2010 Presumpscot River Lower Main Stem Monitoring

Report Submitted To

Casco Bay Estuary Partnership

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[1] Table 1 corrected, GPS coordinates were reversed for the two sites.

Introduction

FB Environmental Associates (FBE) was hired and assisted by Casco Bay Estuary Partnership (CBEP) to conduct in-stream water quality monitoring at two sites within the lower main stem of the Presumpscot River during the summer of 2010. This monitoring was intended to support consideration of reclassification of that portion of the river from Class C to B, and focused on dissolved oxygen (DO) water quality criteria. Datasondes were placed at two sites in the river from late July to early October, and found DO conditions during the deployments generally met Class B standards. A Quality Assurance Project Plan (QAPP) for this project entitled "Lower Presumpscot River Main Stem Reclassification Effort," dated July 9, 2010, is on file with CBEP and Maine Department of Environmental Protection.

Methods Summary

CBEP's YSI 6000 series datasondes were deployed by researcher Cayce Dalton (FBE), with assistance from Kailee Mullen (FBE) and Matt Craig (CBEP), at two sites from July 30 to October 8. The sondes sampled at 15 minute intervals while deployed. Two pairs of sondes were used, allowing a one pair to be swapped for another during each field visit. Calibration, post-deployment calibration checks, and data download occurred in the FBE lab. The sondes were equipped with the following sensors:

- Temperature / conductivity probe;
- Rapid-pulse (non-optical) dissolved oxygen probe;
- Depth sensor (built-in to sonde); and
- For most deployments, pH probe.

The rapid-pulse DO probe recorded percent saturation of oxygen, and the sonde used onboard electronics to calculate DO mg/L with data from the temperature/conductivity probe. Although depth data was recorded throughout the deployments, the sondes were not fixed in place, and were susceptible to movement along the streambed during heavy flow, and slight variation in placement from one deployment to another. Therefore the depth data should be considered approximate. Specific conductance was collected throughout the deployment, and pH was collected whenever a pH probe was available. These additional parameters beyond DO were not examined in detail, but are presented along with the DO data for reference and future study.

The two sampling locations were recorded by GPS (Table 1 and Figure 1). The downstream site, P1, is located approximately 120 meters upstream from the Maine Turnpike Falmouth Spur. The watershed immediately upstream from the site is a generally wooded corridor, with an especially undeveloped segment from approximately the Route 100 bridge downstream to the head of tide.

The upstream site, P2, is in the heavily developed portion of the lower river, below the industrial site in Westbrook around the Saccarappa Dam. It is approximately 260 m upstream from the US Route 302 bridge at the municipal border between Westbrook and Portland. It is also approximately 200 m upstream from the confluence with Mill Brook.

