The Grand Experiment

Effect of Nitrogen Load Reductions on Water Quality in the Upper Piscataqua River

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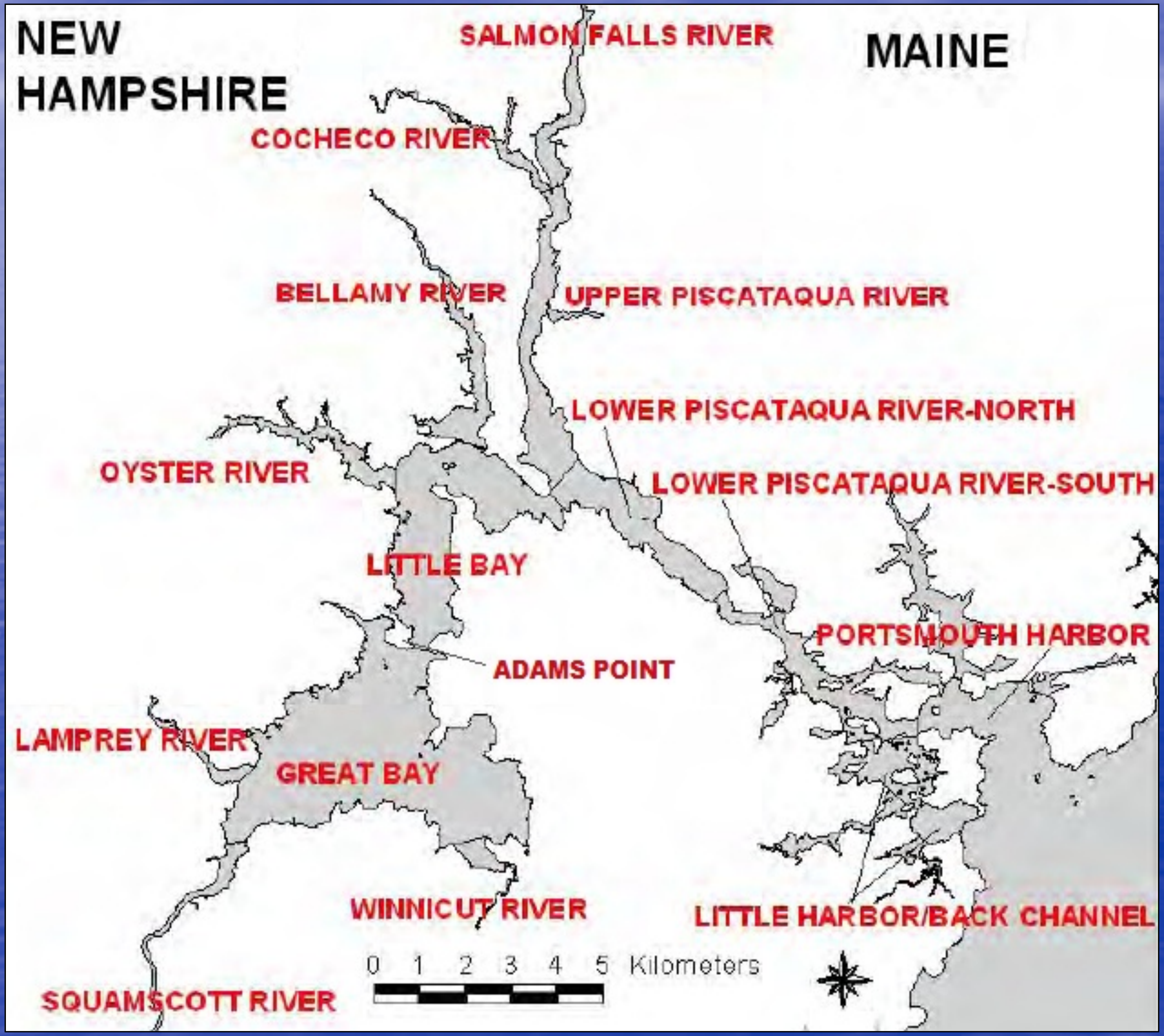
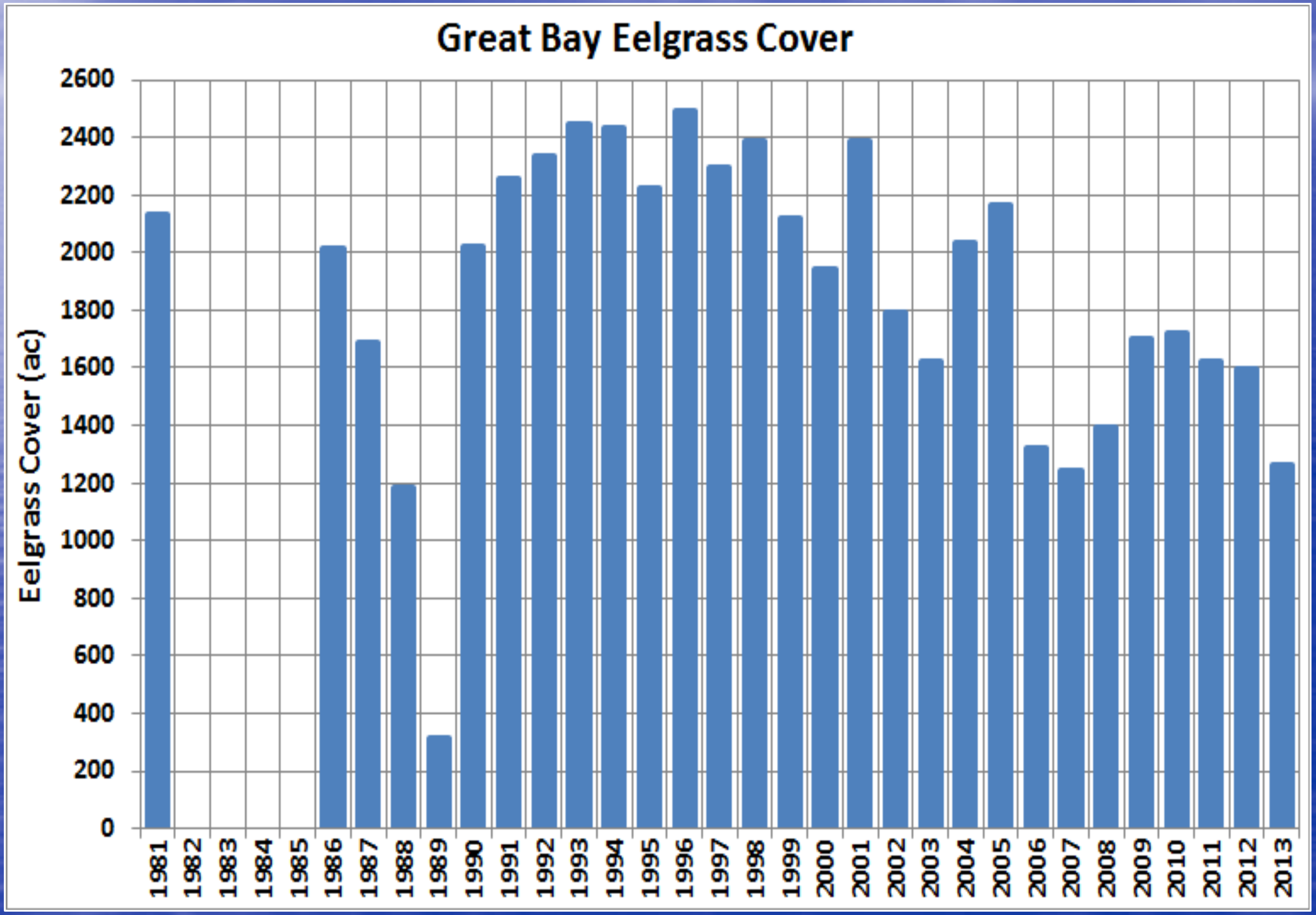
What Are the Issues?

