Assessment Report Phase II

Environmental Factors Relevant to Eelgrass in the Neponset River Estuary

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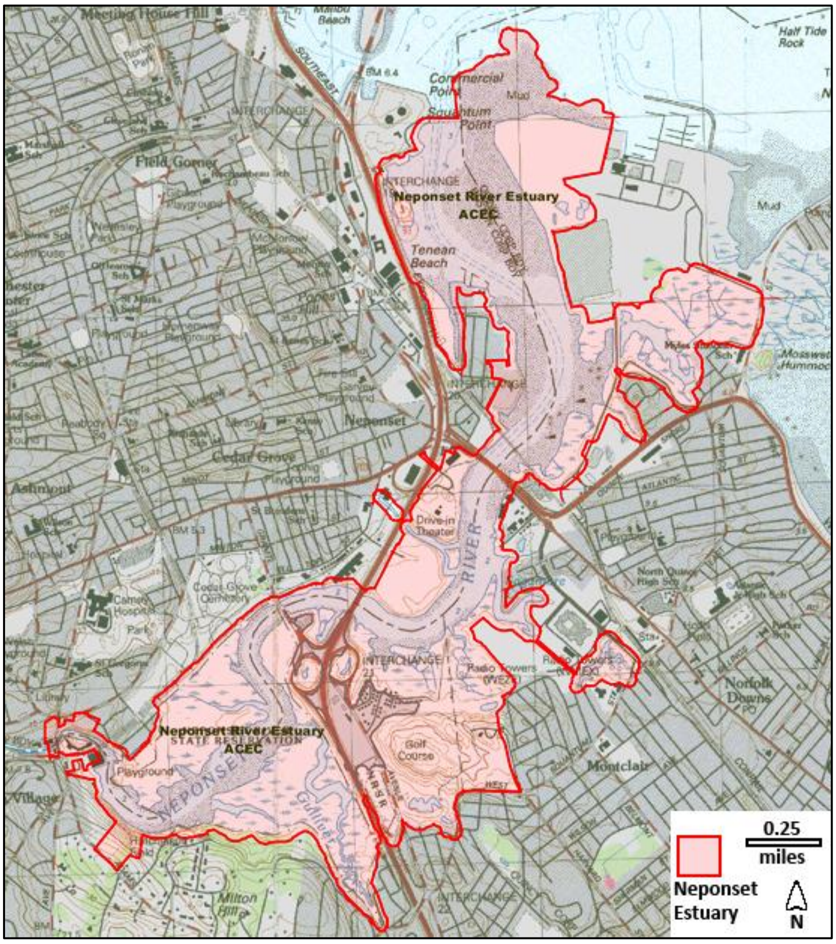
Introduction

Our ultimate aim is to construct a management plan for the reintroduction and maintenance of eelgrass in the Neponset River estuary. Other group members have gathered information regarding the environmental factors necessary for eelgrass survival and optimum growth. This document is an assembly and analysis of the environmental conditions pertinent to eelgrass in the Neponset River Estuary.



Map 1. Area of Neponset River estuary evaluated and used for calculations

The abiotic factors evaluated were temperature, pH, salinity, dissolved oxygen, substrate, flow rate, wave action, turbidity, nutrient availability and light intensity. The biotic component of eelgrass survival was evaluated in terms of the diversity of grazers, and the abundance of inhibitors, such as macroalgae. For each of the considered factors, values were obtained or derived by a variety of methods described below, including analysis of data from previous studies, GIS analysis, and the use of models.

Factors were considered across several scales, where suitable data were available. The inter-site variation was assessed so that the final assessment report can examine which particular areas of the Neponset estuary will be best suited for eelgrass reintroduction. The seasonal variation was examined as some factors, such as dissolved oxygen, are important for their minimum and maximum values, rather than their mean. Finally the trends on a longer temporal scale were evaluated as the eventual management plan would have to take into account accumulating or accelerating pressures.

Table 1: Summary of Factors, Methods & Results		
Factor	**Source/Method**	**Result**
Temperature (^oC)	Processed MWRA Data	**Min-Max (Mean)** *Upstream: 0.58 - 25.39 (12.63) Middle: 8.44 - 22.25 (16.24) Mouth: 3.53-20.89 (13.81)
Salinity (PSU)	Processed MWRA Data	**Min-Max (Mean)** Upstream: 0.24 - 31.15 (25.55) Middle: 0.24 - 32.97 (26.91) Mouth: 0.19 - 31.18 (24.24)
Dissolved Oxygen (mg/L)	Processed MWRA Data	**Min-Max (Mean)** Upstream: 5.75 - 9.95 (7.45) Middle: 6.35 - 9.04 (7.76) Mouth: 7.58 - 10.42 (8.73)
pH	Processed MWRA Data	**Min-Max (Mean)** Upstream: 7.21 - 7.95 (7.74) Middle: 7.29 - 7.96 (7.77) Mouth: 7.13 - 8.00 (7.76)
Turbidity (NTU)	Processed MWRA Data	**Min-Max (Mean)** Upstream: 2.00 - 29.50 (11.51) Middle: 2.40 - 29.85 (9.06) Mouth: 2.15 - 28.60(7.96)
Nitrogen	ELM Model	Net DIN: 666413.3 kg N per yr
Substrate	Personal observation in class survey of the estuary	Primarily mud
Flow Rate	Lynn's AP1 (Breault 2002)	0.6 to 3.1 m^3/s
Wave Action	Literature (Rana 2007; seagrassli.org)	Wave action may be negligible for eelgrass growth in Neponset
Light Intensity	Calculated using Secchi data and Beers-Lambert equation ($I_d = I_0e^{-kd}$)	Light Intensity at bottom may be insufficient to support eelgrass growth
Grazers	Review of published and grey Literature	Mute swans, Brant geese, chink snails, marsh and blue crabs are potential grazers in the Neponset
Inhibitors	Processed MWRA Data (Chl a)	**Min-Max (Mean) (µg/L)** ** Mouth: 0.22 - 12.4 (3.166)

