Neponset River Estuary
Area of Critical Environmental Concern
Water Quality and Restoration Action Plan

Rainbow Smelt (*Osmerus mordax*) getting ready to spawn in Gulliver's Creek/Unquity Brook.

January 15, 2014

Prepared By: William Guenther
Environmental Scientist

Neponset River Watershed Association
2173 Washington St.
Canton MA, 02021

Contents

List of Tables

List of Figures

Executive Summary

The Neponset River Watershed Association (NepRWA) has spent over a decade monitoring the water quality of the Neponset River Watershed, focusing almost entirely on the freshwater lakes, rivers and tributaries. This program has had many successes over the years and has helped lead to improved water quality conditions in several areas of the watershed. However this program never directly addressed monitoring and potential improvements in the estuary section of the river.

With water quality having improved the Association feels that it is time to look more closely at the estuary, its current condition with regard to water quality and the potential for restoration initiatives, both short and long term in scope.

This action plan surveys the current monitoring programs that may exist in and around the Neponset estuary, briefly summarize some of their findings and ultimately make recommendations for both short and long term restoration initiatives in several areas to help benefit water quality and overall ecosystem function in the Neponset estuary.

The primary data collection efforts to be examined include the Massachusetts Water Resource Authority's (MWRA) Harbor Monitoring Program, the Division of Marine Fisheries' Shellfish Sanitation and Management monitoring program, the Boston Water and Sewer Commission's (BWSC) Illicit Connection Discharge Detection and Elimination (IDDE) program and monitoring conducted by the Coastal Environmental Sensing Networks (CESN) group associated with UMASS Boston.

The data provided by these groups and programs will be examined and recommendations for several restoration possibilities will be given. The areas of restoration potential will include water quality improvement, salt marsh restoration, the conditional opening of commercial shellfish beds, reestablishment of historic anadromous fish runs and eelgrass restoration.

The hope is that through this document a clearer path can be generated that illuminates the opportunities that NepRWA and other parties might choose to pursue over both a short term scale (1-5 years) and long term scale (10-30 years). While not everything outlined in this action plan may be accomplished within the time frames suggested, it is important nonetheless to have a clear idea of restoration alternatives given the often complicated nature of many of these possible initiatives.

Introduction

For more than a decade, the Neponset River Watershed Association has conducted a volunteer-based water quality monitoring effort aimed at identifying and reducing sources of pollution contributing to violations of surface water quality standards in the freshwater portion of the Neponset River. This program has helped to identify, characterize and eliminate dozens of discharges, including illicit sewer connections, sewer exfiltration, sewer under drains, illegal industrial discharges and, most recently sources of stormwater pollution. It has also been instrumental in providing data that illustrate the need for further restorative efforts in the watershed.

Because the MWRA funds most of the lab work for this program and the MWRA itself collects water quality samples in the Neponset River estuary, the Watershed Association's monitoring program has never addressed the Neponset River estuary. Given the many successes in the freshwater portion of the river and the additional work that the MWRA and BWSC have completed over the years this is an excellent time to take a closer look at the current conditions in the estuary and make a preliminary assessment as to the overall health of the estuary and the potential for restoration in several areas both short and long term.

Neponset Watershed and Estuary Location

The Neponset River Watershed encompasses roughly 120-square miles winding its way through 14 cities and towns (Fig. 1). In 1995 the Neponset River Estuary was designated as an Area of Critical Environmental Concern (ACEC), in response to a nomination by NepRWA. The ACEC designation includes roughly 4 miles of river starting in Lower Mills at the base of the Baker Dam and extending down river to the River's terminus in Dorchester Bay near Squantum Point. The estuary is located in the Town of Milton, City of Quincy and City of Boston. The ACEC for the Neponset River Estuary includes not only the river corridor but also upland habitats encompassing nearly 1,300 acres of protected resource (Fig. 2).

ACECs are nominated at the community level and are reviewed and designated by the state's Secretary of Environmental Affairs. Once designated as an ACEC a framework is created for both local and regional stewardship of the critical resources and ecosystems within its borders.

Interview Process and Purpose

In order to assess the multitude of restoration options that are possible in and around the estuary it was first important to look at past and present data collection efforts as they pertain to the estuary and examine them for the types of data they collect and how those data could be used to direct restoration efforts. It is not known if an effort such as this has ever been undertaken to evaluate water quality data as it directly pertains to the Neponset estuary. To accomplish this, a questionnaire matrix was created and designed to catalogue and organize information from interviews with entities believed to be collecting water quality or biological data in the estuary as well as groups or organizations within close proximity to the estuary that may have a potential interest in future restoration and monitoring in the estuary.

Information gathered in this matrix included the name of the monitoring program along with the start and end date of sample collection if known. Additional information about the frequency of sampling, types of parameters sampled and number of sampling stations was also collected. Finally, information about the availability of the data sets was compiled including information on the location of data sets and their availability to the public (Appendix 1).

Figure 1: Map depicting the Neponset Watershed and associated Areas of Critical Environmental Concern (ACECs).

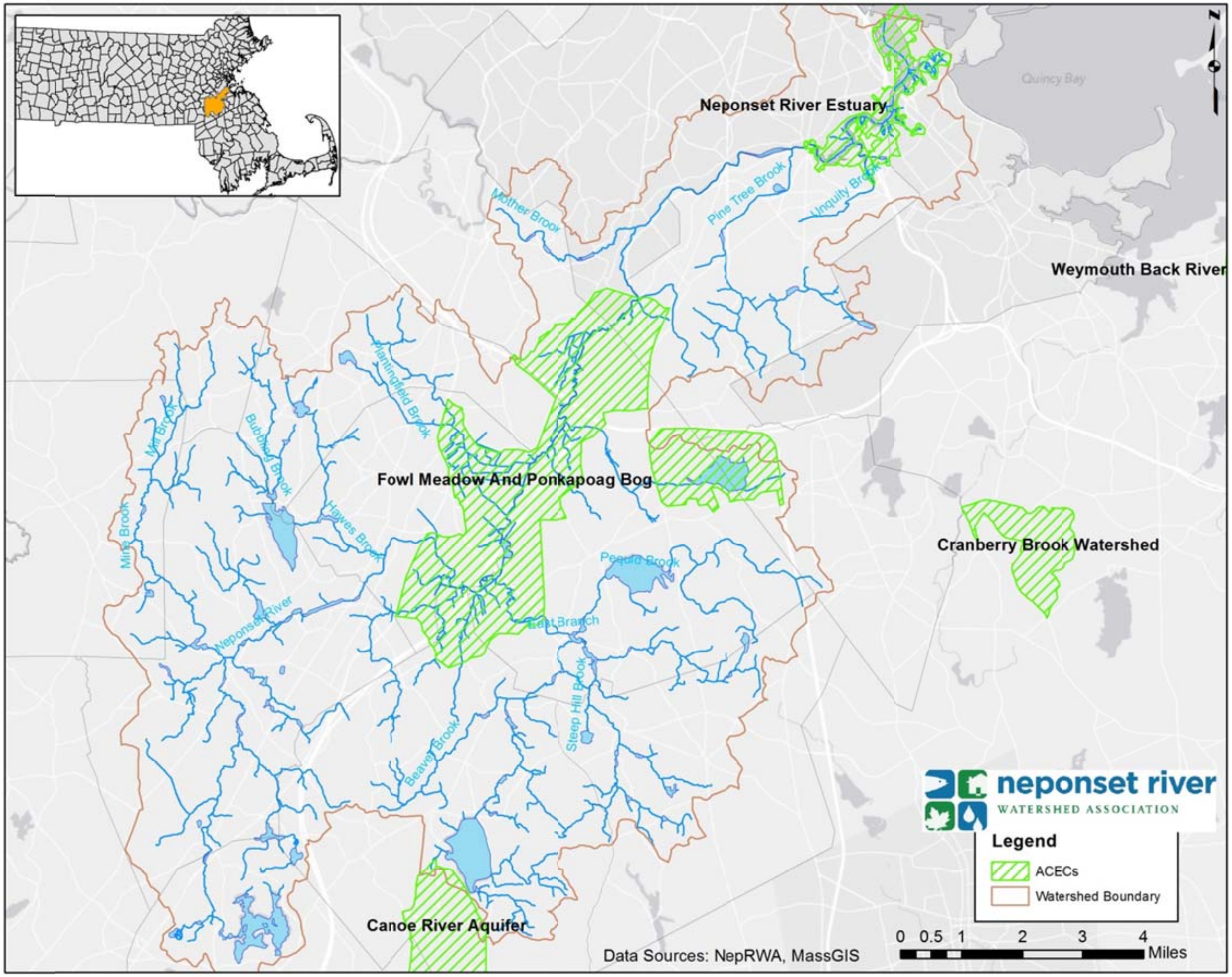
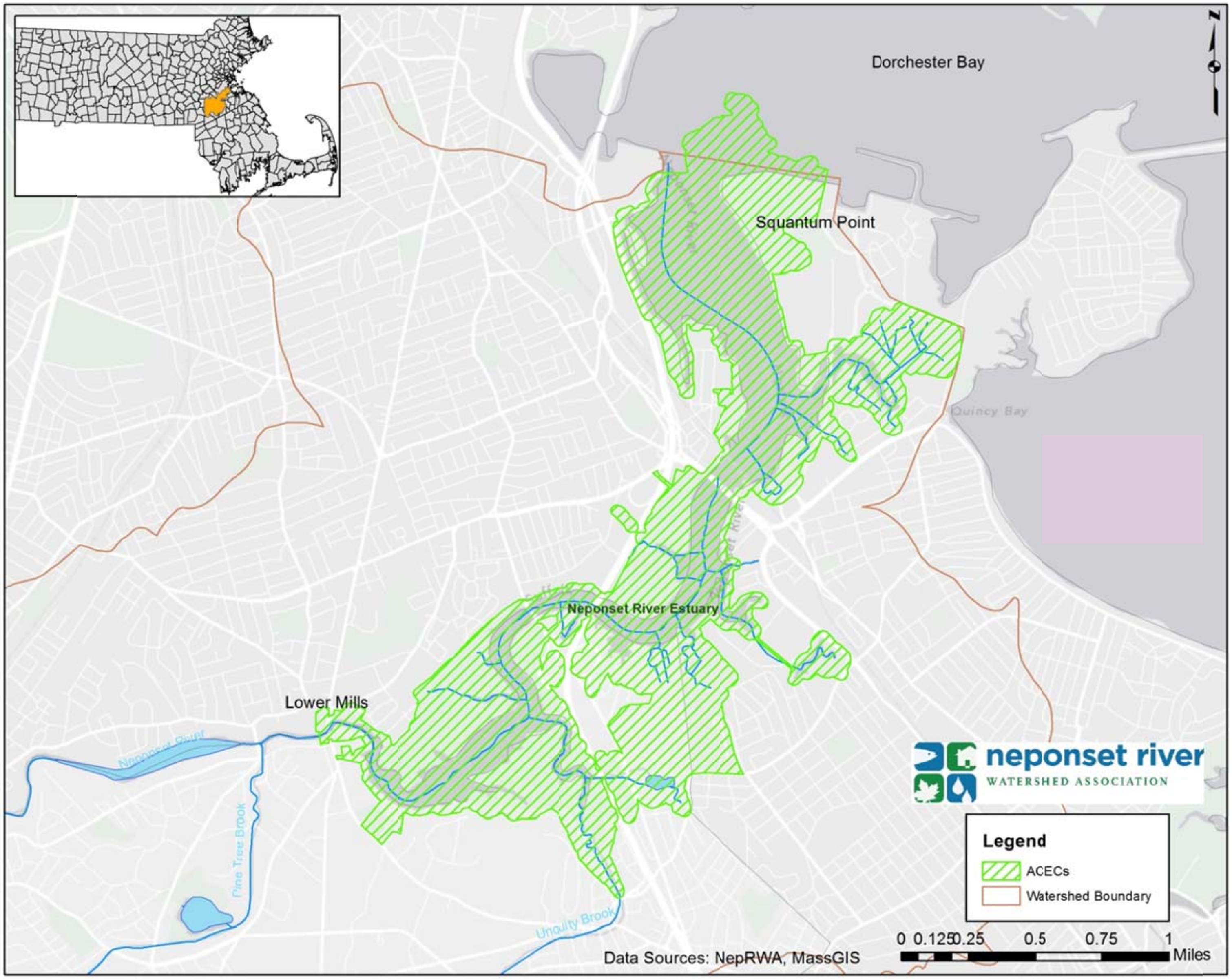