- Great Bay Estuary – EPA Estuary of National Significance
- Eelgrass Beds Appear to be in Decline
- Nutrients Implicated as Cause of Eelgrass Decline
- NNC Developed – target TN as cause of reduced light transmission affecting Eelgrass and D.O. criteria violations
- NNC Challenged as Not Scientifically Defensible
- External Peer Review rejected NNC
- Recommended "Test" to Assess Effects of TN Reduction

Great Bay Estuary



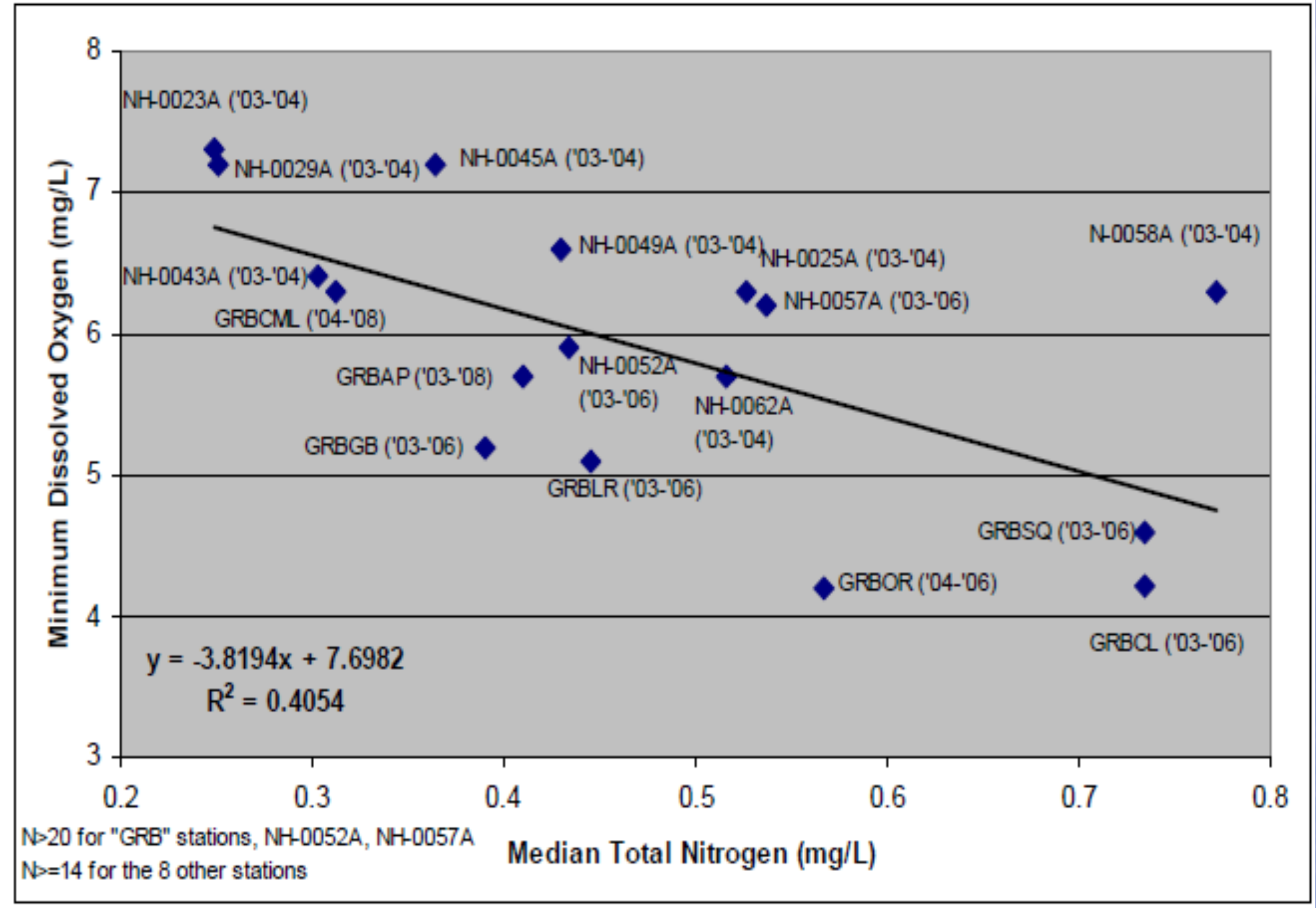
Eelgrass Bed Decline



Conceptual Model

- Increased Nutrient (TN) Loads Stimulate Algal Growth (Chlorophyll-a)
- Algal Growth Affects Water Clarity (light extinction) and Dissolved Oxygen
- Increasing Light Extinction (K_d) Adversely Affects Eelgrass
- Excess Algal Growth Causes Larger Diel D.O. Swings and Increases SOD
- Minimum Diel D.O. Decreases

NNC Development

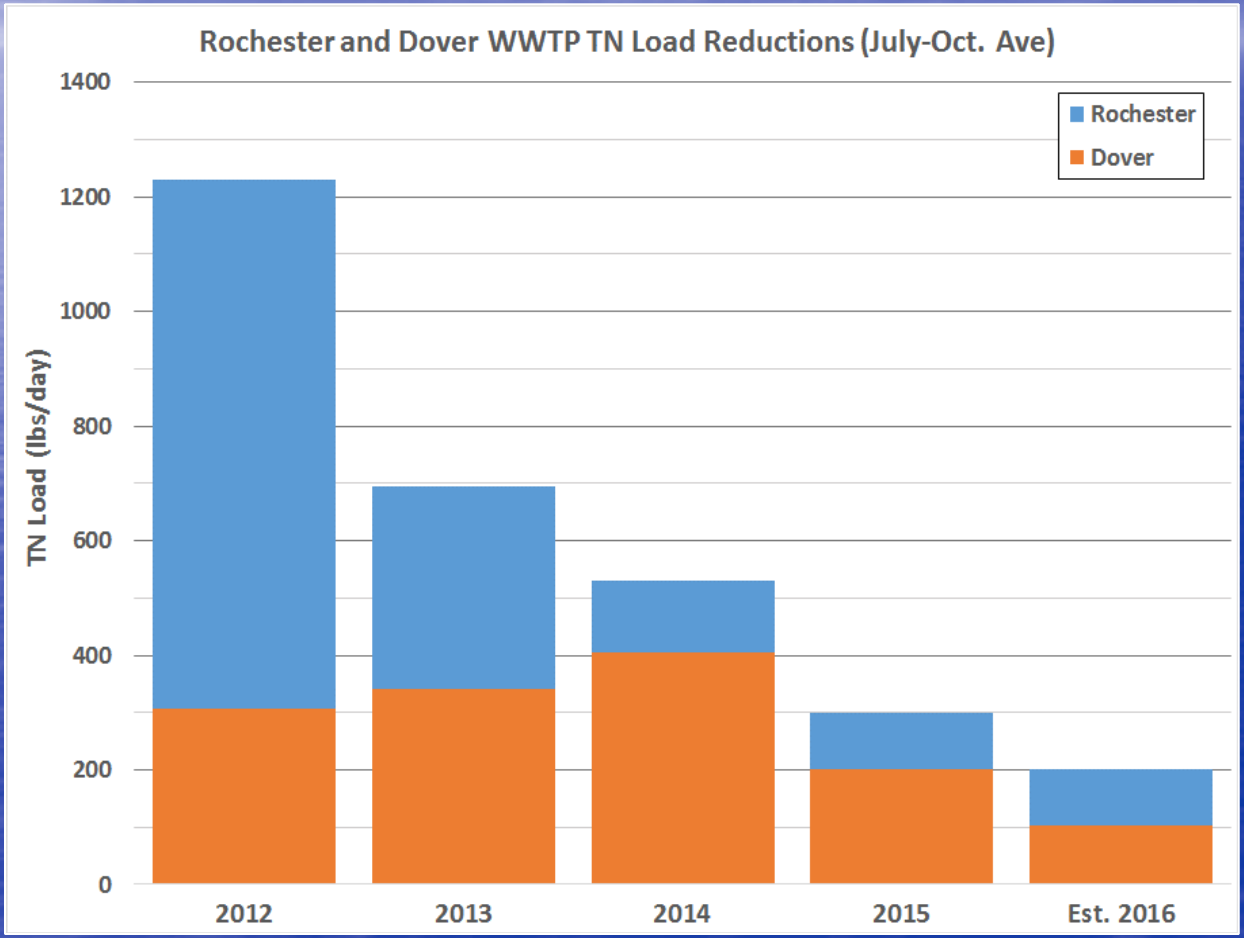


Minimum DO Predicted to Rise by 1 mg/L for TN drop of 0.25 mg/L.