*Upstream: site 055; Middle: sites 054, 042; Mouth: sites 039, 040, 041, 084, 089, 140 **Mouth: site 140

A Note on MWRA Dataset

The Massachusetts Water Resources Authority (MWRA) has conducted sampling of abiotic and biotic factors at various sites in the Neponset River since 1989 (see Assessment Phase I for sites). Data prior to 1994 were insufficient for analysis and were not considered. Neither the factors studied, nor the sites sampled, nor the samples per site, nor the temporal distribution of samples remained consistent across the dataset. Therefore for temperature, pH, salinity, dissolved oxygen, chlorophyll and turbidity, data were first averaged for each site in each season of each year to remove the effects of the varied number of sample repetitions. Intra-site averages were then in turn averaged and standard deviation calculated from the population of site averages. This means that although inter-site variation was considered, intra-site variation was not considered in the analysis. This decision was made as some sites will be eventually deemed fundamentally unsuitable for eelgrass by the amalgamation of environmental factors, in which case intra-site variance will become the primary concern for the remaining, suitable sites.

The data also included many blank cells. A note attached to the data explained that the blank cells either indicated an absence of a sample or a “suspect” result. Without any way of delineating the specific cause of particular blank cells, all were assumed to indicate an absence of a sample. There are also many single-sample seasons represented in the data-set. These would not produce statistical tests with sufficient power for useful inference, but were included in this preliminary analysis as the primary aim was to screen for long-term trends in environmental factors.

As geographic location within the estuary is likely the major interaction in environmental factors, results were summarized into groups of sampling sites. The upstream site was 055; the middle sites were 054 and 042; and the mouth/downstream sites were 039, 040, 041, 084, 089 and 140.

Abiotic Factors

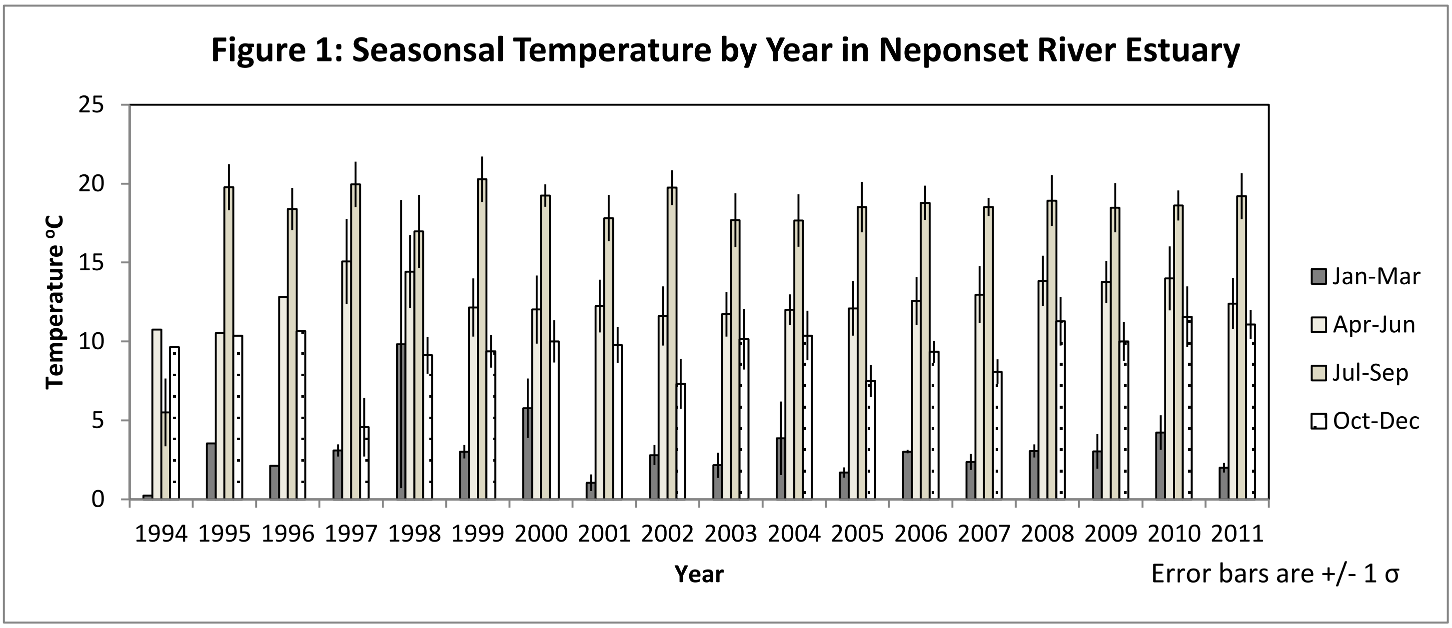
Temperature in the Neponset

Temperature data from all MWRA sampling sites were analyzed from the MWRA dataset. Values for each site in each season in each year were averaged then the average of the intra-site averages was found for each season. Figure 1 shows seasonal averages for each year between 1994 and 2011.

Temperature has a strong seasonal profile, rising from lows in January to March through higher values in April to June to reach a peak in July to September, before dropping again in October to December. There is little in these data to suggest any long-term changes in temperature, although data from the Blue Hills observatory has suggested that local temperatures are rising.