Figure 2: Neponset Estuary ACEC boundary and general location.



Organizations and groups that we identified as potentially having data relevant for this report included the Massachusetts Water Resource Authority (MWRA), Boston Water and Sewer Commission (BWSC), Department of Conservation and Recreation (DCR), Division of Marine Fisheries (DMF), various professors and students at UMASS Boston believed to be collecting data in the estuary or with an interest in estuary function and/or water quality monitoring, the Town of Milton, the City of Quincy, Northeastern University, Mass Department of Environmental Protection (MassDEP), Milton Academy, the Mass Oyster Project and the US Geological Survey (USGS).

Ongoing Data Collection Efforts

Once the interview process was completed it became apparent that there were a limited number of entities currently conducting research and/or collecting environmental samples in the Neponset Estuary. Those conducting sampling in the estuary included the MWRA, individuals associated with UMASS Boston's CESN program, DCR, DMF and to a lesser degree the BWSC (Fig. 3). Outside of these organizations there were no current sampling programs taking place.

The interview process also revealed several sampling programs and studies that have been concluded or are no longer active. These include information on PCB contamination described in reports authored by the USGS. Additionally, information about anadromous fish located in the Neponset estuary compiled by DMF was reviewed as well as information on pollution source tracking conducted by MassDEP.

Massachusetts Water Resource Authority (MWRA)

By far, the largest of all the data collection efforts currently ongoing in the estuary is the MWRA's Harbor Monitoring Program. This program has been taking samples at locations in the Neponset Estuary in some form or fashion since the late 1980's and continues to this day (Fig. 3).

Data collection for this program pertaining to the Neponset Estuary is divided into two parts. Bacteria sampling, which is conducted at 6 locations (sites 055,042,089 and 041)in the estuary and at the mouth of the river in Dorchester Bay and nutrient sampling which is conducted at only two locations, one at the Baker Dam in Milton (Site 055) and finally a short distance beyond the end of the Neponset River in Dorchester Bay (Site 140) (Fig. 3). The frequency of sampling has changed slightly over the years at these locations but is currently conducted roughly on a bi-weekly basis where nutrient stations are sampled one week and the following week stations are sampled for bacteria. This program is set to continue at least until 2017 when the MWRA's NPDES Permit is set to expire. It is unclear if, and to what degree, the monitoring will continue past this date.

UMASS Boston Coastal Environmental Sensing Networks (CESN) Program

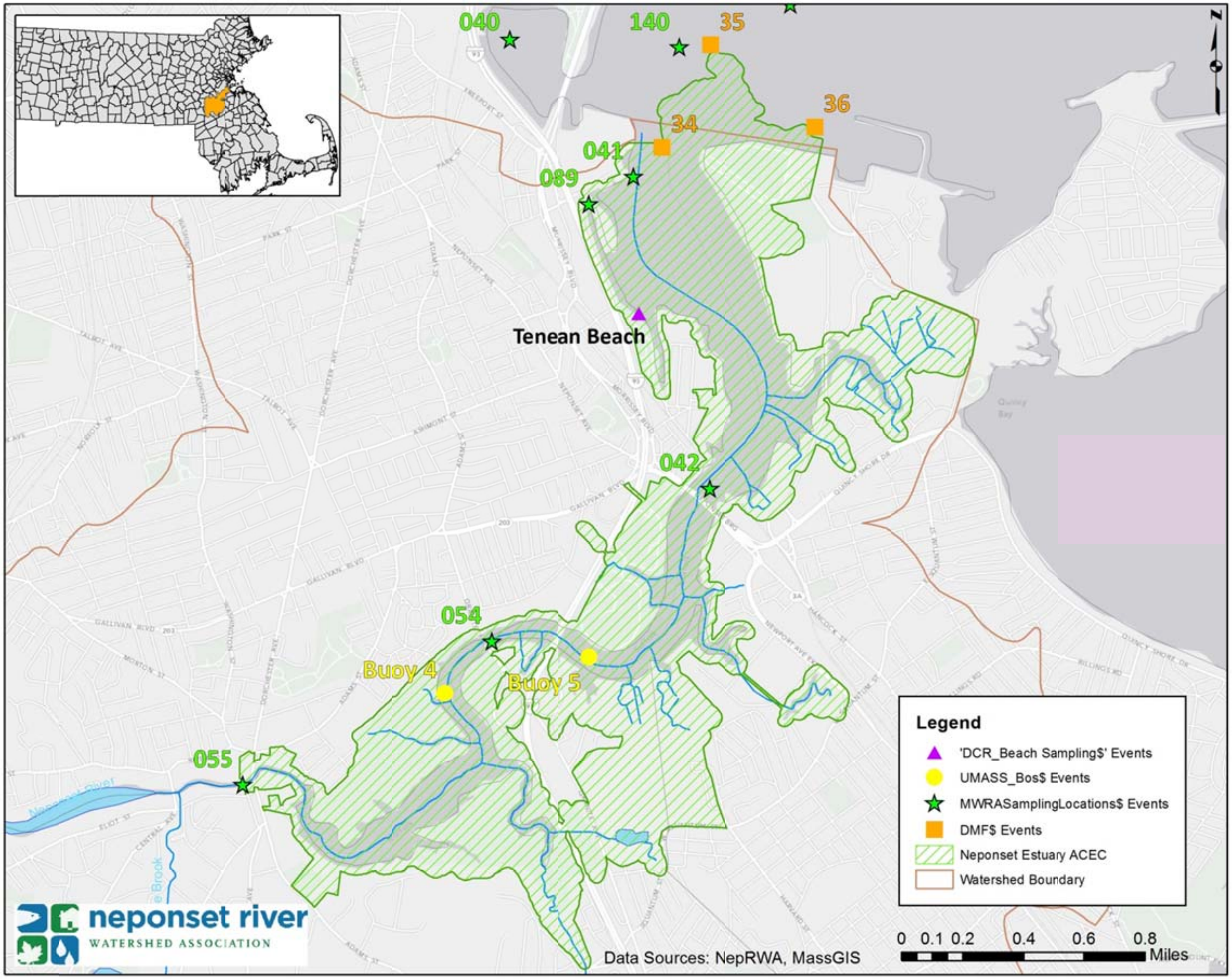
UMASS Boston's CESN Program is an environmental monitoring working group made up of university researchers and students that aims to provide an integrated framework for developing environmental sensor networks in coastal areas. Work by this group primarily focuses on the installation and monitoring of several buoys fitted with remote sensing equipment that are capable of taking continuous and timed measurements for a suite of environmental parameters. The highlight of this program is the real-time nature of the data sets that are retrieved from the buoys' sensors.