Birth of Grand Experiment

- Peer Review – Effects of TN Load Reductions on Estuary Hard to Predict
- Planned "Voluntary" Nitrogen Reductions by Rochester and Dover provide Opportunity for Assessment
- Evaluate "Before and After" Water Quality

WWTP Load Reductions



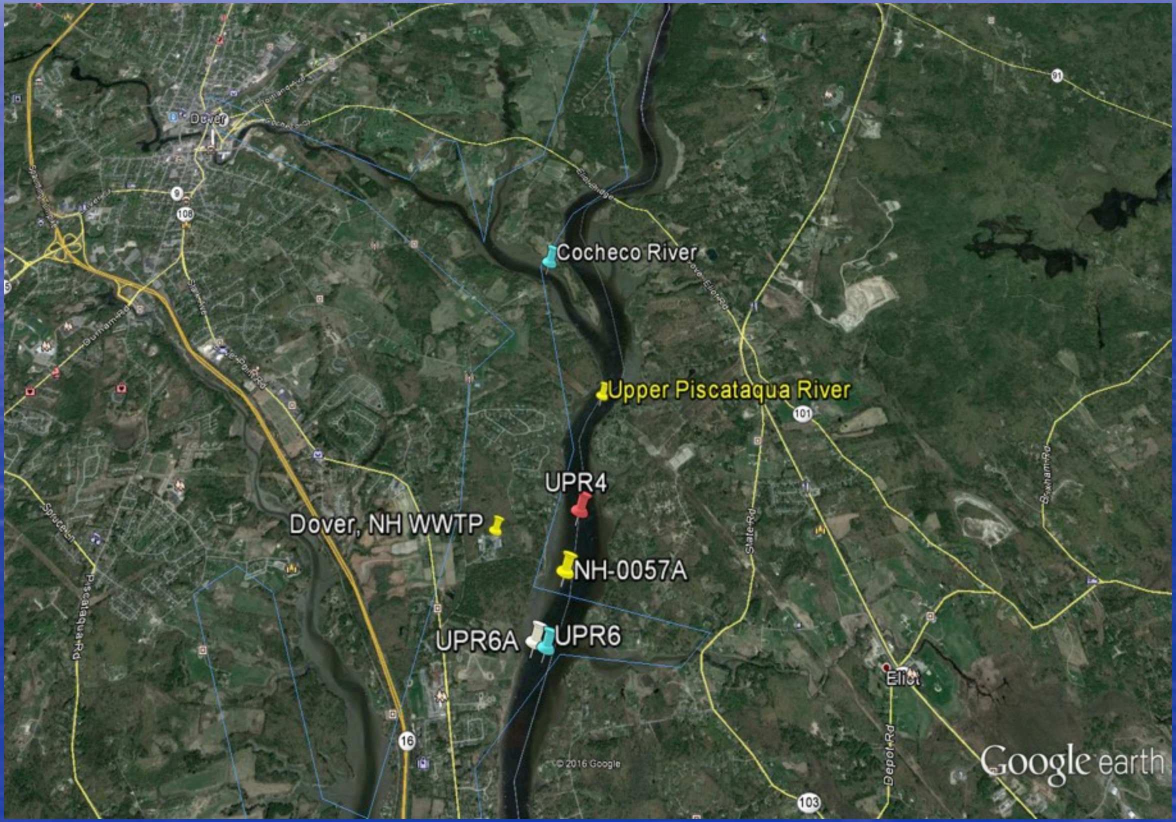
Area of Evaluation

Monitoring Stations

NH-0057A – historical sampling station, lots of data

UPR4 – Upstream of Dover Outfall. Site for D.O. Data Sonde Installation

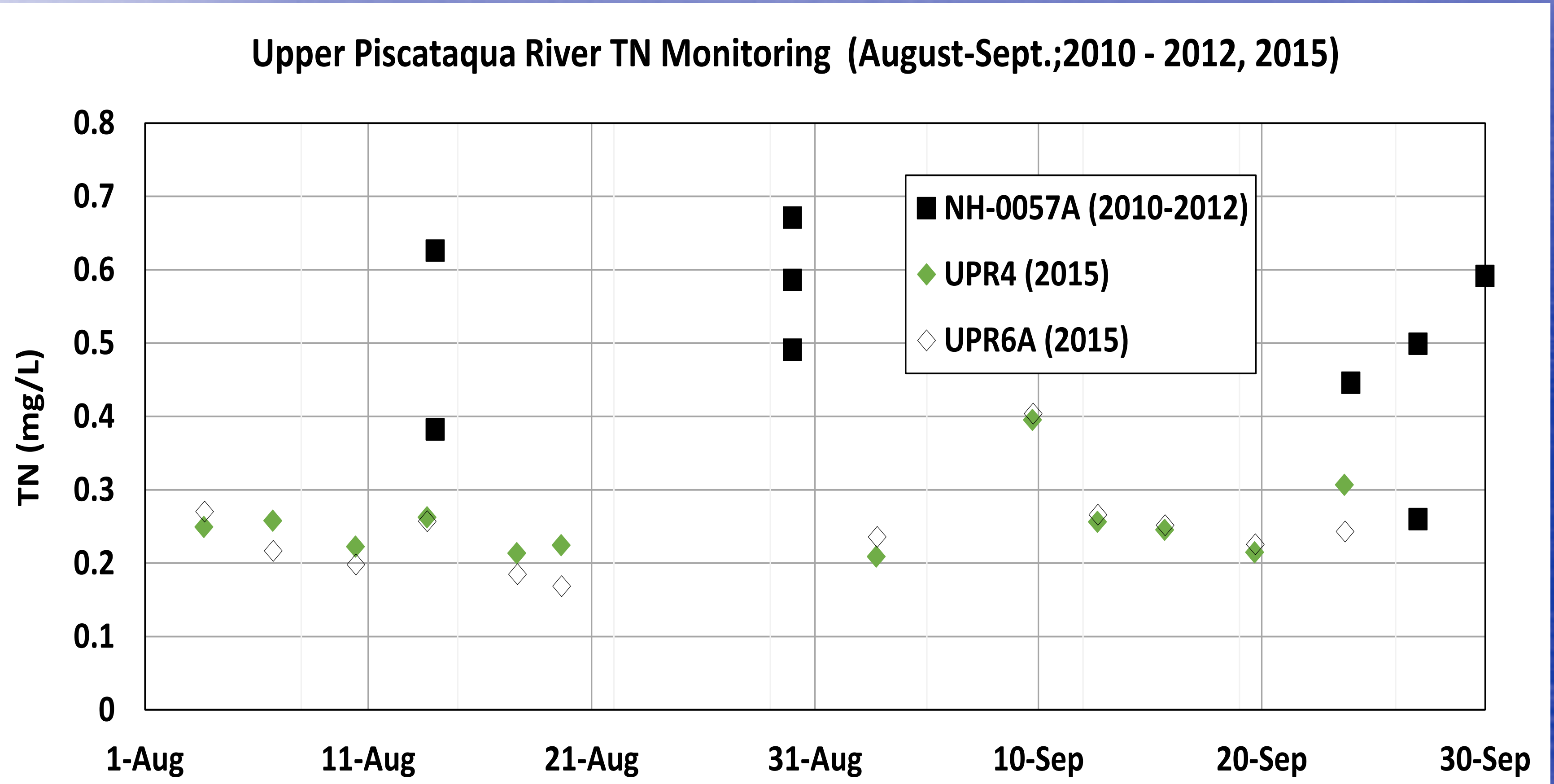
UPR6/ UPR6A – Downstream site for D.O. Data Sonde Installation