Implications for Final Assessment

Despite there being some suggestion that local atmospheric temperatures are rising, the high specific heat capacity of water and the high flushing rate of the estuary into well-mixed water means that this is unlikely to be a concern in the foreseeable future. Temperature changes were likely not a factor in the decline of eelgrass in the Neponset, although they could contribute to the proliferation of inhibitive species such as macroalgae. Temperature is also a strong function of depth, which will play the larger part in available eelgrass and habitat, and unless temperature fluctuations are being contributed by a point source, they cannot be addressed as part of a local management plan.



Salinity

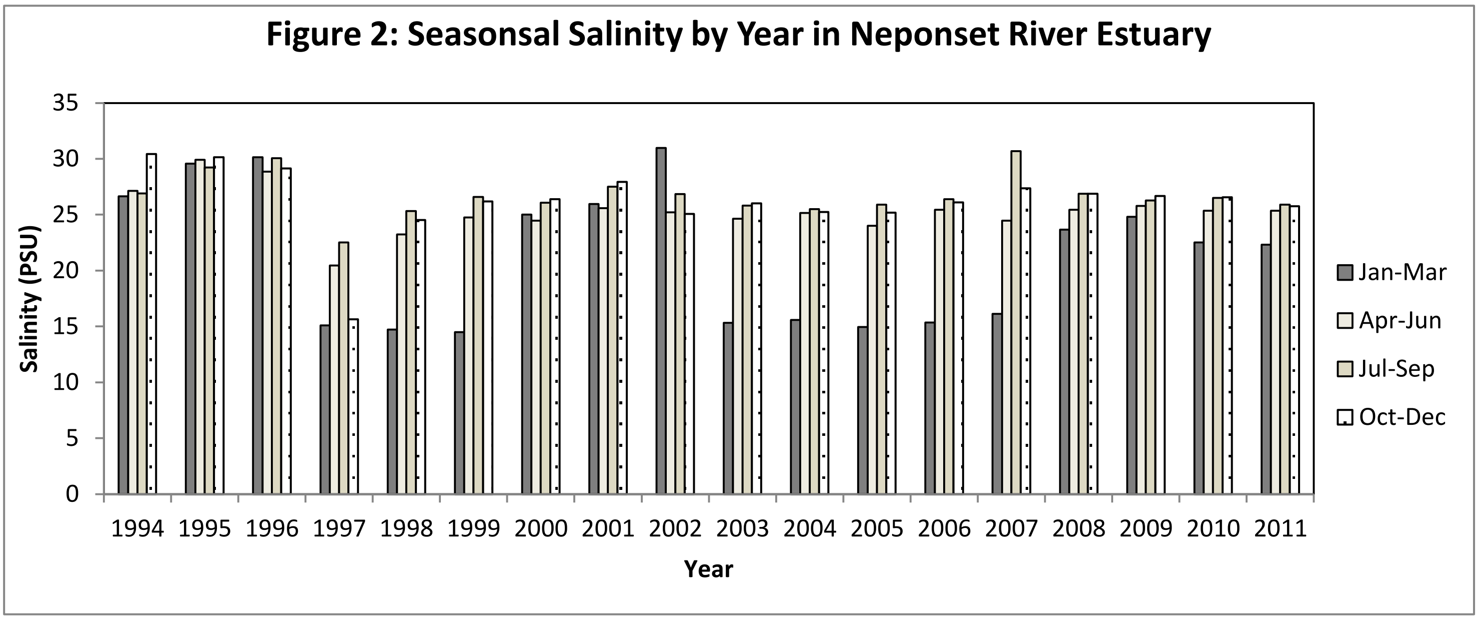
Salinity data from all MWRA sampling sites were analyzed from the MWRA dataset. Values for each site in each season in each year were averaged then the average of the intra-site averages was found for each season. Figure 2 shows seasonal means for each year between 1994 and 2011.

There is little variation within or between years in Spring, Summer and Fall. However there is substantial inter-year variation in Winter (January-March) salinity. This variation probably corresponds to precipitation and snow-melt. In years with low precipitation or late snow-melt salinity is low as fresh-water input is reduced. High salinity years may have resulted from large snow-melts in January-March and high precipitation. Many of the MWRA's samples in the January-March window are taken in March.

There was a great deal of inter-site variation in salinity, as evidenced by the standard deviations (see Appendix, Table 4). The MWRA tends to take samples at multiple sites on the same day, which may produce high inter-site variability as salinity-influencing events upstream will take time to reach downstream areas, so sampling down the estuary will capture that lag as a gradient of salinity.

Implications for Final Assessment

No long-term trend in salinity is suggested by these data. Similarly to temperature, salinity would seem to be controlled by factors that cannot be addressed by a local management plan. However, fresh-water flow is to some extent controlled by upstream dams in the Neponset estuary. Therefore if peak maximum salinity needed to be limited for eelgrass survival there would be the practical possibility of doing so, even though there would likely be complications in implementation.