Buoys have been located at as many as three sites along the Neponset estuary since 2009 and currently are sited at two locations (Fig. 3). The duration of deployment of these sensors has not always been consistent over the lifetime of the project due to factors including maintenance needs, sampling parameter changes and ultimately funding inconsistencies. Despite these challenges, the remote sensing buoys have recorded an impressive data set over the relatively short timeline of deployment and offer a unique opportunity for data collection in the estuary going forward.

Department of Conservation and Recreation (DCR)

Water quality samples are taken by DCR, with assistance from the MWRA, at several Boston Harbor area beaches. Tenean Beach specifically, falls within the Neponset estuary and is one of the beaches currently monitored under this program. DCR currently has one sampling location at Tenean Beach that has been placed to monitor bacteria levels that affect beach closures during the swimming season, May through late August/early September (Fig. 3). Data collection to this point has typically been conducted daily with some small gaps due to extreme weather conditions and quality control issues. Data sets evaluated for this report date back to 2001.

Figure 3: Map depicting sampling locations for the major data collection efforts in the Neponset River estuary as of December, 2013.



Boston Water and Sewer Commission

While the BWSC does not have a water quality monitoring program they do conduct a robust Illicit Discharge Detection and Elimination (IDDE) Program that has been ongoing since the 1980s. The BWSC is responsible for several catchment areas that discharge directly to the Lower Neponset River and estuary with documented issues with illicit connections. Since illicit connections can have a significant impact on receiving waters, through the discharge of untreated sewage effluent to the river and estuary, it was important to include this program in the review and subsequent recommendations for restoration moving forward.

It should be noted that the BWSC is not the only entity that is responsible for outfalls and stormwater catchment areas discharging directly to the Neponset estuary. The Town of Milton and City of Quincy, MA, also own outfalls and catchments discharging to the Neponset. At the time of this writing there was no known illicit connections or problem catchments in these two towns however, both of these towns are subject to the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer (MS4) permit program and conduct their own IDDE programs as part of this program. The IDDE monitoring requirements under the existing MS4 permit are relatively limited, however more extensive monitoring is likely to be required under the forthcoming renewal of the MS4 permits.

While the BWSC IDDE program has been around for some time it is currently guided by a Consent Decree (CD) between the BWSC, the United States Environmental Protection Agency (USEPA), Conservation Law Foundation (CLF) and MassDEP (CLF and USA 2012). Under the Consent Decree, BWSC is following a regimented timeline to complete IDDE investigations in sub-catchment areas throughout the City of Boston, including areas in the Neponset River watershed, its estuary and along Tenean Beach (Fig. 4). Under the CD the BWSC will be completing investigations of "Very High" priority catchments, which include drainage areas discharging to Tenean Beach, by 2014. For the Neponset estuary the area surrounding Tenean Beach is of particular concern.

As the beach investigations are progressing the BWSC is also investigating several "High" priority catchment areas that discharge directly to the Neponset River and/or estuary and which have known water quality problems and suspected illicit connections. Given the proximity of these outfalls to the estuary, it is likely that these investigations and eventual elimination of suspected illicit discharges will have the effect of improving overall water quality in the estuary moving forward.

Division of Marine Fisheries

The Division of Marine Fisheries has both historical and current sampling sites located within the Neponset River estuary for the purpose of characterizing and evaluating the various shellfish resources in the estuary. Current sampling efforts by the DMF, pertaining to the Neponset estuary, include sampling locations near the mouth of the river on Buckley's Bar (C-34, C-35, and C-36) adjacent to Squantum Point, in Quincy (Fig. 5). Water samples are taken at these locations and analyzed for fecal coliform bacteria, the indicator organism used to evaluate the health and safety of shellfish resources detailed in the National Shellfish Sanitation Program (NSSP) (FDA 2011). Sampling stations do exist at additional locations in the estuary and were sampled historically dating back to the mid 1980's but data collection efforts are now focused exclusively on Buckley's Bar (Fig. 5).

Figure 4: Location of BWSC outfalls and contributing catchment areas for Very High and High priority levels under the Consent Decree. Outfall 12L296 is owned by the MassDoT and BWSC owns and operates the catchment discharging to the outfall.