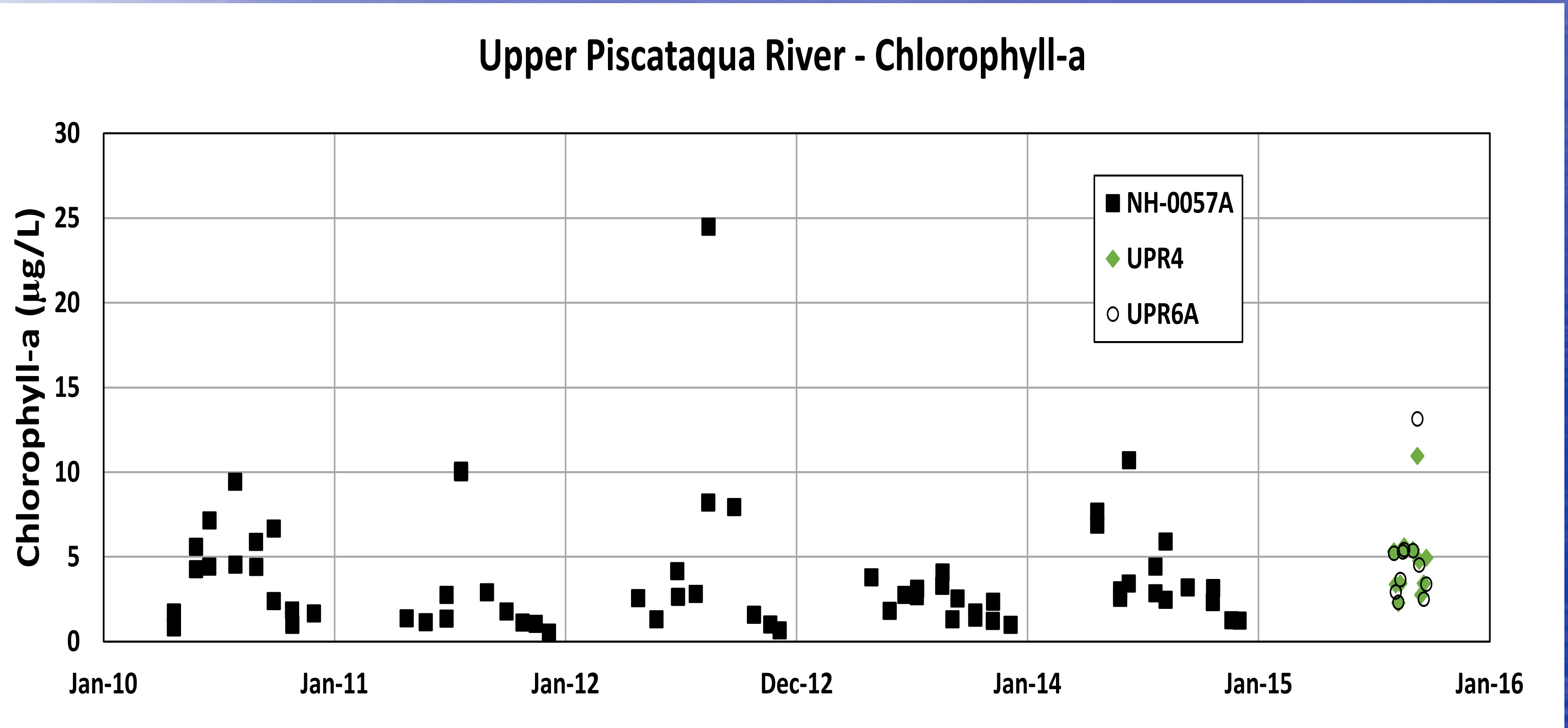
Summary of Available Data

- NH-057A: Historical data collected once a month (to 2014). Typically, grab samples collected at high and low slack tide.
- UPR4/UPR6: D.O. Sondes installed in 2012. Sequential installation from 7/26 – 8/21.
- UPR4/UPR6A: D.O. Sondes installed in 2015nconcurrently from 8/3-8/26 and 9/2-9/24. Grab samples collected in afternoon at slack.

