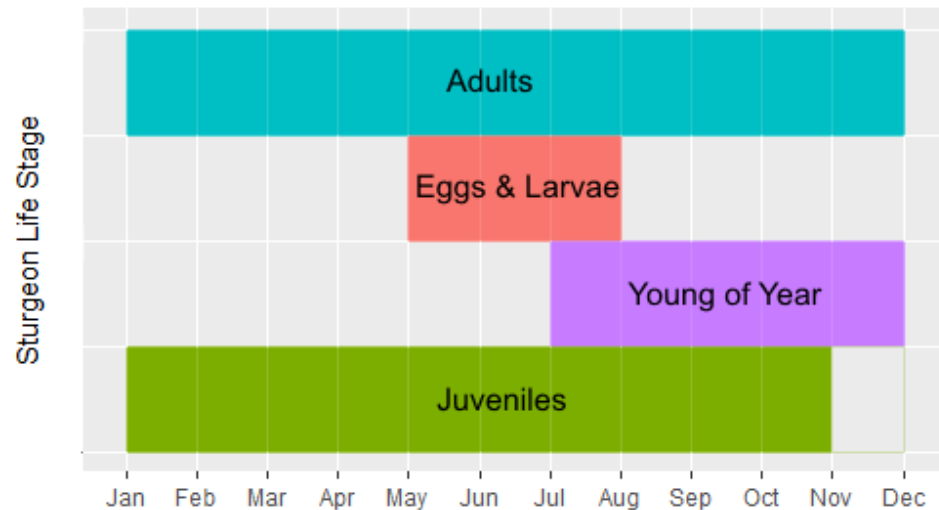
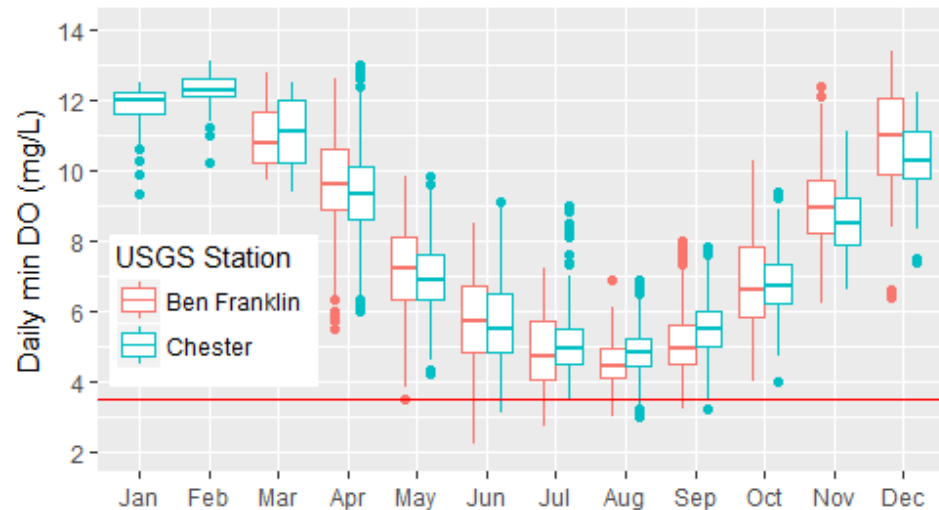
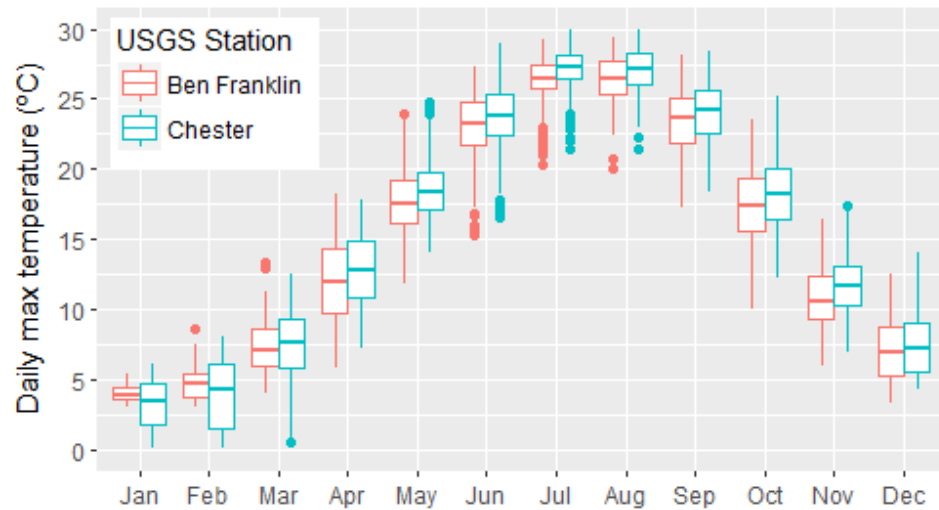