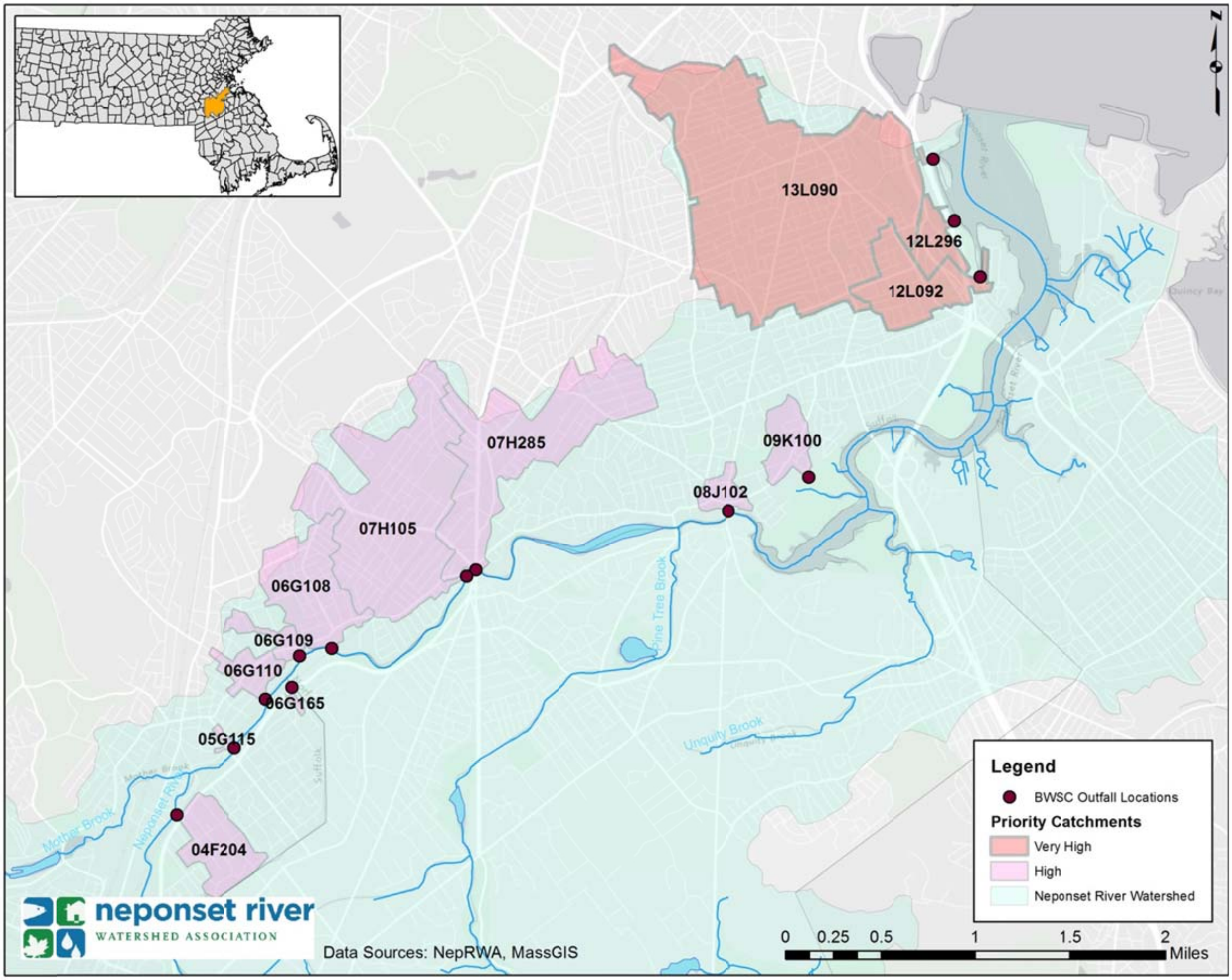
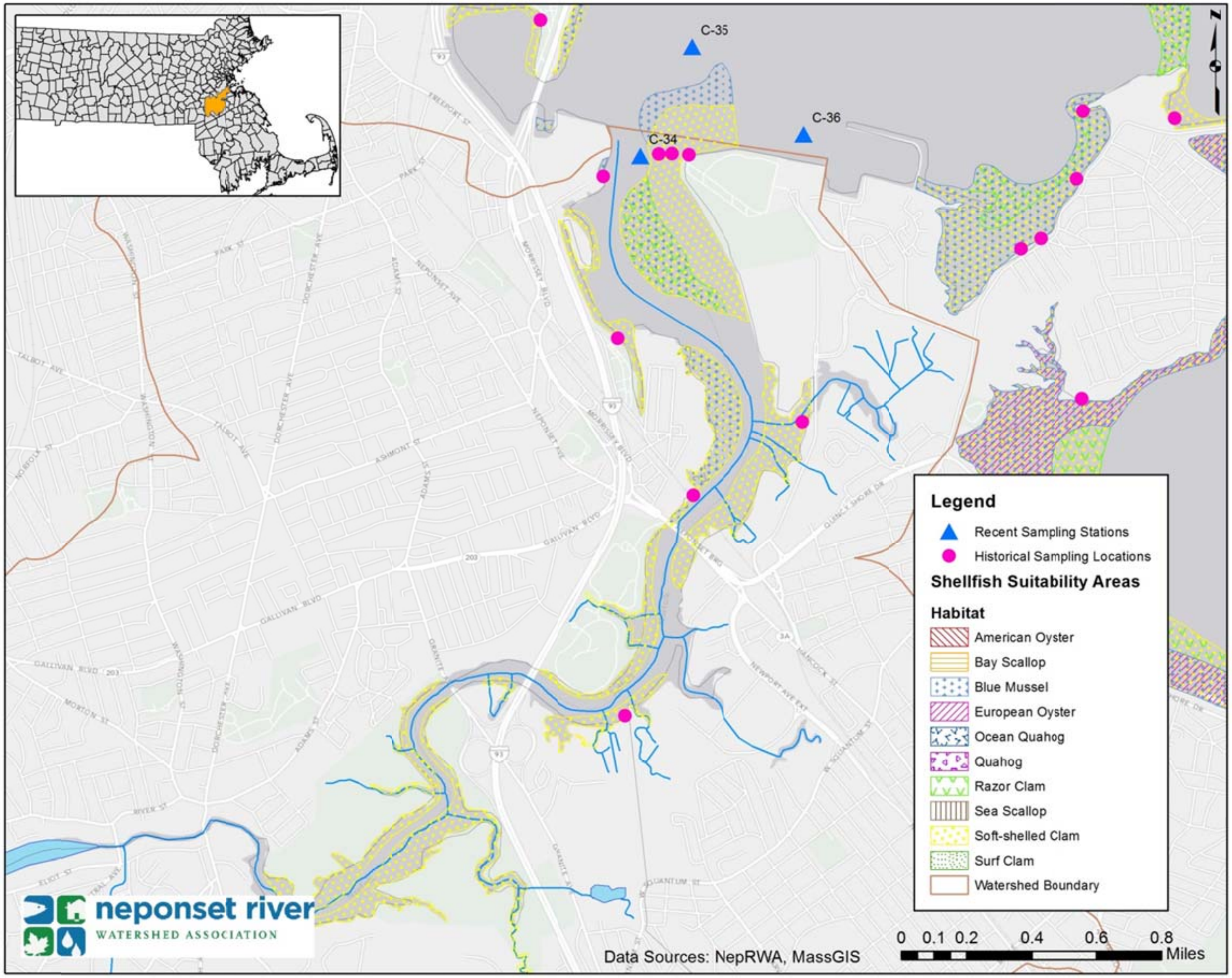


Figure 5: Shellfish beds and Division of Marine Fisheries (DMF) sampling locations within the Neponset River estuary and associated with Buckley's Bar.



Potential Areas for Restoration

To the maximum extent possible, with the data sets available, this document will explore several restoration alternatives and examine possible barriers to restoration, short and long term alternatives and the next steps required to reach suitable restoration end points. The short list of restoration alternatives was adapted from a more comprehensive table of restoration alternatives tracked as part of the Massachusetts In-Lieu Fee (ILF) Program administered by the Massachusetts Division of Marine Fisheries (DMF) pursuant to the 2008 Army Corps of Engineers regulations (Table 1)(Carr et al. 2012). The list of alternatives detailed under the MA ILF program was consolidated to reflect the major areas of restoration deemed most appropriate and specific to the Neponset estuary through the experience of the Neponset River Watershed Association (NepRWA). The restoration alternatives examined here are:

1. Water Quality Improvement
2. Saltmarsh Restoration
3. Anadromous Fish Enhancement
4. Shellfish Restoration and Harvesting
5. Eelgrass Restoration

By no means is this an exhaustive list of all potential restoration initiatives that could be envisioned for the Neponset River estuary. Rather, this list attempts to comprise the major restoration projects that could be envisioned both on a short and long term basis and that could have the greatest impact on the overall health of the Neponset estuary.

Table 1: Restoration opportunities for coastal and estuarine habitat impacts under the MA ILF program

Open Water	Water Quality Improvement	Salt Marsh	Salt marsh restoration
	Sediment remediation		removal of tidal restrictions
	Marine debris removal		Sediment remediation
	Fish habitat enhancement		Conservation easements
	Coastal fill removal	Streams	Fish passage (dam removal, ladders)
	Shellfish restoration		Water level management
SAV	Eelgrass planting		Water quality improvements
	Modification of mooring hardware	Intertidal	Marine debris removal
			Shellfish restoration

Water Quality Improvement

Of all the restoration alternatives to be explored in the Neponset estuary the most important from a recreational standpoint is the attainment of primary and secondary contact recreation standards through improvements to overall water quality. Improved water quality would also help to decrease the impacts of cultural eutrophication resulting in overall improved conditions for numerous plant and animal species.

The Massachusetts Water Quality Standards list numerical standards for several analytes and resource water conditions ranging from A, B and C in freshwater and SA, SB and SC in saltwater. The freshwater portions of the Neponset River watershed are categorized as B waters and the estuary is categorized as an SB water. The most important standards, with regard to the Neponset, are those for bacteria since the Neponset already has a TMDL for bacteria. Additionally, bacteria levels are the primary indicator used to evaluate use attainment for primary and secondary contact recreation. While bacteria are the indicator group used for these determinations the organisms used for these evaluations differ for fresh and saltwater systems. For freshwater systems the indicator bacteria are *E.coli* and for saltwater they are *Enterococci*.

According to the Massachusetts WQSs for primary contact recreation (i.e. swimming) in class SB waters, the geometric mean for the most recent five samples for enterococci bacteria shall not exceed 35 colonies/100mL and no single sample shall exceed 104 colonies/100mL. For secondary contact recreation the geometric mean shall not exceed 175 colonies/100mL for the most recent six month period for and no more than 10% of the samples shall exceed 350 colonies/100mL (314 CMR 4.00).

For the freshwater sections of the Neponset River the bacteria criteria are very similar however the indicator bacteria used are *E.coli* instead of *Enterococci*. For Class B waters in the freshwater Neponset *E.coli* shall not exceed 235 colonies per 100mL for single samples and the geometric mean of the five most recent samples taken during the bathing season shall not exceed 126 colonies per 100mL (314 CMR 4.0).

In addition to standards for bacteria the Mass WQS list numerical or narrative standards for dissolved oxygen, pH, temperature, solids, color and turbidity, oil and grease and taste and odor. These standards are used to determine the ability of a particular resource water to support aquatic life. These standards are as follows:

Dissolved Oxygen: Shall not be less than 5.0 mg/l. Seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained. Where natural background conditions are lower, DO shall not be less than natural background.

Temperature: Shall not exceed 85°F (29.4°C) nor a maximum daily mean of 80°0F (26.7°C), and the rise in temperature due to a discharge shall not exceed 1.5°F (0.8°C) during the summer months (July through September) nor 4°F (2.2°C) during the winter months (October through June);

pH: Shall be in the range of 6.5 through 8.5 standard units and not more than 0.2 units outside of the natural background range. There shall be no change from natural background conditions that would impair any use assigned to this Class.

Solids: These waters shall be free from floating, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

Color and Turbidity: These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use assigned to this class.

Oil and Grease: These waters shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course, or are deleterious or become toxic to aquatic life.

Taste and Odor: None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to this class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.

At this time there are no numerical standards for nutrients such as phosphorus and nitrogen. Despite the lack of current numerical standards the US Environmental Protection Agency (USEPA) has created guidance for the creation of these numerical standards in the form of Total Maximum Daily Loads or TMDLs (USEPA 1999, USEPA 2001). Additionally the State of Massachusetts has a narrative standard that addresses nutrients that reads as follows:

Unless naturally occurring, all surface waters shall be free from nutrients in concentrations that would cause or contribute to impairment of existing or designated uses and shall not exceed the site specific criteria developed in a TMDL or as otherwise established by the Department pursuant to 314 CMR 4.00.