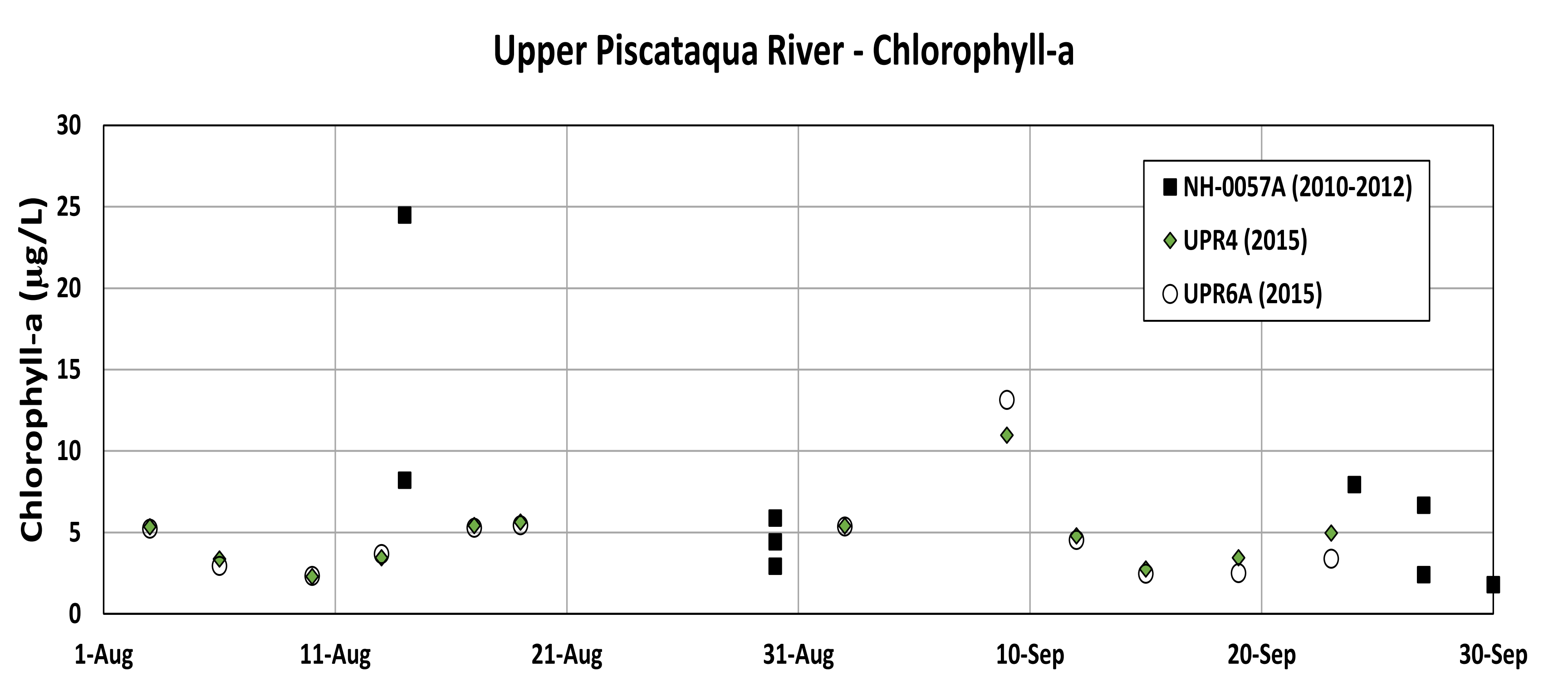
Nutrient Reduction



Algal Biomass

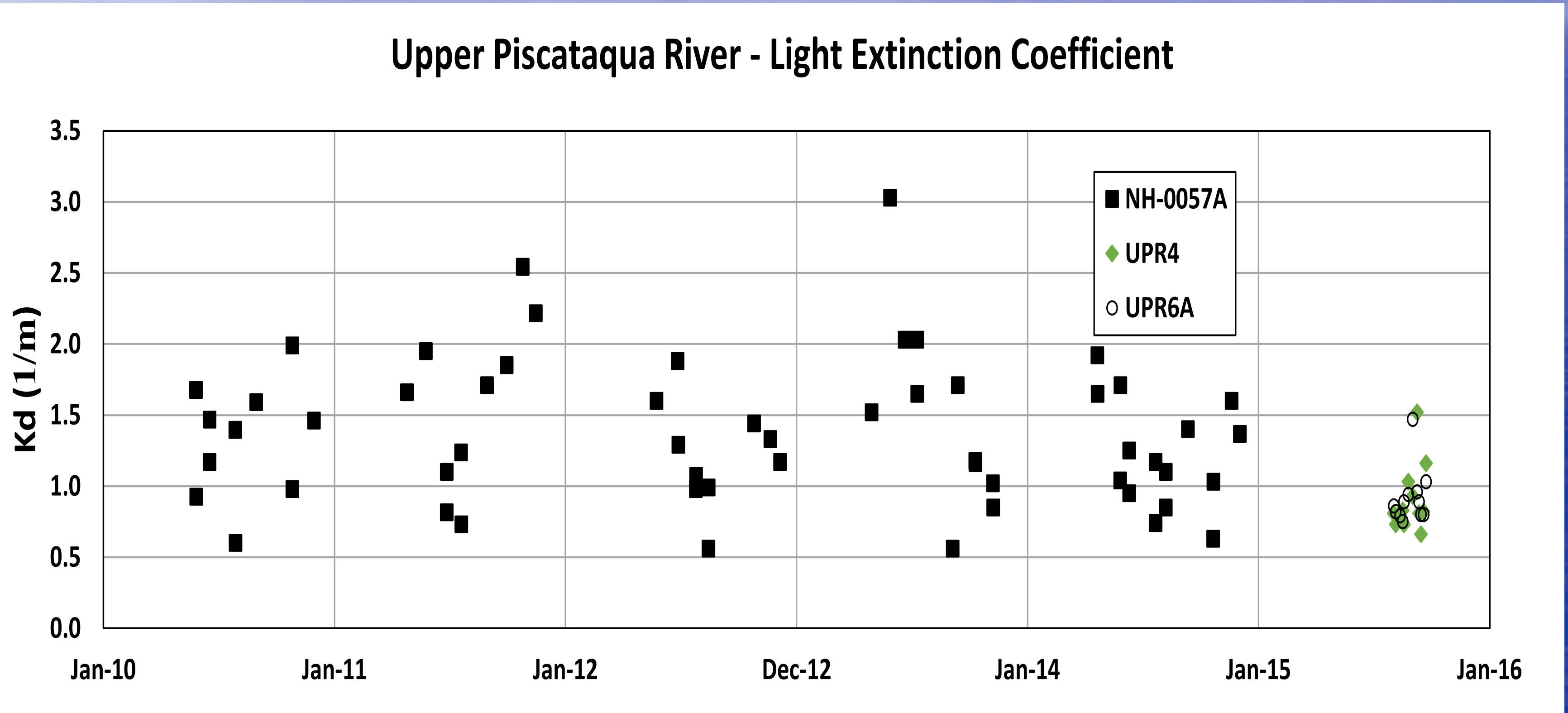


Algal Growth Comparison



No Significant Difference (P = 0.34)

Light Extinction



Factors Controlling K_d

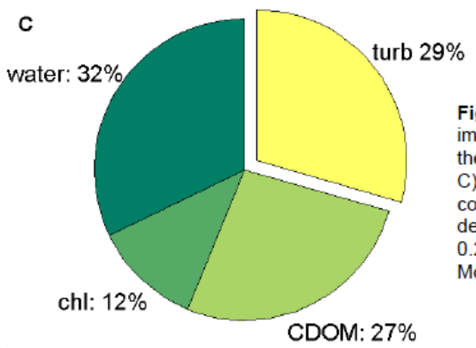
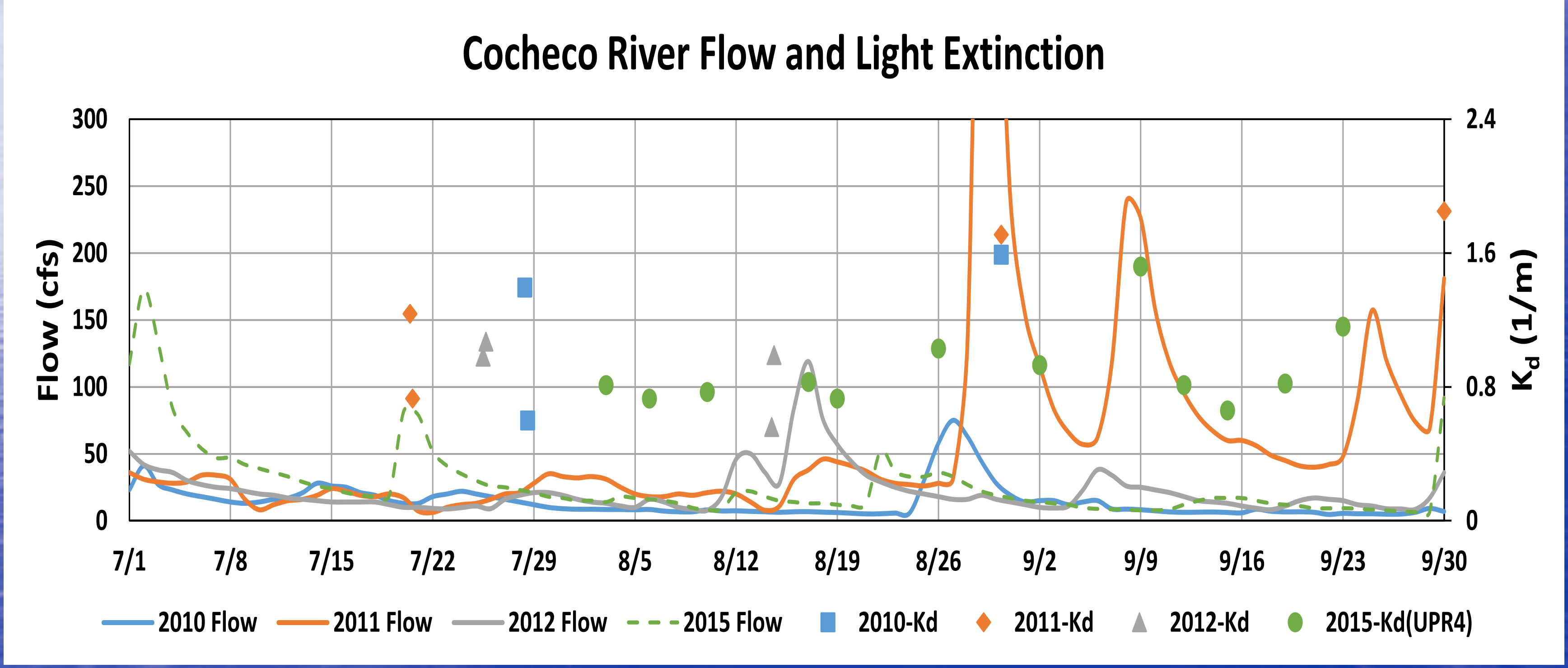


Figure 8.5 Contributions of the optically important constituents to K_d(PAR) measured at the Great Bay Coastal Buoy.
C) The mean daily contribution of each component. The water contribution reflects that derived by the multiuple linear regression of 0.245 m^{-1} which is higher than that estimate by Morel et al. (2007) of 0.1544 m^{-1}.