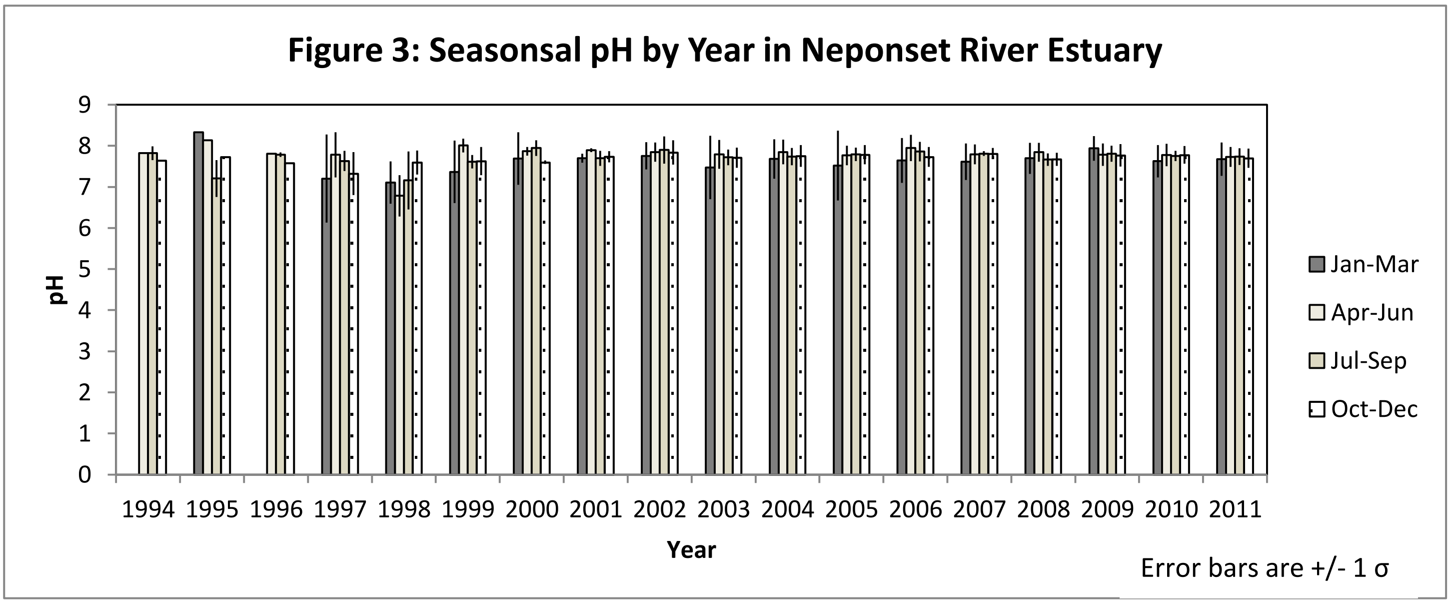
pH

pH data from all MWRA sampling sites were analyzed from the MWRA dataset. Values for each site in each season in each year were averaged then the average of the intra-site averages was found for each season. Figure 3 shows seasonal means for each year between 1994 and 2011. January-March data was absent for years 1994 and 1996.

There is little inter-season or inter-site variation in pH, and no evidence to suggest a long-term trend. Slightly higher variation in earlier sampling years may be the result of less precise sampling techniques and equipment.

Implications for Final Assessment

With little change in pH documented over the last 18 years, and low variation between seasons and sites, pH was unlikely a factor in the decline of eelgrass and is also not a primary target for management recommendations.



Dissolved Oxygen

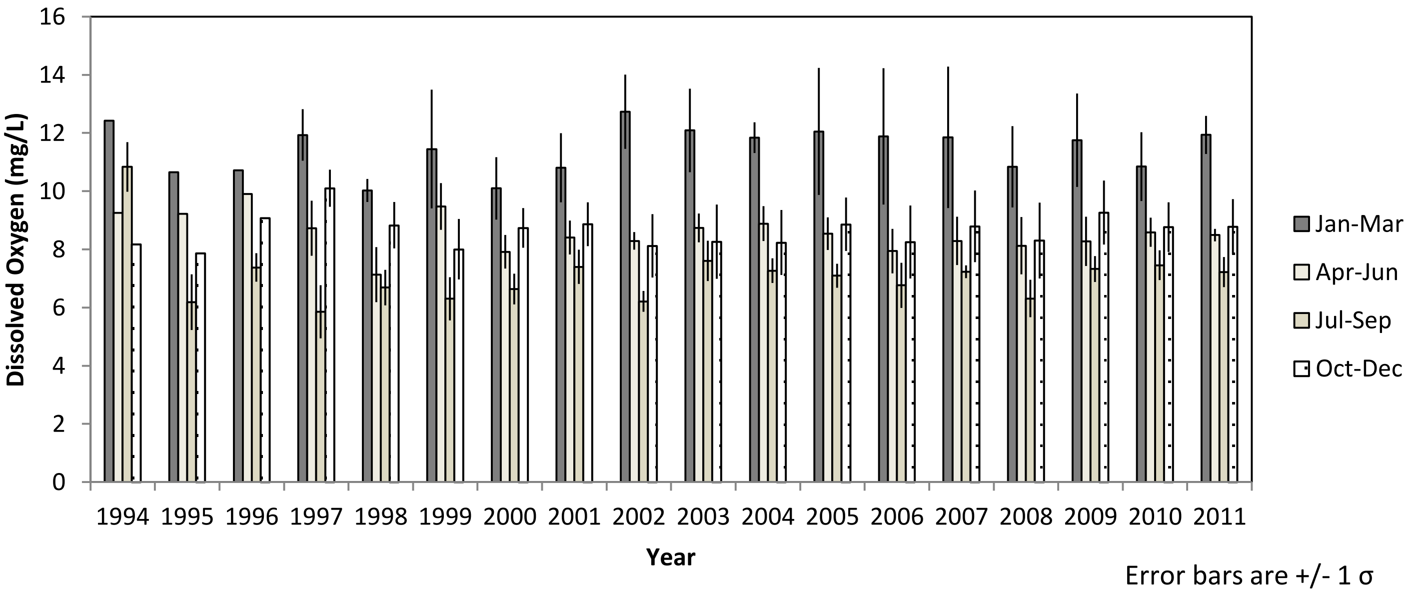
Dissolved oxygen data from all MWRA sampling sites were analyzed from the MWRA dataset. Values for each site in each season in each year were averaged then the average of the intra-site averages was found for each season. Figure 4 shows seasonal means for each year between 1994 and 2011.