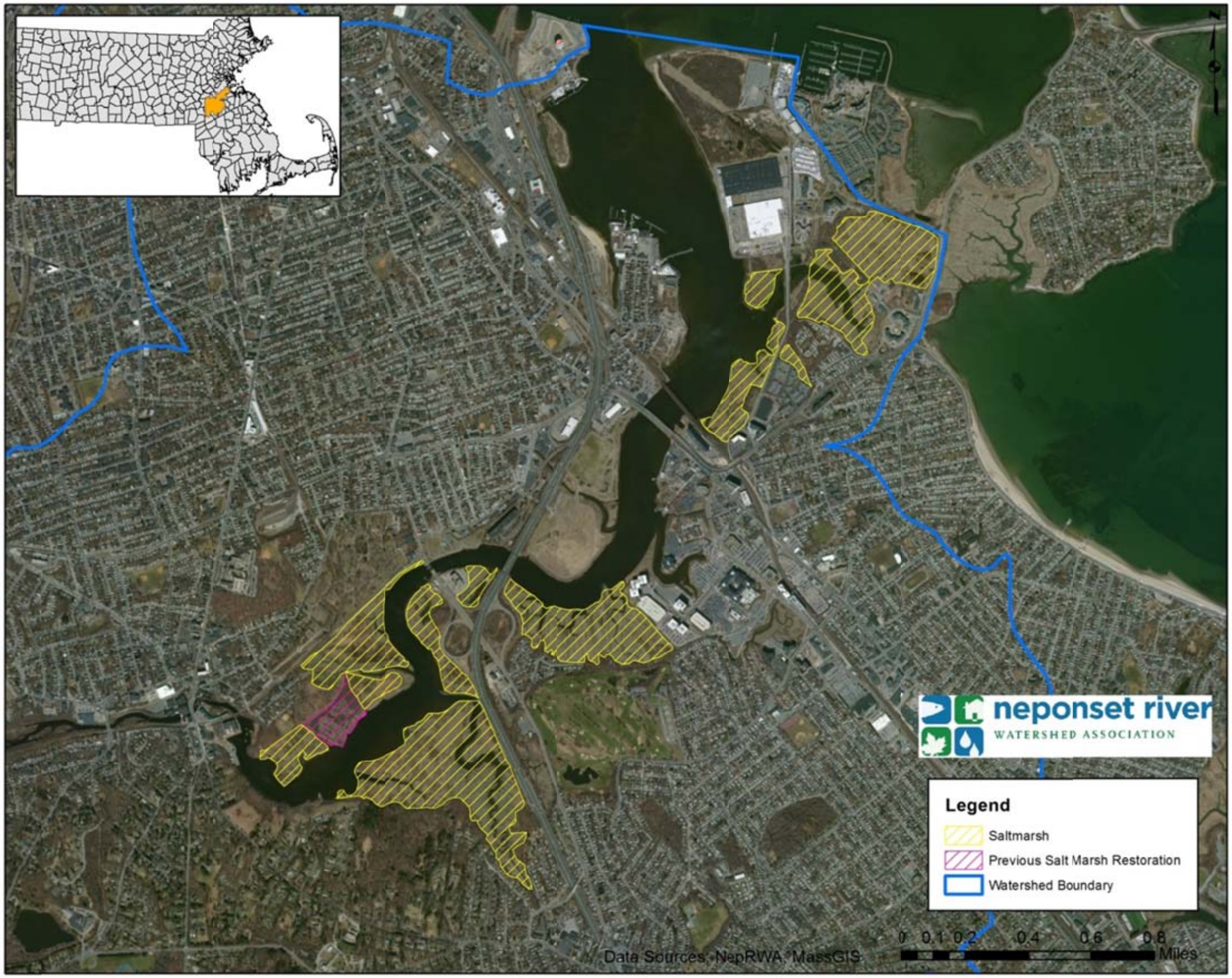
Any existing point source discharge containing nutrients in concentrations that would cause or contribute to cultural eutrophication, including the excessive growth of aquatic plants or algae, in any surface water shall be provided with the most appropriate treatment as determined by the Department, including, where necessary, highest and best practical treatment (HBPT) for POTWs and BAT for non POTWs, to remove such nutrients to ensure protection of existing and designated uses. Human activities that result in the nonpoint source discharge of nutrients to any surface water may be required to be provided with cost effective and reasonable best management practices for nonpoint source control.

Salt Marsh

The restoration of salt marsh in the Neponset estuary is also a considerable priority. The salt marshes in the Neponset are the largest contiguous marshes that remain in and around Boston Harbor. There are several areas that have established marshes (Fig. 6). Marshes have significant influence on the health of estuaries and adjacent resources. In addition to being critical habitat for a multitude of native plant and animal species marshes also play a role in nutrient cycling and nutrient abatement throughout the estuary and ultimately Boston Harbor. They also play a role in flood protection by creating a barrier between upland habitats and the open Harbor.

Salt marshes in the Neponset River estuary have been subjected to a number of impairments over the years including mosquito ditching, deposition of dredge spoil and other filling, and tidal restrictions. Salt marsh restoration has already taken place at one location on the Dorchester side of the river back in 2005 but opportunity for continued restoration may exist at this site, as well as on multiple scales in other areas throughout the estuary (Fig. 6) (USEPA, DCR, DER pers. comm.).

Figure 6: Map showing the location of past salt marsh restoration in the Neponset River estuary and locations of additional salt marshes that could be investigated for restoration potential based on personal communication with USEPA, DCR and DER.



Anadromous Fish

The Neponset estuary is home to numerous fish species but is particularly important because it possesses both historical and currently significant spawning habitat for several anadromous fish species. Anadromous fish are those species that breed and spawn in freshwater and spend their adult lives in saltwater. American Shad (*Alossa sapidissima*), Alewife and Blueback Herring (*Alosa pseudoherengus, Alosa aestivalis*) and Rainbow Smelt (*Osmerus mordax*) have all historically depended on the Neponset River and its estuary for critical spawning habitat.

River herring and American shad have been documented in the Neponset River in recent years but at very low numbers as they are limited from reaching native spawning and nursery habitat upstream of the Walter Baker Dam (Reback et al. 2005)(Fig. 7). American shad populations have declined sharply from historic levels in Massachusetts. The Neponset River is only one of eight rivers in Massachusetts where American shad are presently known to occur (Reback et al. 2005).

The estuary also hosts one of the state's most significant rainbow smelt runs just below the Baker Dam on the Neponset River and a much smaller run on Gulliver's Creek in Milton (Fig. 7). The Neponset River smelt run is one of the largest in the state and supports a popular recreational fishery in Boston Harbor. The spawning habitat for smelt in the Neponset River extends for over 300 m downstream from the Baker Dam in Lower Mills (Chase 2006).