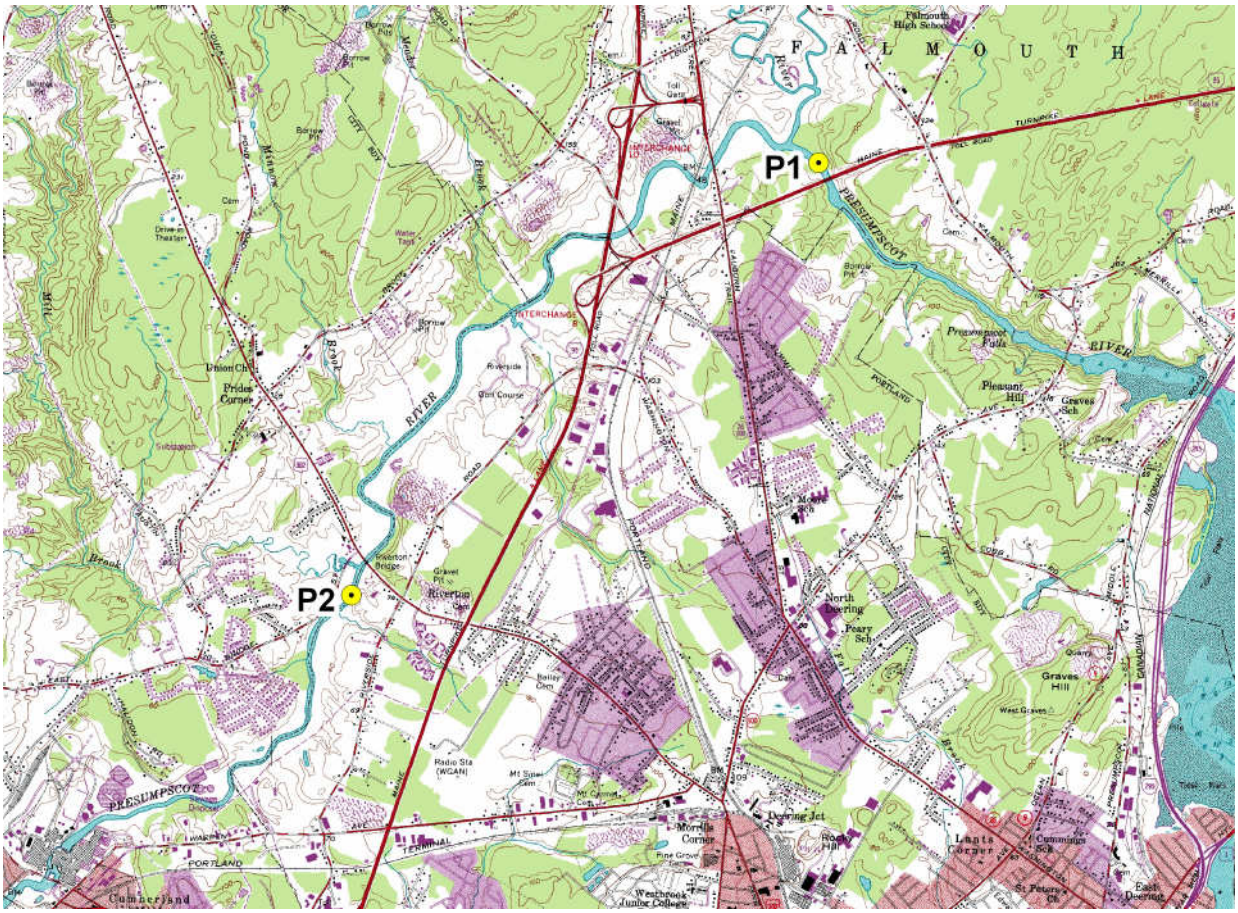

Figure 1: Location of sample sites on the Presumpscot River, near Portland, Maine, with USGS base map.

Table 1: GPS Location of sites, taken on September 16, 2010.
Coordinate systems UTM WGS1984 zone 19N.

P1 – Downstream	P2 – Upstream
19T 0396401 4842549	19T 0393146 4839538

Deployment was accomplished by attaching the sondes with cable ties to the inside top of an approximately 2' wide x 3' long x 1.5' high wire cage (lobster trap), ensuring the sonde would rest approximately 6-12 inches above the stream bed. Each cage was weighted with bricks or diving weights, and was attached to a small marker float to aid in retrieval. The cages were transported by canoe to the deployment site, lowered carefully in place to maintain orientation of the cage, and secured with a steel cable which ran from the cage along the stream bottom to a nearby tree on the bank. Three deployments were conducted (Table 2).

Table 2: Datasonde Deployment Dates in the Presumpscot River

Action	P1 - Downstream	P2 - Upstream	Duration
Deployed	7/30/2010 17:45	7/30/2010 16:00*	25 days
Retrieved	8/25/2010 12:30	8/25/2010 10:45*	
Deployed	8/25/2010 12:45	8/25/2010 11:15	22 days
Retrieved	9/16/2010 11:30	9/16/2010 10:00	
Deployed	9/16/2010 12:15	9/16/2010 10:45	22 days
Retrieved	10/8/2010 15:00	10/8/2010 14:00	

** DO membrane punctured during deployment*

Figure 2: Datasonde deployment system being prepared by Cayce Dalton.

Figure 3: Close up of datasonde deployment method, with diving weights attached to bottom of cage.

Figure 4: Looking downstream to site P1, with deployment site marked by a small float. Maine Turnpike Falmouth Spur bridge in background.

Figure 5: Site P2, upstream from US Route 302 bridge (seen at extreme right) at the Portland-Westbrook municipal boundary. Marker float for deployment site at lower left of photo.

Results

Five of six deployments yielded useful oxygen data, resulting in 10,939 data points for DO mg/L and percent saturation, each. The first deployment at P2 (upstream) suffered a DO membrane puncture shortly after it was deployed; only temperature, pH, and specific conductivity data are valid for that deployment. Across all deployments, there was a consistent diurnal fluctuation of about 0.3 - 0.5 mg/L, with minima at night and maxima in the afternoon. The DO pattern at P1 appeared to lag behind the upstream site at P2 by about 6 - 8 hours. Raw data are summarized in Table 3, Table 4, Figure 6, and Figure 7.