There is a strong seasonal profile for dissolved oxygen, with the highest values in January-March, falling through April-June to lows in July-September, before rising again in October-December. This is no surprise as dissolved oxygen levels area function of temperature, which varies seasonally. January-March consistently has the highest variation, in agreement with the higher variation in Winter temperatures. There is no suggestion of a long-term trend in dissolved oxygen.

Implications for Final Assessment

Dissolved oxygen is toxic to eelgrass at concentrations above 100µM (Terrados *et al* 1999; via Kenly's AP2). This is one of the factors that could be primarily limiting to eelgrass reintroduction and survival. However, there is little to suggest that dissolved oxygen has been increasing over time. Some of the interacting factors in dissolved oxygen concentrations, such as temperature, cannot be influenced by a local management plan. However, macroalgae abundance is an example of an influence on dissolved oxygen concentration that could be addressed by a management plan, in that case by limiting anthropogenic nutrient inputs.

Figure 4: Seasonsal Dissolved Oxygen by Year in Neponset River Estuary



Error bars are +/- 1 σ

Turbidity

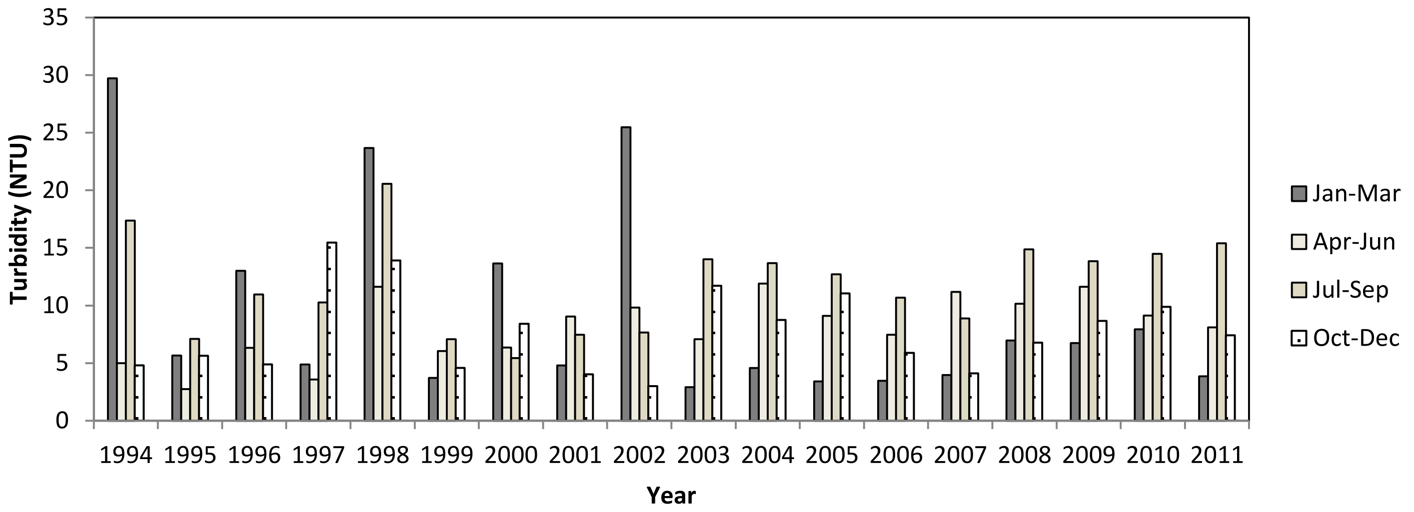
Turbidity data from all MWRA sampling sites were analyzed from the MWRA dataset. Values for each site in each season in each year were averaged then the average of the intra-site averages was found for each season. Figure 5 shows seasonal means for each year between 1994 and 2011.

Turbidity varies greatly in the Neponset. It has very high inter-site variation (see Appendix, Table 4), high but profiled seasonal variation, and variation without trend between years. Many interacting factors influence turbidity, including flow-rate and phytoplankton abundance, in turn controlled by other environmental factors such as nutrient availability and rainfall. Turbidity is the primary scaling factor for light intensity over depth, a major limitation to eelgrass growth.

Implications for Final Assessment

Because of the high variation and low sampling rates in the MWRA data it is impossible to analyse a trend over time. This is a shame, as an increase in turbidity would provide an excellent explanation for the decline of eelgrass, due to a limitation of growth rates and available habitat. In the absence of sufficient data, Secchi disk data was analyzed to produce light intensity estimates for the depths of the various MWRA sampling sites (see **Light Intensity**).

Figure 5: Seasonsal Turbidity by Year in Neponset River Estuary



Light Intensity

Secchi depths from all MWRA sampling sites were analyzed from the MWRA dataset for 2010 and 2011. Secchi depths were averaged for each site and the Beers-Lambert equation (Equation 1) was used to calculate the expected light intensity at the average depths of each site. Attenuation coefficients in the MWRA dataset were incorrect, and were recalculated. Light intensity at the surface was assumed to be 8.5Mj/m^2/day, as per data for Bedfordshire, UK (Burgess 2009).

This was compared to the known minimum light intensity for eelgrass growth of 75-150μE/m^2/day (Kemp *et al.* 1983; via Kenly's AP2), to suggest whether each site would be suitable for eelgrass (Table 2). Light intensity must be 6.4-12.9E/day for growth. As shown by the conditional formatting of Table 2, none of the MWRA sites would provide suitable habitat for eelgrass growth in terms of light intensity, based on their depth and attenuation coefficients. However, at shallower depths, small changes in the attenuation coefficients resulted in a predicted light intensity at the bottom suitable for net eelgrass growth.