Shellfish

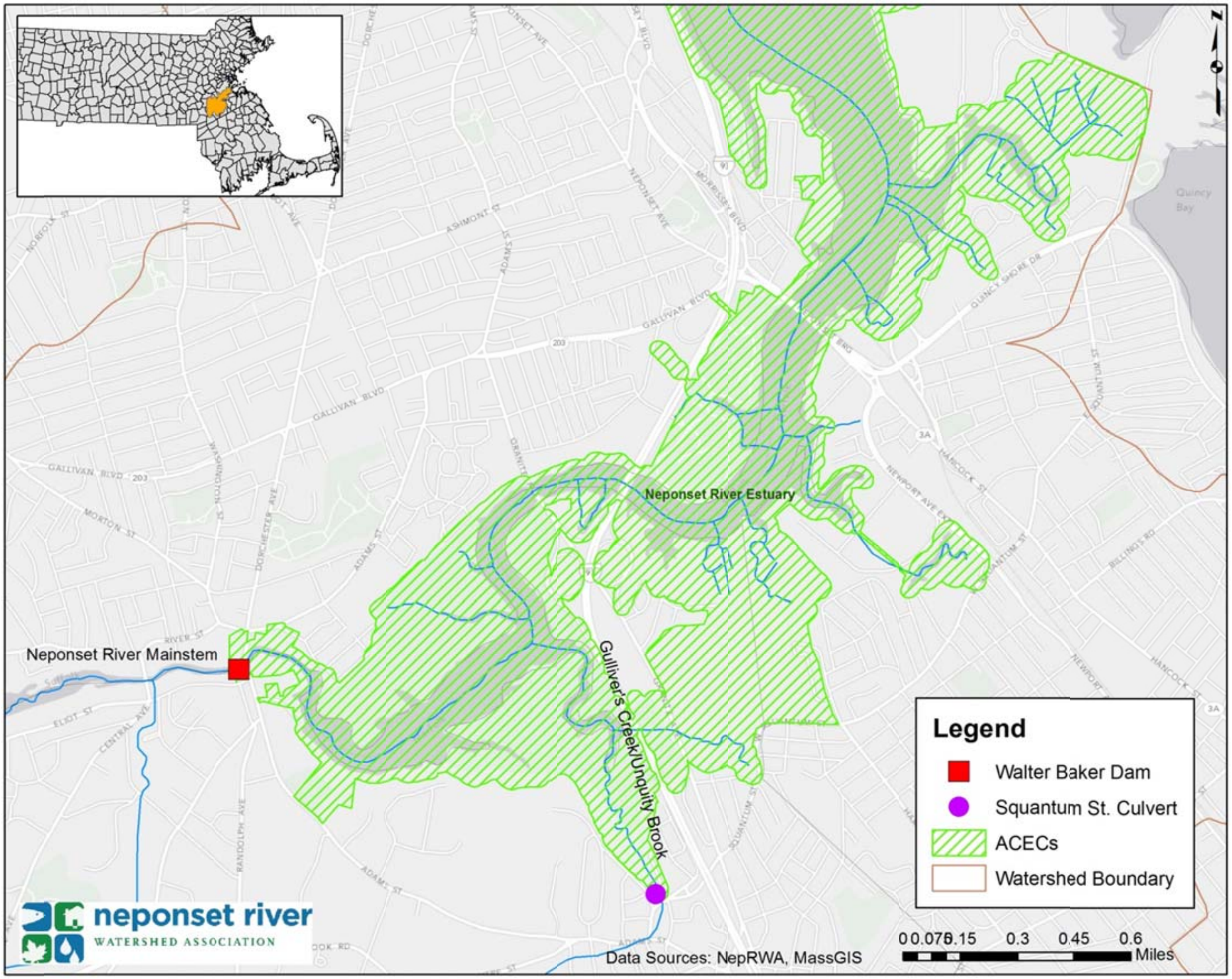
Many species of shellfish call the Neponset estuary home including soft shell clams, razor clams, and blue mussels among others. There are two shellfish restoration goals worth exploring on the Neponset which are: the reintroduction of native American Oysters (*Crassostrea virginica*) and the opening of commercial shellfish beds for conditional harvest. At present these shellfishing locations are closed to all harvest.

While oysters do not currently occur in the Neponset estuary at this time it is thought that historically they may have (Massachusetts Oyster Project pers. comm.). Oysters have the ability to improve water quality conditions through their capacity to filter water. In doing so, oysters can decrease suspended solids, lower nutrient levels and provide habitat for other benthic organisms (Massachusetts Oyster Project pers. comm.).

In addition to oysters, there are significant softshell clam beds that exist throughout the estuary but primarily at the confluence of the lower river and Dorchester Bay in the area surrounding Squantum Point known as Buckley's Bar (Fig. 5). This area has been closed to shellfishing due to elevated bacteria levels since the 1960's (DMF Casey pers. comm.). Since that time, the elimination of many CSO discharges to the estuary by the MWRA and BWSC, improvements to the sewage conveyance system by BWSC and elimination of both treated and raw effluent discharges to Boston Harbor have significantly improved water quality in the Dorchester Bay/Neponset River area.

Water quality considerations play a key role in the potential for shellfish restoration. In order to sustain populations viable for harvest, suitable conditions need to exist including but not limited to, proper light penetration, sedimentation rates, water current speeds and substrate conditions. Additionally, shellfish intended for harvest need to meet certain criteria for bacteria levels in surrounding waters and be free from toxins, both naturally occurring and anthropogenically deposited.

Figure 7: Location of the two major barriers to anadromous fish passage in the Lower Neponset River estuary, the Walter Baker Dam and a culvert on Gulliver's Creek/Unquity Brook at Squantum St. in Milton, MA.



Eelgrass

Eelgrass plays an important multifaceted role in the overall health of estuaries and saltwater ecosystems. The benefits of eelgrass as a basis for primary production, nursery habitat and as a critical component of sediment and shoreline stabilization are well documented (Short et al. 2002). While the extent of historical eelgrass beds in the Neponset estuary are not known the potential benefit to overall ecosystem and estuary health could be important to rehabilitating and restoring the estuary should eelgrass restoration be viable.

In order for eelgrass restoration to be successful several factors need to exist. The primary drivers for successful reintroductions are light penetration, wave energy, substrate and a location away from future anthropogenic disturbance such as dredging or mooring fields (Short et al. 2002). Several studies have looked into the potential for eelgrass restoration throughout Boston Harbor, including the Neponset River estuary (Batelle 2009, Estrella 2009, Anchor QEA 2010).

Summary of Available Monitoring Program Data

MWRA Harbor Monitoring Program

By far the largest data collection effort in the Neponset estuary has been undertaken by the MWRA's Harbor Monitoring Program. This program has been taking samples at several locations throughout the estuary from the late 1980s through today (Fig. 3). The monitoring program has six stations that relate to the Neponset. Four of these stations (055, 042, 041 and 089) are in the estuary and focus on physical and biological parameters. The other two sampling stations (055 and 140) also include nutrient analyses. It is also important to note that station 055 is not in the estuary but in the freshwater portion above the Baker Dam in Lower Mills, and the station at the mouth of the river is somewhat seaward of what might be considered the actual mouth of the Neponset River.

The parameters sampled at these estuary locations include different forms of bacteria (*E.coli*, *Enterococci* and Fecal Coliform), temperature, salinity, specific conductance, dissolved oxygen, pH and turbidity. The parameters sampled at the two nutrient sampling sites included analysis for some of the same physical parameters as the other stations but also analyses for ammonium, nitrate+nitrite, total nitrogen, phosphate, total phosphorus, total dissolved nitrogen, particulate nitrogen and particulate carbon. It is notable however that sites 055 and 140 only had three nutrient parameters in common, ammonium, nitrate+nitrite and phosphate.

For site 055 and 140 the most striking trend is the change in average yearly ammonium concentration over time. While both sites have seen decreases in ammonium since the mid 1990's site 140 has seen decreases in the amount of ammonium by a far wider margin than site 055. Site 055 went from an average concentration of 0.058 mg/L of ammonium during the time period 1996 through 2000, decreasing to an average of 0.047 mg/L of ammonium during the period from 2001 through 2012 (Table 4, Fig. 8). Over the same two time periods site 140 decreased from 0.093 mg/L to 0.032 mg/L of ammonium (Table 4). A large contributing factor to the decreases in ammonium over time is likely linked to the removal of CSO discharges near sites 054 and 042 in 2000, the movement of the main effluent discharge coming from the Deer Island Treatment Plant from Boston Harbor to 9 miles offshore and later, the removal of CSO discharges near site 089 in 2007. Concentrations of nitrate+nitrite and phosphate have seen slight declines over the course of the MWRA monitoring but have remained relatively constant over time. Furthermore the overall concentrations of nitrate+nitrite and phosphate are similar at stations 055 and 140, with the concentrations of each being somewhat higher upstream at 055.

The trends in enterococci bacteria levels, dating back to 1989, generally show improvement during dry weather (see Tables 6 and 7, Fig. 9). The most dramatic improvements have occurred at the more upstream stations, likely reflecting both the higher starting values and progress over time in reducing illicit connections. Enterococcus levels during dry weather have always been significantly lower at most of the downstream stations in the Neponset estuary, and have shown modest further improvement over time, the one exception being station 089 which had high historical enterococcus levels and which has experienced dramatic dry weather improvement.

Bacteria concentrations during wet weather are significantly higher than those observed during dry weather. Since 2000, sites in the estuary have had an annual geometric mean for enterococci bacteria exceeding 35 colonies/100mL, 18 times or 28% of the time. During wet weather conditions, bacteria levels have exceeded the swimmable standard 34 times, or 52% of the time, at these same locations (Table 2). This is likely the result of stormwater inputs.

Table 2: Frequencies of failures to meet the primary contact water quality standard for Class SB waters, a geometric mean for enterococci bacteria not to exceed 35 colonies/100mL, since 2000, using yearly geometric means. Data made available by the MWRA.

Site	Dry Weather	Wet Weather	% Fail Dry	% Fail Wet
054	9	12	69%	92%
042	2	8	15%	62%
089	7	12	54%	92%
041	0	1	0%	8%
140	0	1	0%	8%
Total	18	34	28%	52%

In spite of the frequent exceedance of swimmable standards during wet weather in recent years and particularly in the upper part of the estuary, overall wet-weather bacteria concentrations, seem to have generally improved over time, based on yearly geometric means (Tables 6 and 7, Fig. 9). However, at station 140, which is in Dorchester Bay just beyond the end of the Neponset, wet weather bacteria levels are now generally at or near the swimmable standard.

It does appear that the estuary fares better when judging bacteria levels against secondary contact recreation standards (i.e. boating standards). Since 2000, annual geometric means for all sites in the estuary are meeting secondary contact recreation standards for enterococci bacteria (175 colonies/100mL) except site 054, for one year during that time frame, and site 089, for eight years (Tables 2-3 and 6-7, Fig. 9).