All DO deployments experienced moderate sensor drift, with post-deployment calibration checks consistently showing 107 - 110% oxygen saturation under 100% conditions. This suggests that readings trended slightly higher than actual in-stream DO as each deployment progressed (see Discussion). Raw data files are being provided to Casco Bay Estuary Partnership along with this report.

Water temperature was near peak level of about 26 °C when deployments started, remaining high through early August. Temperature peaked again around September 2 - 4, after which time it declined steadily for the remainder of the study. Temperatures upstream (P2) were slightly higher than downstream (P1). Depth data suggest active management of river levels, since the river stage seems to drop during storms, and begins to show a pattern of daily oscillations on September 16.

Table 3: Summary statistics for site P1 (downstream).

	Temperature (C)	Specific Conductivity (mS/cm)	DO % saturation	DO mg/L	Depth (m)	pH
Number of samples	*6705*	*6705*	*6705*	*6705*	*6705*	*4581*
Maximum	26.1	0.13	117.9	10.9	1.81	7.41
75th percentile	24.3	0.09	107.8	9.68	1.26	7.11
Average	**21.5**	**0.09**	**103.7**	**9.17**	**1.21**	**7.02**
25th percentile	18.6	0.08	99.3	8.63	1.11	6.92
Minimum	14.7	0.06	86.9	7.26	0.81	6.71

Table 4: Summary statistics for site P2 (upstream).

	Temperature (C)	Specific Conductivity (mS/cm)	DO % saturation	DO mg/L	Depth (m)	pH
Number of samples	*6709*	*6709*	*4234*	*4234*	*6709*	*6709*
Maximum	26.3	0.11	115.5	10.6	2.49	7.97
75th percentile	24.5	0.08	104.7	9.63	1.77	7.31
Average	**21.9**	**0.07**	**101.9**	**9.22**	**1.66**	**7.23**
25th percentile	18.7	0.07	98.9	8.81	1.49	7.11
Minimum	14.8	0.06	54.7*	5.14*	1.24	6.59