Table 2: Estimated Light Intensity

Station	Secchi depth (m)	Site depth (m)	Light intensity at site depth (E/day)
39	1.56	3.94	1.32
40	1.56	2.96	3.84
41	1.44	5.90	0.10
42	1.19	5.80	0.02
54	0.98	6.02	0.003
84	1.69	6.46	0.15
89	1.19	2.12	4.77
140	1.89	8.25	0.058

Equation 1. Beers-Lambert Equation for Light Attenuation

$I_d = I_0 e^{-kd}$

I_d is light intensity at depth *d*. I_0 is light intensity at depth 0. *k* is the attenuation coefficient (1.7/Secchi depth).

Implications for Final Assessment

Light intensity at depth may well be a major limiting factor in eelgrass survival and growth in the Neponset estuary. It is the impact resulting from many of the intuitive drivers and pressures in the estuary system. For the final assessment it would be useful to produce predictions for the various attenuation coefficients observed to see whether a change in the attenuation coefficient via management practices would make substantially more habitat suitable for eelgrass growth. Light intensity seems likely to be the proxy for the effects of any management recommendations made.

Accurate bathometry data would greatly improve estimations of light intensity from turbidity and Secchi disk depths. If light intensity is one of the major limiting factors in eelgrass growth then bathymetric data is the major limiting factor in understanding light intensity. There are ways of inferring or extrapolating depth profiles; and these will be a key component of the final assessment report.

Wave Action

Per Kenly's assessment phase II, eelgrass will be uprooted in habitats where wave action is higher than 1.5m/s. It is unlikely that wave action will be a significant problem in the Neponset River Estuary, as wave action in general is considerably reduced in an estuary that has limited mouth access (Rana 2007). Eelgrasses are exposed to a wide range of hydrodynamics, such as tides, currents and wave action, but are in general fairly tolerant (seagrassli.org). Wave action should be monitored in the mouth portions of the estuary, as they will be more susceptible to disturbance during storms and episodic events than segments deeper into the estuary.

Nitrogen

With the assumption derived from assessment phase I that nitrogen is the limiting nutrient for primary productivity in the Neponset River estuary, the Estuary Loading Model (ELM REF) was employed to estimate the net dissolved inorganic nitrogen in the estuary. The inputs used for the ELM, as well as their sources and associated assumptions can be seen in Table 3.

The ELM estimated net Dissolved Inorganic Nitrogen (DIN) loading of the Neponset River estuary at 666413.3kg N/year. This would suggest a loading rate of 205.37gN/m^2/year given 3.25km^2 of estuary area. This is either an indication of extreme eutrophication (39-45gN/m^2/year was suggested as high by Kenworthy, 1996) or that the nitrogen contributed by freshwater/land-derived sources is overestimated in the model.

Implications for Final Assessment

It was previously suggested in Assessment Phase I that an overestimation of land-derived/freshwater nitrogen could be the result of an inclusion of a high percentage of septic tanks in households in the area, while in actual fact most houses are connected to sewers that terminate at Deer Island after secondary treatment. Addressing this parameter, to which the initial Nitrogen Load Model (NLM) is particularly sensitive, could improve estimations of nitrogen loading for the management plan.

Table 3: ELM Model Inputs

Input	Estimation	Method/Source
Land derived TDN load (kg per year)	410393.3	Output from NLM Model (phase 1 assessment nload.mbl.edu) [half of original value; total NLM output value covers all N entering estuary]
Land derived TDN input to the freshwater portion (kg per year)	410393.3	Output from NLM Model (phase 1 assessment nload.mbl.edu) [half of original value; total NLM output value covers all N entering estuary]
Open water area (ha)	217	Considered to be the same as surface area at high tide; data from Gardner, Chen & Berry 2005, via Lynn's AP1
Average depth (m)	4.21	Averaged all bottom depths within and between sites from MWRA physical data 1994-2011 (mwra.state.ma.us)
Tidal range (m)	3	Zhu & Olsen 2009 via Lynn's AP1
Tidal period (hrs per day)	6	Boston Tide Charts (boatma.com/tides)
Number of houses	259827	334.4 houses per square mile, converted to square km, multiplied by 300 km^2 (census-charts.com)

Salt marsh area (ha)	107.513	Tiner *et al.* 1998; via Lynn's AP1
Eelgrass bed area (ha)	0	Eelgrass Mapping Project Viewer (mass.gov)
Total watershed area (ha)	33669.8	neponset.org/Watershed.htm
Length of estuary perimeter (m)	16000	Visual estimation using GIS (maps.google.com)
Flushing time of the freshwater reach (days)	0.063	Used the relative surface areas over tidal range (Gardner, Chen & Berry 2005, via Lynn's AP1) to calculate slope; assumed estuary was conic to calculate volume; used volume over flow rate to calculate flushing time.