Table 3: Frequency of failures to meet the secondary contact water quality standard for Class SB waters, a geometric mean for enterococci bacteria not to exceed 175 colonies/100mL, since 2000, using yearly geometric means. Data made available by the MWRA.

Site	Dry Weather	Wet Weather	% Fail Dry	% Fail Wet
054	0	1	0%	8%
042	0	0	0%	0%
089	1	8	8%	62%
041	0	0	0%	0%
140	0	0	0%	0%
Total	1	9	2%	14%

In the year 2000, the MWRA and BWSC completed separation of combined sewers near sites 054 and 042. By 2007 additional separation was completed near site 089. In addition, BWSC has been implementing efforts to eliminate illicit connections on an ongoing basis. We would also observe that there has been relatively little change in stormwater management infrastructure (i.e. retrofitting to clean up street runoff as opposed to sewage contamination) in these neighborhoods during the period for which monitoring data is available. All of the above leads us to conclude that the improvements in wet weather results are likely primarily a function of efforts to eliminate CSOs and illicit connections as well as improvements to ambient water quality in the harbor. While there may be some further ground to be gained through BWSC's ongoing efforts to eliminate remaining illicit connections, it appears that new efforts to treat polluted urban runoff from all three neighboring communities will be needed if swimmable water quality standards are to be achieved during wet weather, particularly in the upper estuary.

The one pronounced exception to the positive trend in wet weather results is station 089 near the Commercial Point CSO (Fig. 9). Here the data show sharp decreases in bacteria concentrations during the period 2000 to 2007, followed by substantial increases from 2008 through 2012. These increases would seem to coincide with completion of CSO elimination in 2007, and could potentially reflect the discontinuation of interim disinfection measures that had been in place prior to completion of sewer separation work in this area. Alternatively, there may be remaining sanitary sewer overflows occurring inside the 089 collection system or unidentified illicit connections which are forced out to the river only during wet weather events. The notion that some source of sewage input rather than "pure" stormwater is still playing a significant role at 089 is bolstered by a 2009 report by DEP that suggested strong evidence of a human bacteria source, based on human marker sampling (Birnbaum and Zink 2009).

Table 4: Average Yearly concentration of ammonium (mg/L) at sites 055 and 140.

Year	Site 055	Site 140
Overall Average (All Years)	0.051	0.057
1994		0.103
1995		0.098
1996		0.091
1997	0.064	0.078
1998	0.059	0.112
1999	0.057	0.101
2000	0.052	0.067
2001	0.052	0.025
2002	0.048	0.036
2003	0.047	0.037
2004	0.059	0.037
2005	0.050	0.039
2006	0.041	0.028
2007	0.045	0.023
2008	0.049	0.048
2009	0.042	0.033
2010	0.044	0.027
2011	0.039	0.028
2012	0.048	0.018

Table 5: Average concentration of ammonium for years pre and post CSO elimination in the Neponset River estuary.

Years	Site 055	Site 140
1994-2000	0.058	0.093
2001-2012	0.047	0.032

Figure 8: Average yearly concentration of ammonium for sites 055 and 140. No distinction is made for wet vs. dry weather.

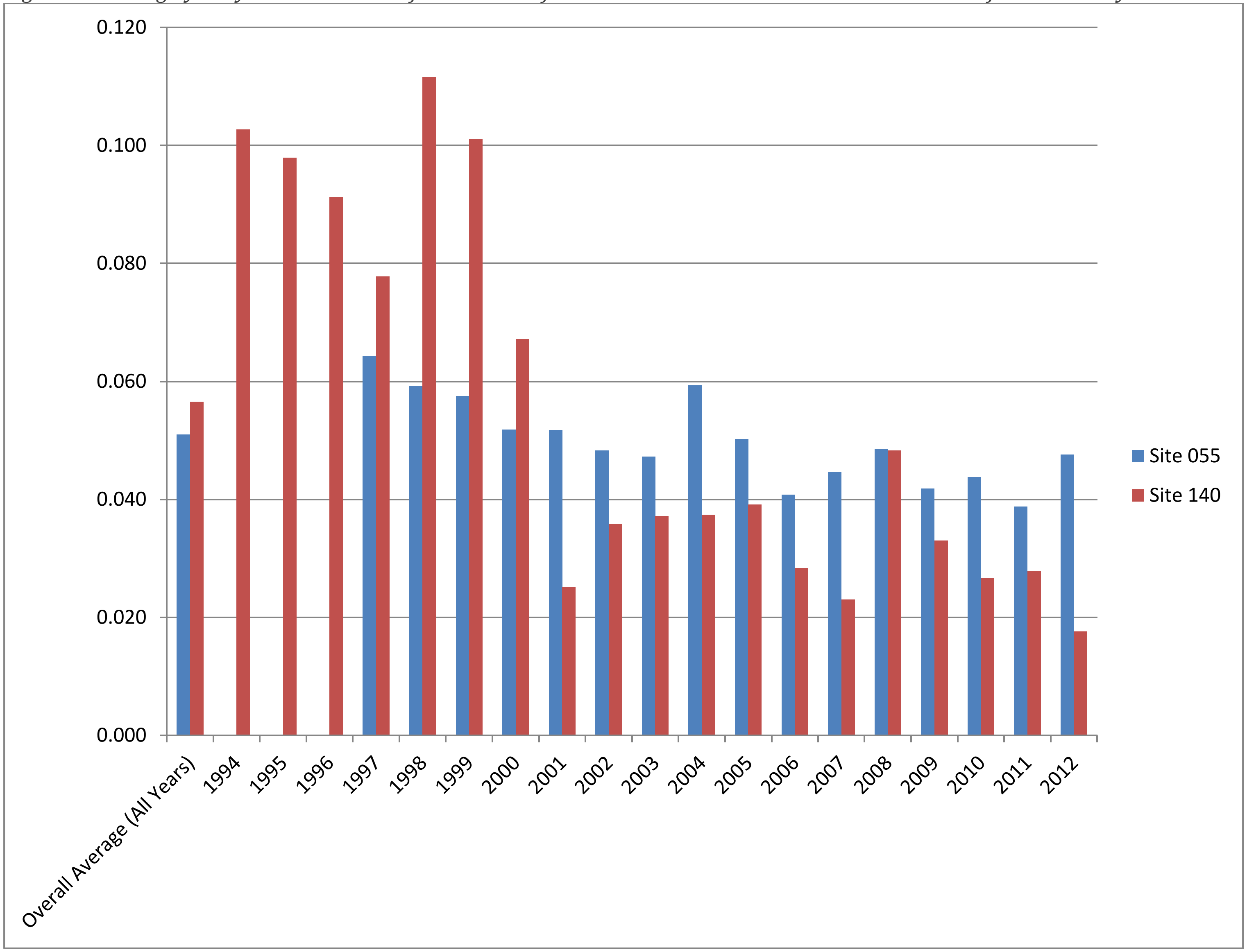
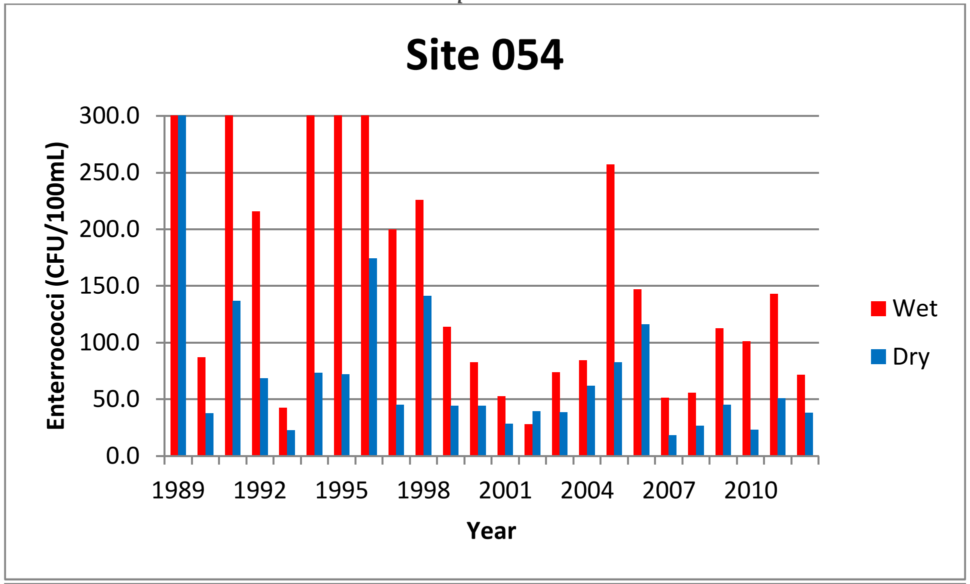
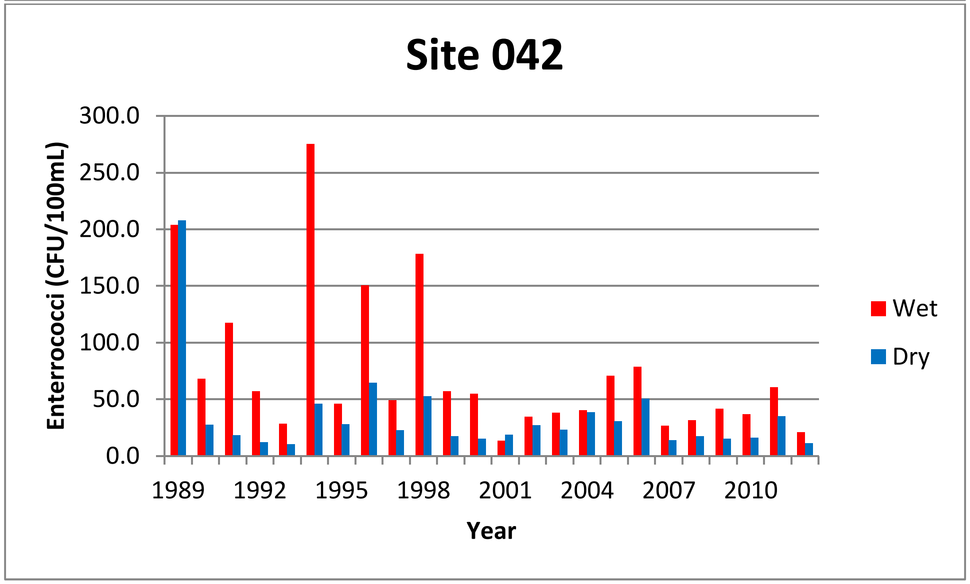
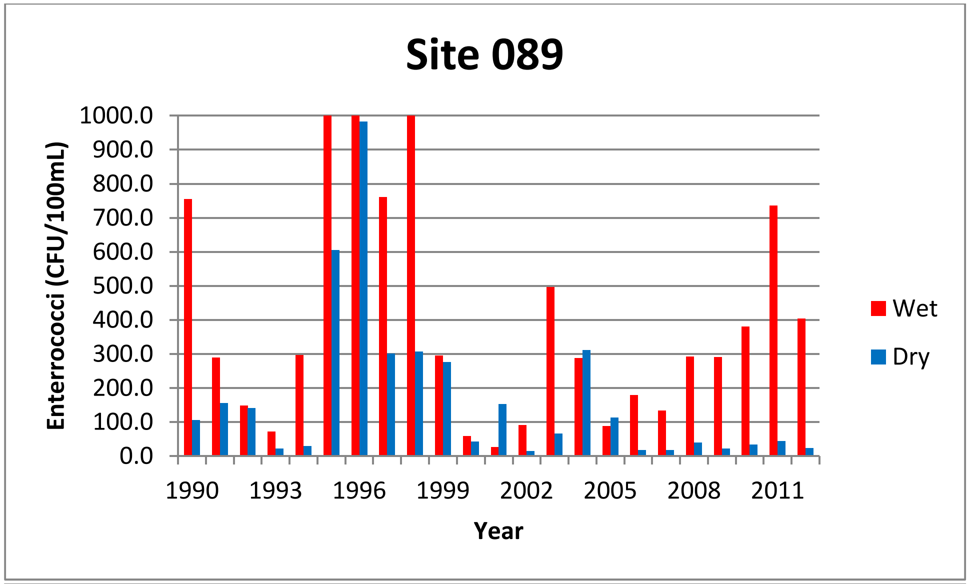