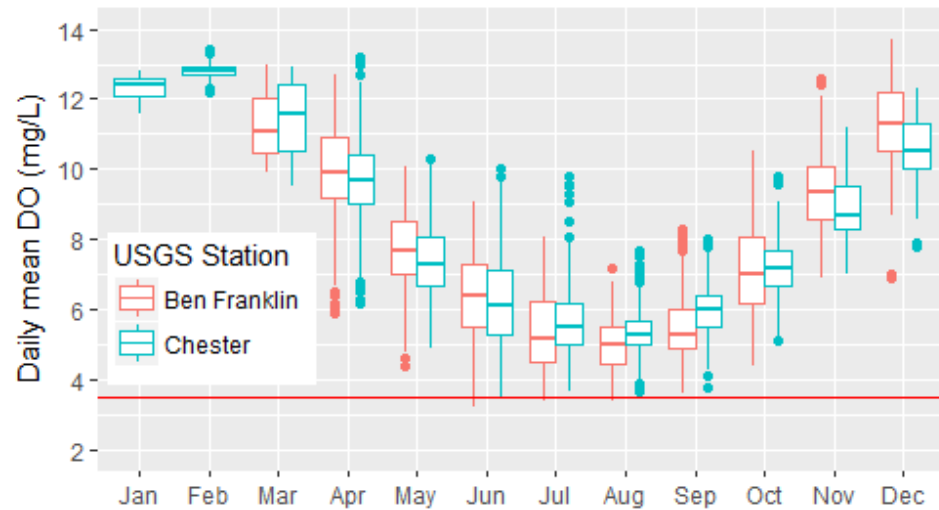
Mean DO Percent Saturation vs. Mean Temperature 2000-2018