Biotic Factors

Inhibitive Species

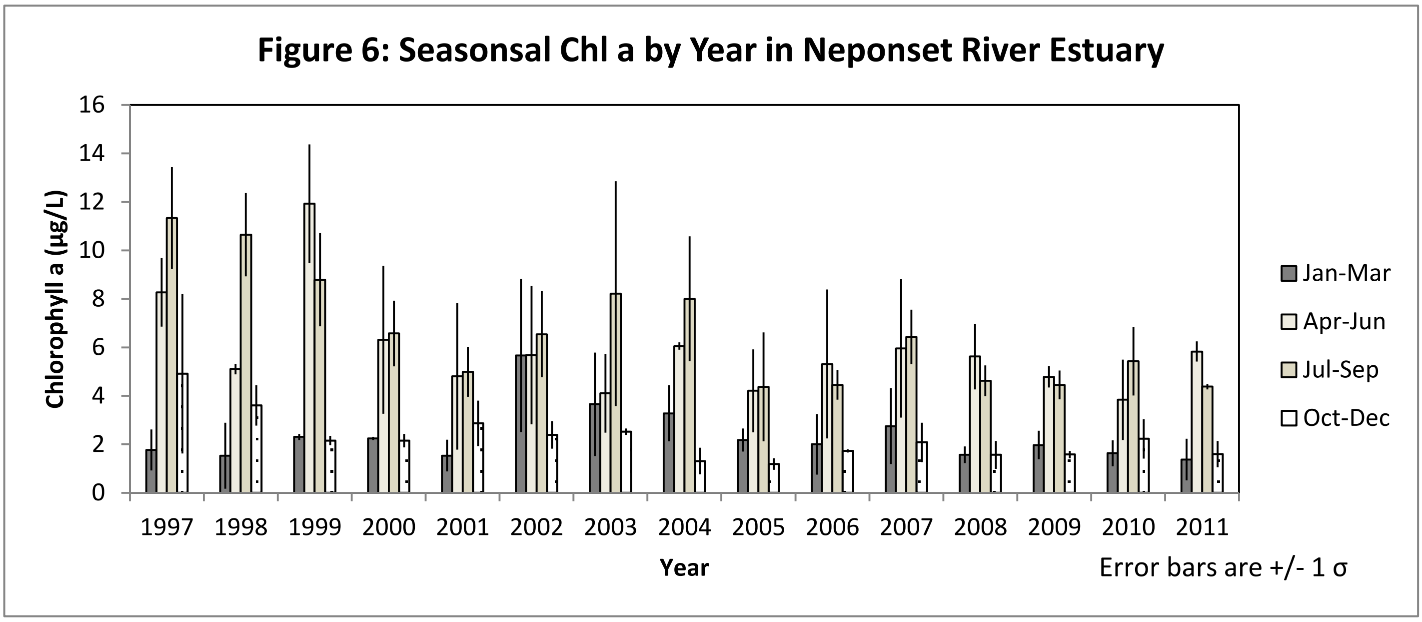
Inhibitive species are those that limit eelgrass growth indirectly, such as macroalgae and phytoplankton that increase turbidity and lower light intensity. Chlorophyll a was taken to be a proxy for inhibitive species abundance and averaged from the MWRA dataset from 1997-2011 across sites, for each season, in each year.

Chlorophyll a showed a reasonably strong seasonal profile, with maximum peaks in the summer or fall in every year, and minimum peaks in winter or spring. Although the data suggested some reduction of Chlorophyll a on a temporal scale, the variance is high and the sampling techniques have likely changed in this time. Also data was not available from 1994 as per other MWRA datasets. Chlorophyll a concentrations appear largely unchanged since 2005. A Neponset River Water Quality Assessment Report (1999), noted excessive algal growth on substrates in the Neponset River estuary, and attributed them to nutrient loading, storm water run-off and reduced water flow.

Implications for Final Assessment

Chlorophyll a is a proxy for light intensity available for eelgrass photosynthesis, and as such is a useful companion to light intensity estimates derived from Secchi disk data and the Beers-Lambert equation. High chlorophyll a concentration can also be a sign of nutrient loading. Also, detritus resulting from algal blooms can cause oxygen depletion in the bottom waters.

An accurate bathymetric survey and a thorough habitat assessment of the Neponset river estuary may also be useful to understanding and quantifying the impacts of the organisms associated with chlorophyll a.



Grazing Species

Eelgrass meadows are an integral part of the trophic food web in estuarine systems. Many organisms rely on eelgrass as a food source, either directly or indirectly (consumption of detritus or epiphytic matter). Typically, eelgrass does not constitute a large proportion of the diet of its consumers, as it contains a high amount of cellulose and is difficult to digest (seagrassli.org; Nienhuis & Groenendijk 1986). The majority of fauna that graze eelgrass are either migratory water fowl or macroinvertebrate, with the exception of cownose rays and green sea turtles.

In general, avian grazers include mute swans, Brant geese, Canadian geese, coots, pochards, teals, pintails, wigeons, and mallards (Nienhuis & Groenendijk 1986). All of these water birds are a potential threat in Dorchester Bay, except the pochard duck which is found only in Eurasia and Africa (birdweb.org). Swans and geese pose the greatest potential grazing pressure in the Boston area, as they are common year-round and are abundant in migration numbers.

Macroinvertebrate grazers of eelgrass include various crabs, snails, sea slugs, sea hares, amphipods, and isopods (seagrassli.org). Blue crabs, marsh crabs and chink snails are considered predominant consumers of eelgrass (delaware.gov; Altieri *et al.* 2012; Wilbur *et al.* 2007), and are all found in Massachusetts waters. A non-native amphipod species decimated eelgrass beds in San Francisco Bay, deeming the small crustaceans a potentially formidable player in eelgrass biomass reduction (Reynolds *et al.* 2012). Determining how various amphipod species may affect eelgrass growth in Neponset Estuary is unknown, but there are many species present in the area. The sea slug, *Elysia catulus*, is a noted grazer in New York, and is presumably also present in the Boston area (seagrassli.org). The isopod, *Idotea chelipes*, is also a known grazer of eelgrass, but is not a threat to the Neponset system, as they are not present in US Atlantic waters (Poore & Schotte 2012). It is possibly, though, that there are other local members of the isopoda family that may also graze on eelgrass, but that it is not presently recorded.

Green sea turtles and cownose rays feed on eelgrass, but will not be a potential threat in Boston waters, since they are limited by their range to lower latitudes (flmnh.ufl.edu).