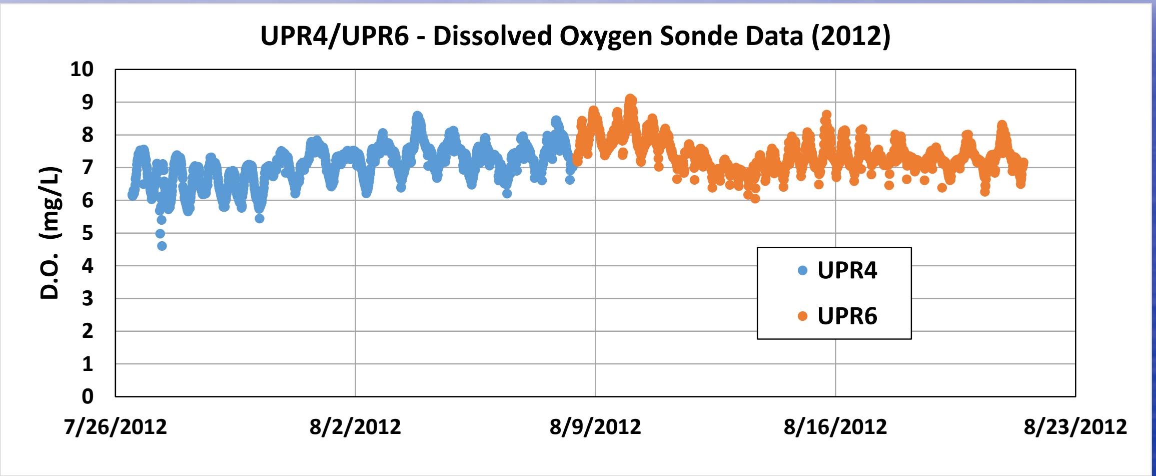
Colored Dissolved Organic Matter (CDOM) and Non-Algal Particulates (NAP) occur naturally and account for the majority of influence on K_d.

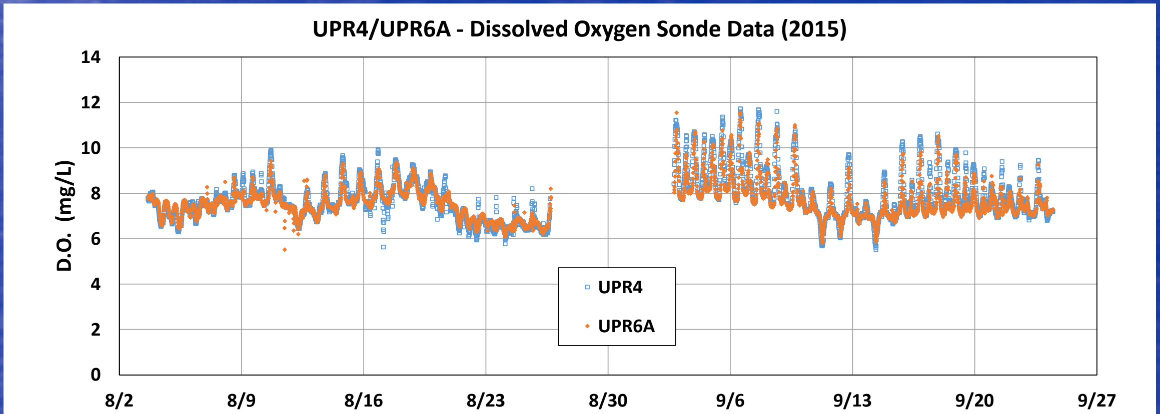
CDOM in the runoff from the Salmon Falls River.