Mean DO Percent Saturation vs. Mean Temperature 2000



DO, Temperature and Atlantic Sturgeon



Evaluation of Alternative DO Criteria

Alternative DO criteria evaluated for observed data

Small number of years strongly influence interpretation of attainment of alternative criteria (2002, 2005, 2008, 2012)

Also investigated attainment with DO subsidy (adding DO incrementally). **NOTE: DO subsidy not intended to reflect any specific real-world scenario, project, etc.**

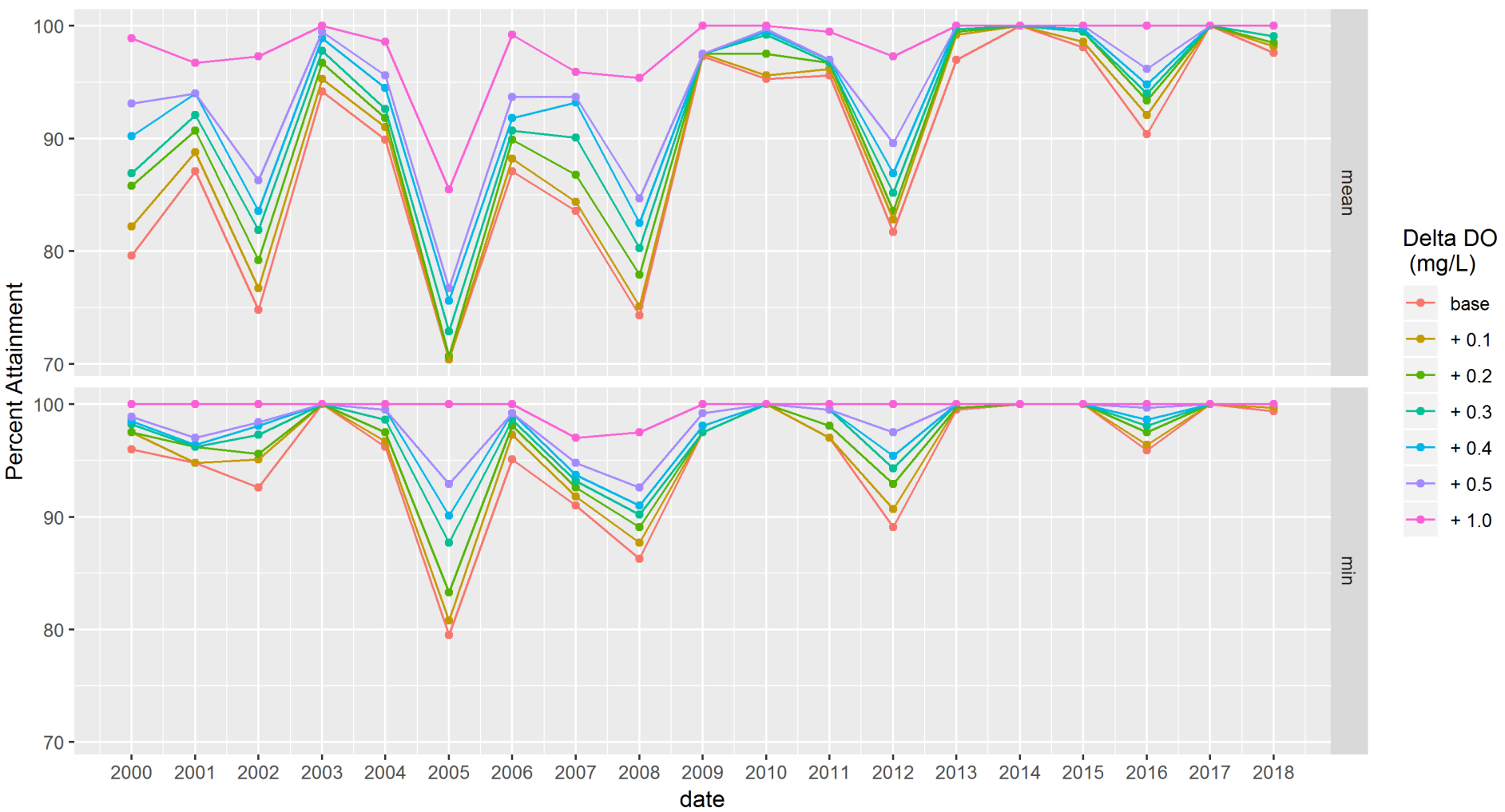
Scenario	Ben Franklin Br.		Chester	
	Min	Mean	Min	Mean
DEL USA	4	NA	5	NA
Alt1	3	4	3	4
Alt2	3.5	4.5	3.5	4.5
Alt3	4*	5	4	5
Alt4	NA	NA	4.5	5.5
Alt5	NA	NA	5*	6
Alt6	NA	6	NA	6*

Ben Franklin Alternative Criteria Attainment

year	min > 3	min > 3.5	min > 4	mean > 4	mean > 4.5	mean > 5	mean > 6
2000	100	98.9	96	98.9	93.1	79.6	64
2001	100	97	94.8	96.7	94	87.1	66.8
2002	100	98.4	92.6	97.3	86.3	74.8	67.1
2003	100	100	100	100	99.5	94.2	84.1
2004	100	99.5	96.2	98.6	95.6	89.9	76.2
2005	100	92.9	79.5	85.5	76.7	70.4	66
2006	100	99.2	95.1	99.2	93.7	87.1	78.1
2007	97	94.8	91	95.9	93.7	83.6	69
2008	97.5	92.6	86.3	95.4	84.7	74.3	68.3
2009	100	99.2	97.5	100	97.5	97.3	87.1
2010	100	100	100	100	99.7	95.3	84.7
2011	100	99.5	97	99.5	97	95.6	90.1
2012	100	97.5	89.1	97.3	89.6	81.7	77.3
2013	100	100	99.5	100	100	97	77.3
2014	100	100	100	100	100	100	83.3
2015	100	100	100	100	100	98.1	81.1
2016	100	99.7	95.9	100	96.2	90.4	71.3
2017	100	100	100	100	100	100	79.2
2018	100	100	99.4	100	100	97.6	89.3

Ben Franklin Alternative 3 (min 4mg/L, mean 5mg/L) Criteria Attainment

USGS Station 01467200 Ben Franklin Bridge Percent Attainment of Alternative DO criteria with DO increase



PWD's Early Action Strategy

- ▶ PWD Effluent Ammonia Reduction
- ▶ Dissolved Oxygen (DO) Partnership