Implications for Final Assessment

Seasonality of grazers will be an important aspect in grazing pressure on eelgrass. Migration patterns of water fowl will create episodes in the year in which grazing will be extensive, and may be particular detrimental to seedlings and new shoots of the plants. In 2006, an attempt to propagate an eelgrass bed off of Boston Harbor by the Massachusetts Office of Coastal Zone Management and MIT failed in large part to fouling and grazing by swans and geese (Wilbur *et al.* 2007).

As it stands, there is no quantification of actual grazing numbers. Estimation of population abundances and grazing pressure will be useful for extrapolation of transplant success, and should be addressed in the final report.

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APPENDIX: Mean and Standard Deviations for Salinty and Turbidity

Date	Salinity Mean	Salinity SD	Turbidity Mean	Turbidity
Jan-Mar 1994	26.66	N/A	29.72	N/A
Jan-Mar 1995	29.57	N/A	5.67	N/A
Jan-Mar 1996	30.15	N/A	13.00	N/A
Jan-Mar 1997	15.10	21.19	4.88	4.42
Jan-Mar 1998	14.72	20.76	23.67	2.15
Jan-Mar 1999	14.51	20.39	3.70	1.22
Jan-Mar 2000	25.03	11.34	13.65	11.32
Jan-Mar 2001	25.95	10.51	4.80	3.19
Jan-Mar 2002	30.98	N/A	25.49	1.61
Jan-Mar 2003	15.32	21.31	2.92	0.82
Jan-Mar 2004	15.59	21.72	4.57	N/A
Jan-Mar 2005	14.96	20.80	3.40	N/A
Jan-Mar 2006	15.36	21.39	3.45	N/A
Jan-Mar 2007	16.12	22.56	3.96	N/A
Jan-Mar 2008	23.68	13.14	6.95	0.96
Jan-Mar 2009	24.82	13.74	6.74	0.85
Jan-Mar 2010	22.51	12.78	7.94	2.66
Jan-Mar 2011	22.33	14.75	3.84	1.38
Apr-Jun 1994	27.13	N/A	5.00	N/A
Apr-Jun 1995	29.90	N/A	2.75	N/A
Apr-Jun 1996	28.85	N/A	6.33	N/A
Apr-Jun 1997	20.45	17.65	3.57	3.11
Apr-Jun 1998	23.23	10.30	11.62	8.27
Apr-Jun 1999	24.74	9.17	6.03	2.93
Apr-Jun 2000	24.47	9.38	6.36	2.48
Apr-Jun 2001	25.59	9.63	9.05	2.76
Apr-Jun 2002	25.23	9.49	9.82	5.39
Apr-Jun 2003	24.65	9.24	7.06	2.76
Apr-Jun 2004	25.16	9.50	11.91	4.26
Apr-Jun 2005	24.01	9.11	9.10	2.85
Apr-Jun 2006	25.44	9.59	7.46	2.61
Apr-Jun 2007	24.48	9.41	11.19	4.65
Apr-Jun 2008	25.46	9.60	10.17	5.26
Apr-Jun 2009	25.78	9.75	11.63	2.63
Apr-Jun 2010	25.35	9.52	9.13	3.67
Apr-Jun 2011	25.35	9.46	8.11	1.92
Jul-Sep 1994	26.89	1.59	17.36	2.13
Jul-Sep 1995	29.22	2.20	7.10	3.04
Jul-Sep 1996	30.05	1.26	10.97	1.59
Jul-Sep 1997	22.51	14.69	10.26	7.64
Jul-Sep 1998	25.32	11.29	20.55	11.31
Jul-Sep 1999	26.60	9.92	7.06	2.47
Jul-Sep 2000	26.06	9.87	5.45	2.80
Jul-Sep 2001	27.51	10.30	7.47	3.51
Jul-Sep 2002	26.85	10.02	7.67	2.59
Jul-Sep 2003	25.81	9.63	14.02	5.31
Jul-Sep 2004	25.50	9.59	13.69	5.69
Jul-Sep 2005	25.89	9.69	12.72	4.02
Jul-Sep 2006	26.38	9.89	10.67	5.07
Jul-Sep 2007	30.68	1.10	8.88	2.92
Jul-Sep 2008	26.87	10.08	14.87	4.85
Jul-Sep 2009	26.28	9.10	13.85	2.49
Jul-Sep 2010	26.50	9.27	14.50	6.63
Jul-Sep 2011	25.91	9.70	15.39	6.56
Oct-Dec 1994	30.42	N/A	4.80	N/A
Oct-Dec 1995	30.14	N/A	5.63	N/A
Oct-Dec 1996	29.14	N/A	4.89	N/A
Oct-Dec 1997	15.63	21.90	15.47	12.92
Oct-Dec 1998	24.54	10.23	13.91	11.07
Oct-Dec 1999	26.19	10.58	4.57	0.99
Oct-Dec 2000	26.40	9.94	8.40	3.37
Oct-Dec 2001	27.95	10.43	4.02	1.25
Oct-Dec 2002	25.06	10.13	3.00	1.59
Oct-Dec 2003	26.01	9.73	11.71	5.43
Oct-Dec 2004	25.25	9.45	8.74	4.74
Oct-Dec 2005	25.17	9.48	11.04	3.18
Oct-Dec 2006	26.10	9.92	5.87	3.20
Oct-Dec 2007	27.37	10.24	4.10	0.87
Oct-Dec 2008	26.88	10.06	6.78	0.99
Oct-Dec 2009	26.68	10.00	8.65	3.68
Oct-Dec 2010	26.56	9.92	9.89	4.34
Oct-Dec 2011	25.76	9.65	7.40	1.95