K_d Related to Inflow

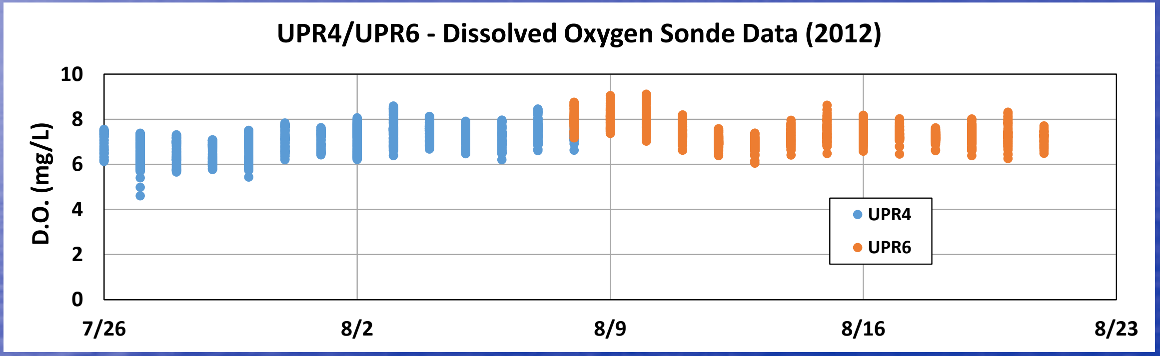


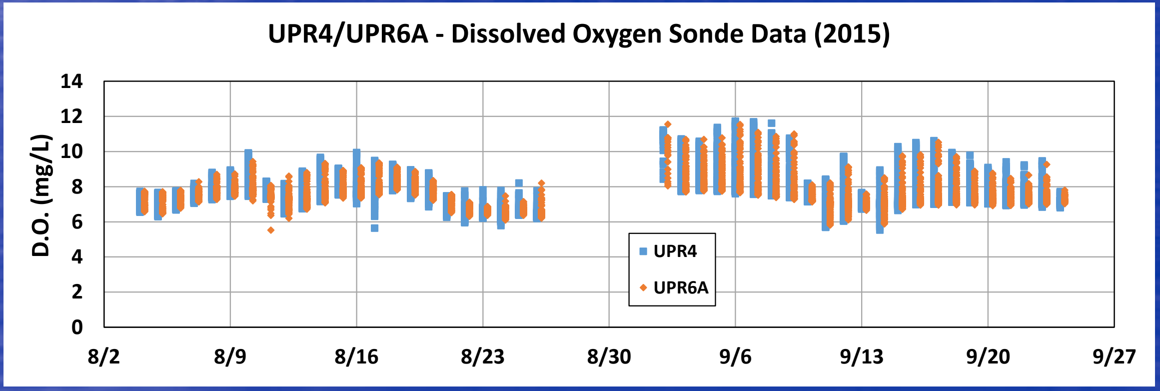
Dissolved Oxygen



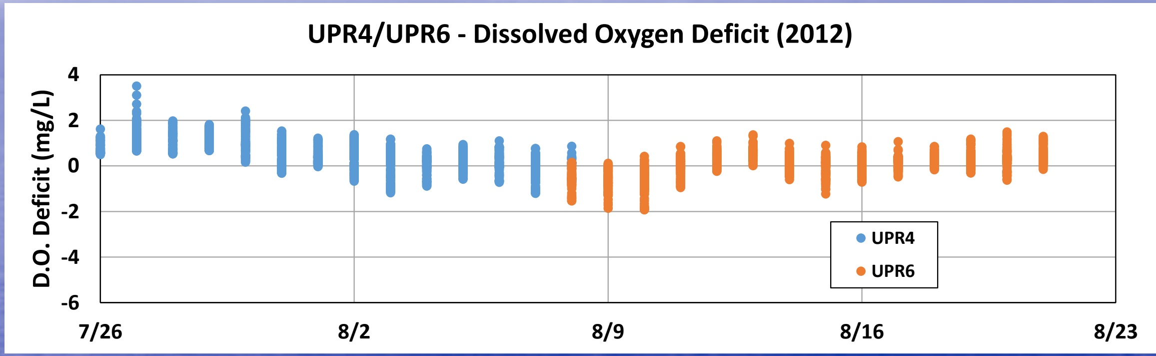


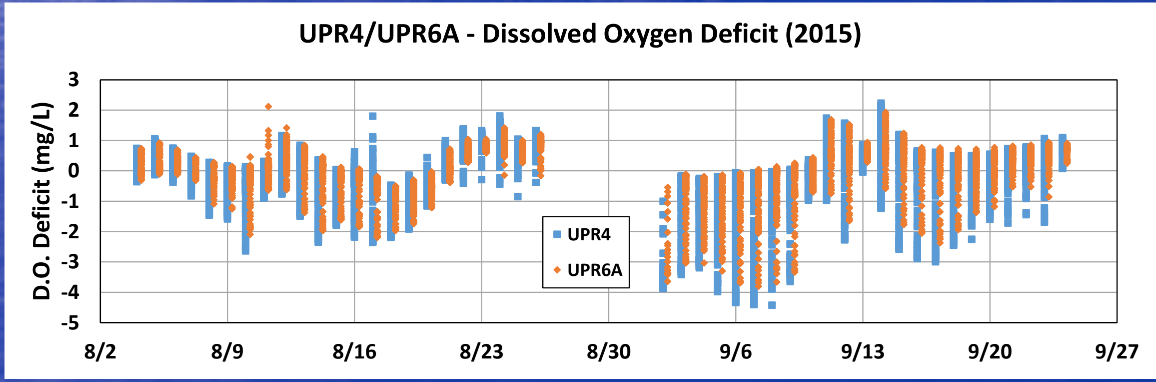
Diurnal Variation



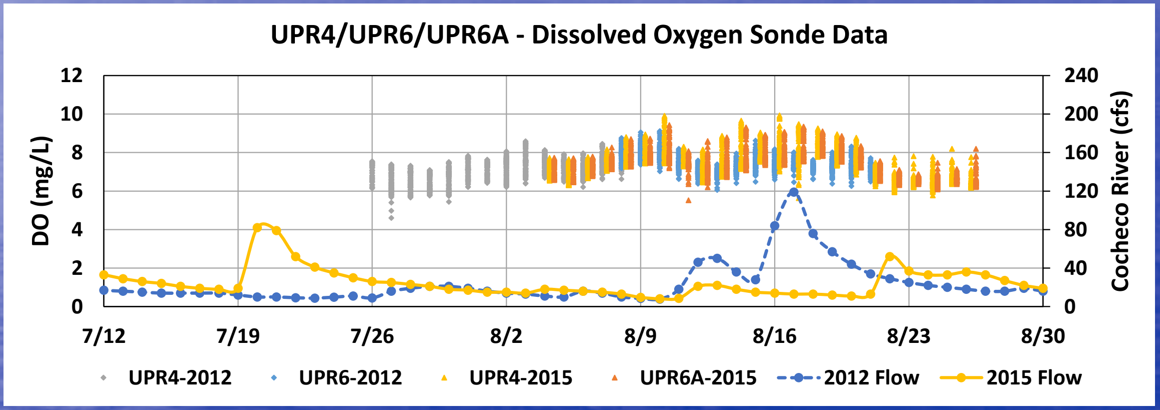


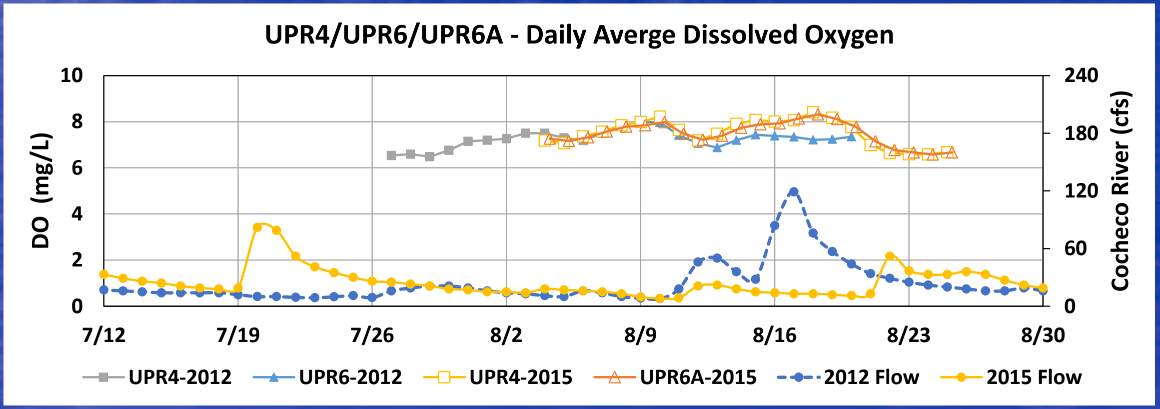
D.O. Deficit


UPR4/UPR6 - Dissolved Oxygen Deficit (2012)
D.O. Deficit (mg/L)
4
2
0
-2
-4
-6
7/26
8/2
8/9
8/16
8/23
UPR4
UPR6


UPR4/UPR6A - Dissolved Oxygen Deficit (2015)
D.O. Deficit (mg/L)
3
2
1
0
-1
-2
-3
-4
-5
8/2
8/9
8/16
8/23
8/30
9/6
9/13
9/20
9/27
UPR4
UPR6A

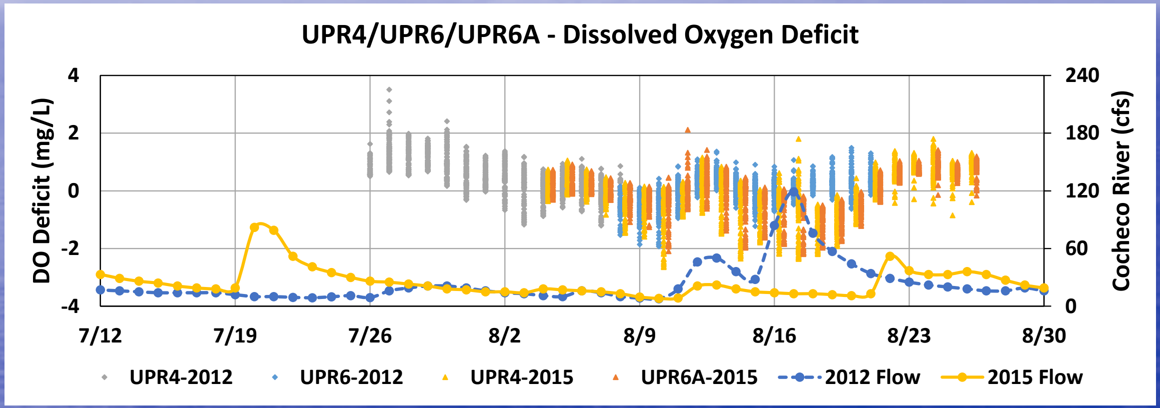
D.O. Concentration Comparison

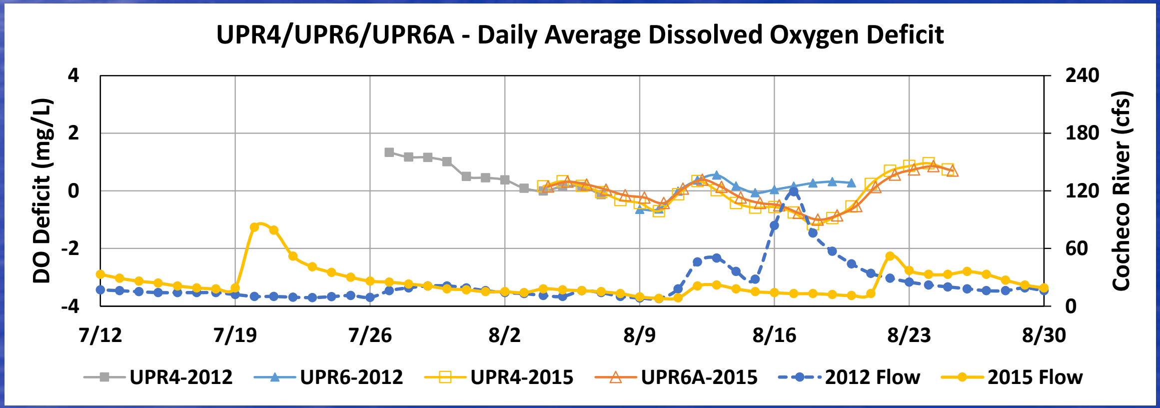




D.O. Deficit Comparison

(b)