** Only a single reading was below 7 mg/L, and it is believed to be a measurement error. See Discussion.*

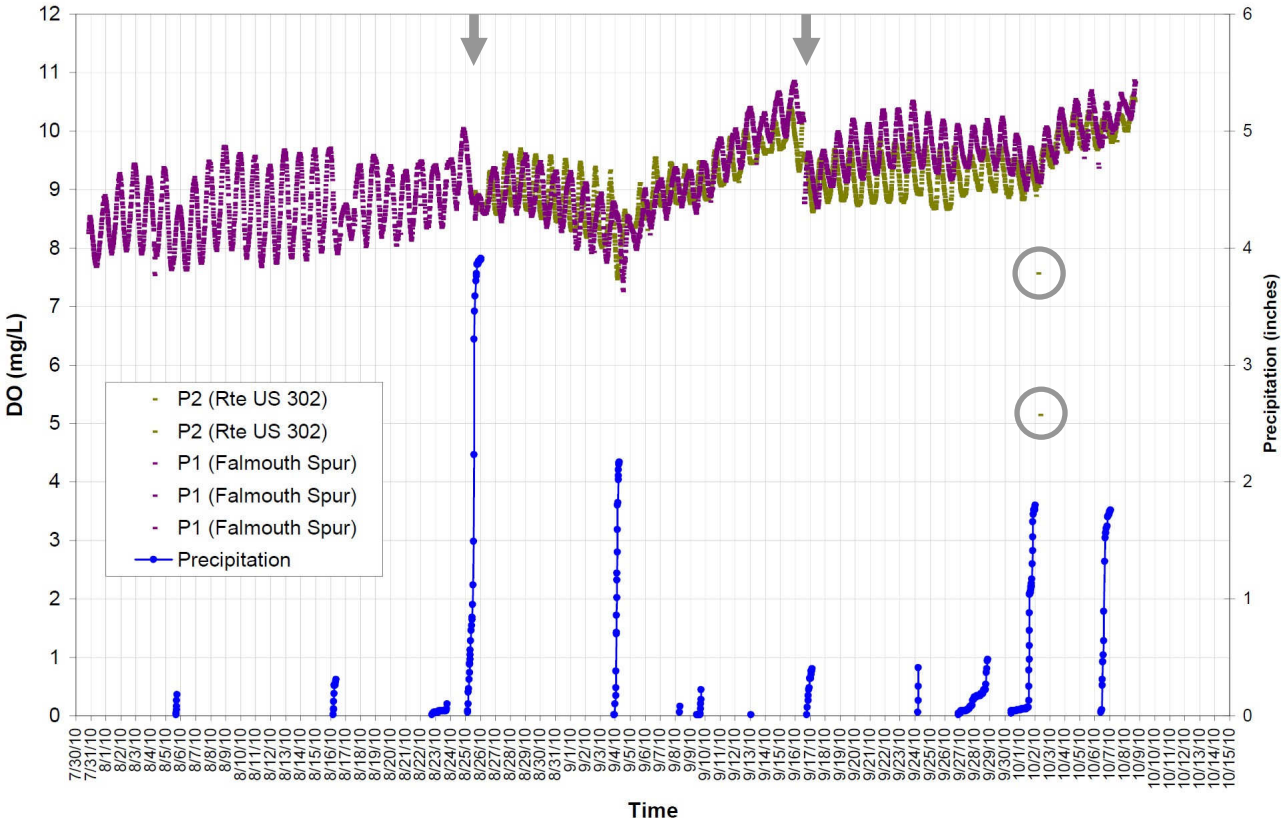

Figure 6: Raw dissolved oxygen data, with cumulative event precipitation from Portland Jetport (souce: weatherunderground.com). Two data outliers—possible measurement errors—are circled. Redeployments and associated data discontinuities are indicated with arrows.

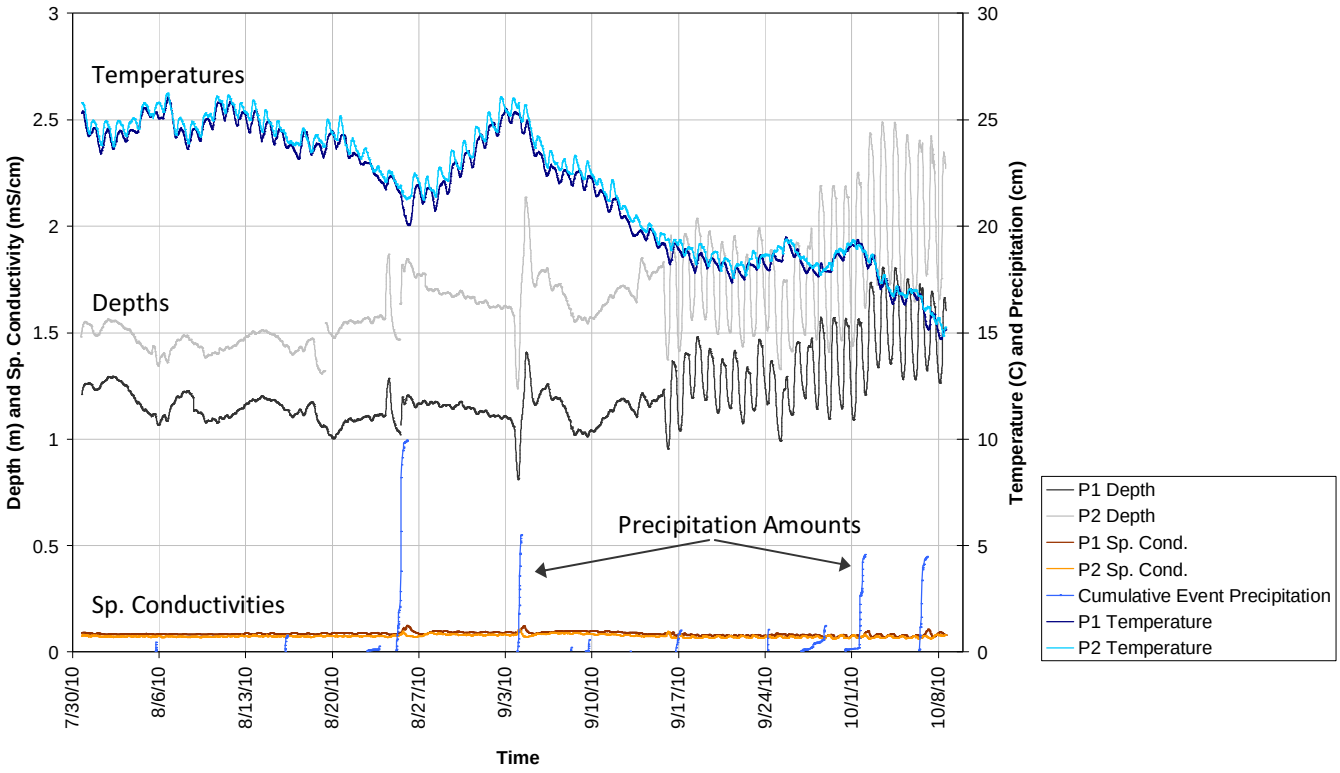

Figure 7: Synopsis of depth, temperature, specific conductivity, and precipitation. Note that sondes were not fixed to a benchmark location, so depth measurements should be considered approximate.