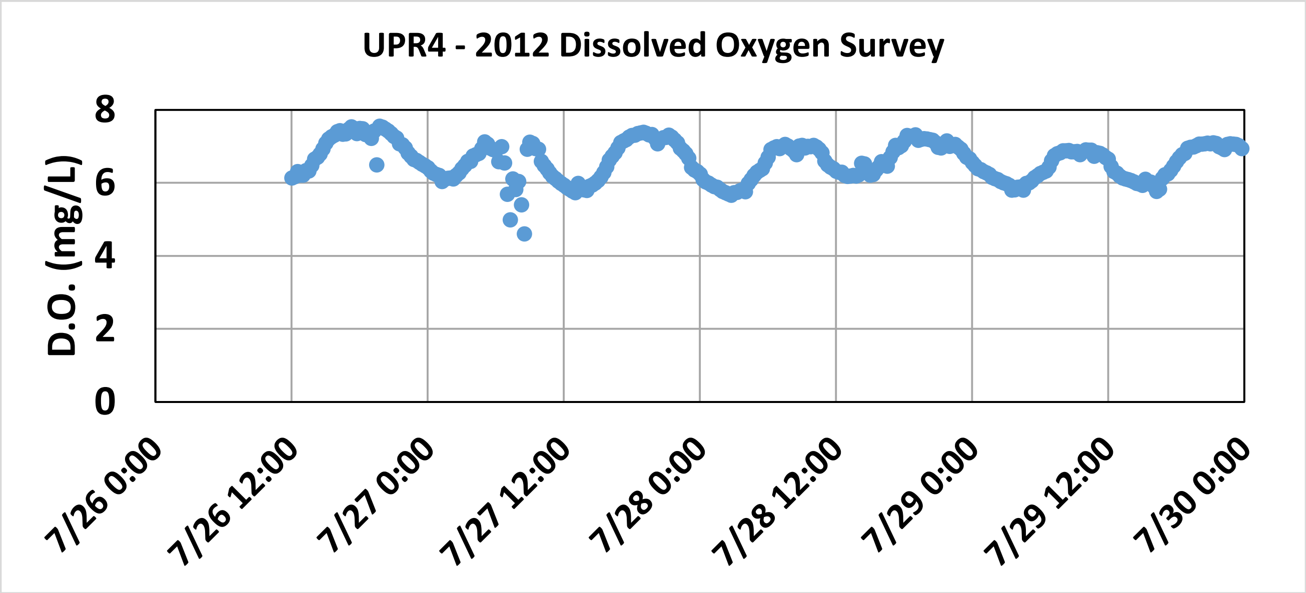


D.O. Comparison Summary

Survey Year	2012		2015			
Survey Dates	7/26-8/8	8/8-8/21	8/3-8/26		9/2-9/24	
Station	UPR4	UPR6	UPR4	UPR6A	UPR4	UPR6A
Median TN (mg/L)	0.50*		0.24	0.21	0.25	0.25
Average DO (mg/L)	7.1	7.4	7.5	7.5	8.0	7.7
Minimum Diel DO (mg/L)	5.7	6.3	5.9	6.1	5.5	5.8
Diel Range (mg/L) Median	1.7	1.6	1.6	1.3	3.0	2.9
Diel Range (mg/L) Average	1.8	1.6	1.8	1.5	3.0	2.6
DO Deficit (mg/L) Median	0.42	0.16	-0.08	0.06	-0.39	0.02
DO Deficit (mg/L) Average	0.52	0.07	-0.09	-0.04	-0.48	-0.12

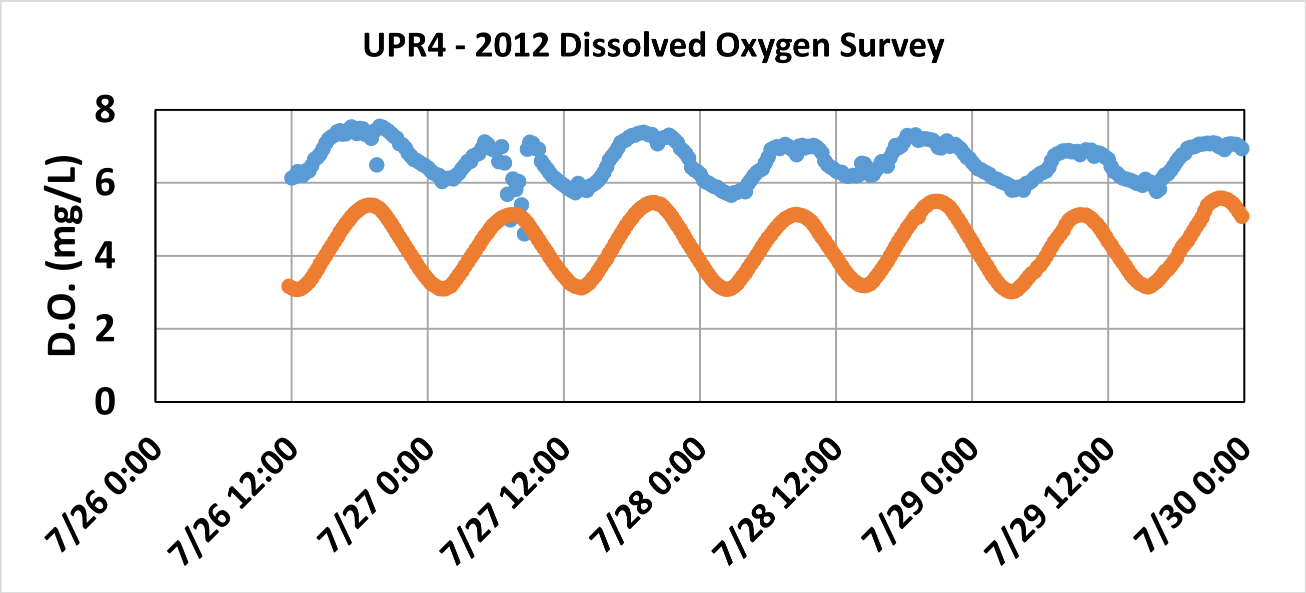
* Median TN concentration for August-September, 2010-2012

Other Considerations



Minimum D.O. is 5.7 mg/L
Two peaks, two minimums per day
Peaks and minimums occur at night and during the day

Other Considerations



Plot of meter depth with D.O. shows diurnal variation is caused by tides

Conclusions

- No significant change in algal biomass between 2010-2012 and 2015.
- No significant change in light extinction coefficient related to change in TN.
- No significant change in minimum D.O., diel D.O. range, or D.O. deficit between 2010-2012 and 2015
- Fluctuations in D.O. related to tides.

Therefore, TN not a significant factor for these parameters.

New Challenges for LIS

- New Claims (December, 2015)
  - Greater TN Reductions needed for D.O. and Eelgrass (Stormwater, Point Sources)
- Questionable Approach
  - TMDL Still being Implemented
  - Outdated information on TN for eelgrass protection
  - Use of Empirical Relationships needs close review for site-specific application

For More Information:

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