Discussion

The data generally show good oxygen conditions throughout the study period, with no significant periods of hypoxia. The minimum readings at both sites were close to 7 mg/L, except for a single low outlier at site P1 in October (discussed below). DO percent saturation remained well above 75% throughout the entire period.

The lowest readings (except for the outlier) occurred in the early morning of September 4, 2010. The minimum raw data remained above 7 mg/L. However, there are two factors which indicate some uncertainty as to whether the 7 mg/L level was actually breached:

- Sensor drift occurred during all deployments, with DO readings probably gradually trending higher than actual conditions over the course of each deployment.
- The DO probe has a range of accuracy of approximately ± 0.15 mg/L, given stream conditions (approximately 7 mg/L and 24 °C) when the minimum readings occurred.

It is fair to say that actual DO conditions that occurred from approximately 8:30-11:30 am on September 4 at site P1, were within a few tenths of a mg/L of the Class B freshwater standard of 7 mg/L.

The second instance of low DO in the raw data occurred at site P2 (7.56 mg/L at 10/2/2010 4:15 am, and 5.14 mg/L at 10/2/2010 7:00 am). These readings contrast with every other reading that day, which was above 9 mg/L. One possible explanation is that algae or decaying organic material fouled the sonde, trapping low DO

water next to the probe surface. Algae fouling was observed on the sonde body and deployment cages at every retrieval, although the probe faces were typically clean, and post-deployment calibration checks were fine except for the previously mentioned DO sensor drift.

Another possibility is that perhaps the rain event the day before, or a dam release, may have flushed low DO water into the river, causing a very brief low-DO slug of water to pass though the system. Sebago Lake levels were compared to the data, but no clear pattern was found. This possibility is considered very unlikely because each of the two data points are completely isolated in time from the otherwise high DO readings that day. In other words, there is no hint of decline before or rebound after these two outliers. The explanation of temporary fouling at the probe surface is therefore considered more likely.

The overall picture that emerges from this data set is that the lower main stem of the Presumpscot River had a minimum seasonal DO of approximately 7 mg/L in 2010, which was reached briefly (3 hours total, or less than 0.3% of the study period). The minimum DO was so close to the Class B standard that it is, in fact, difficult to tell whether the water quality criterion was breached, given the accuracy of the equipment.

Conclusions and Recommendations

The data set presented here shows generally good dissolved oxygen conditions, with two brief moments of uncertainty as to whether a 7 mg/L standard was maintained. It is worth noting that the season-long use of datasondes results in a far more comprehensive dissolved oxygen record than grab sampling or spot sampling. Melissa Evers of DEP Bureau of Land & Water Quality has on occasion raised the question of whether sonde data should be evaluated differently than less frequent sampling methods when considering attainment of water quality criteria. In near-continuous sonde data, there is a much greater likelihood of finding a brief period where readings cross just below water quality criteria. Percentile-based criteria may be an alternative, ensuring that a tiny percentage of readings slightly below the criteria do not alone result in a stream not meeting its standards.

Continued sampling in future years would allow year-to-year variability to be observed. Continued sampling may also help answer the question of whether the outlier low DO readings in October are representative of river conditions (if the pattern is repeated), or if they are due to measurement error such as sensor fouling.

If future sampling is considered, we have the following recommendations.

- During this study, we used high-sensitivity DO membranes, which turned out to be unnecessary given the relatively high DO values seen. The high-sensitivity DO membranes are more susceptible to sensor drift, and we do not recommend they be used again in the Presumpscot.
- Shortening deployments to two to three weeks would be more labor intensive, but may be a worthwhile strategy to limit the risk of data gaps.
- Sampling began somewhat late in the season because datasondes were employed elsewhere and unavailable. Ideally, the sampling season should begin earlier.
- Casco Bay Estuary Partnership assisted with datasonde deployment and retrieval, which allowed a longer sampling season than otherwise would have been possible given the budget. This approach is recommended when possible.