Figure 9: Yearly geometric mean of wet and dry enterococcus bacteria levels progressing from upstream to downstream in the estuary. Data provided by MWRA. CSO elimination near sites 054 and 042 was completed in 2000 and CSO elimination was completed near site 089 in 2007.






Site 089
Enterococci (CFU/100mL)
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1990
1993
1996
1999
2002
2005
2008
2011
Year
Wet
Dry

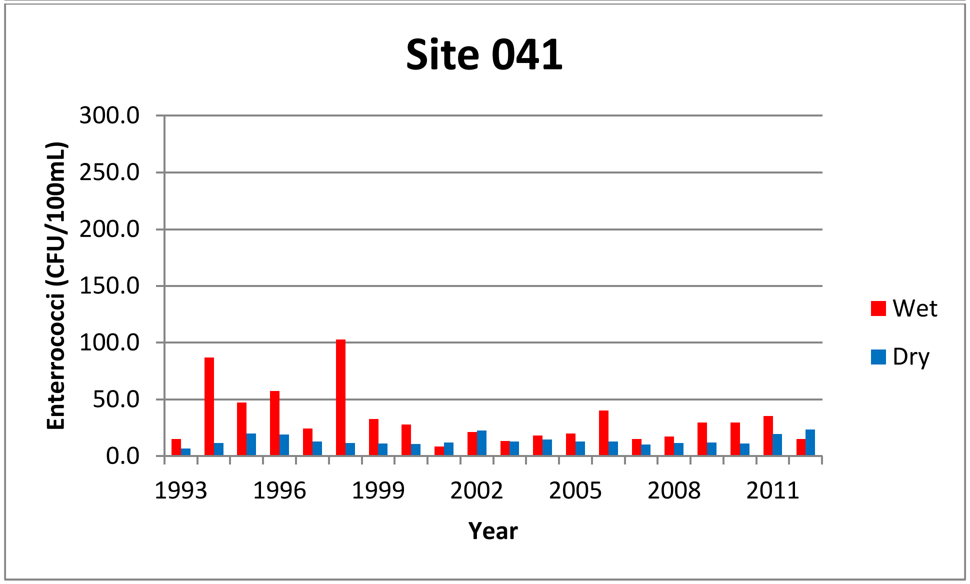

Site 041
Enterococci (CFU/100mL)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1993
1996
1999
2002
2005
2008
2011
Year
Wet
Dry

Table 6: Yearly geometric means for enterococcus bacteria levels at MWRA sampling stations during dry weather condition s 1989-2012

	Sites											
	055		054		042		041		089		140	
Year	Enterococcus	N	Enterococcus	N	Enterococcus	N	Enterococcus	N	Enterococcus	N	Enterococcus	N
1989	1260.0	1	318.2	2	208.0	1						
1990	389.3	12	37.9	3	27.5	3			106.3	9		
1991	666.8	11	136.9	8	18.4	8			156.2	23		
1992	228.6	13	68.3	15	11.9	11			141.6	28		
1993	143.0	14	22.5	6	10.2	6	6.7	6	22.5	7		
1994	359.6	6	73.4	7	45.9	7	11.2	6	29.7	6	5.0	6
1995	182.6	12	72.2	12	28.2	10	19.9	12	605.7	12	11.5	18
1996	384.3	13	174.1	13	64.5	11	18.8	11	983.2	15	26.6	11
1997	178.3	31	45.3	12	22.5	13	13.0	13	300.7	19	12.4	19
1998	202.6	21	141.2	3	52.7	3	11.4	3	306.6	6	14.0	19
1999	101.0	27	44.2	11	17.6	12	11.1	12	275.8	21	12.6	17
2000	152.1	18	44.3	11	15.2	13	10.4	11	43.0	11	8.1	14
2001	145.9	23	28.3	15	18.8	19	11.9	18	152.6	23	9.0	19
2002	107.4	17	39.6	5	27.0	8	22.3	8	14.6	8	8.3	17
2003	177.4	21	38.5	9	23.2	12	13.0	12	65.7	12	10.3	15
2004	166.9	10	61.8	5	38.5	7	14.7	7	311.0	7	10.2	12
2005	108.1	8	82.7	7	30.6	9	12.8	9	113.6	9	11.4	12
2006	43.5	10	116.1	5	50.4	5	12.7	5	18.4	5	14.1	14
2007	29.1	12	18.3	12	13.8	13	10.0	13	18.2	13	12.9	11
2008	24.0	10	26.6	9	17.5	9	11.3	9	40.6	9	12.3	10
2009	31.7	11	45.2	9	15.2	11	11.8	11	21.9	11	10.0	10
2010	31.4	13	23.2	9	16.0	9	10.8	9	33.2	12	10.7	11
2011	60.9	4	51.1	14	34.9	14	19.6	14	43.9	14	15.4	9
2012	20.4	11	38.1	6	11.2	6	23.6	6	23.2	6	11.1	13

Table 7: Yearly geometric means for enterococcus bacteria levels at MWRA sampling stations during wet weather condition s 1989-2012.

	055		054		042		041		089		140	
Year	Enterococcus	N	Enterococcus	N	Enterococcus	N	Enterococcus	N	Enterococcus	N	Enterococcus	N
1989	1313.5	7	380.3	11	203.8	10						
1990	527.6	10	87.1	7	68.0	7			755.2	9		
1991	1744.5	17	400.9	14	117.4	11			289.4	36		
1992	415.7	7	215.9	21	57.2	6			148.1	30		
1993	301.5	11	42.6	5	28.3	5	15.1	5	71.6	5		
1994	1246.6	8	498.4	8	275.2	8	87.0	8	297.5	8	14.8	13
1995	359.6	16	313.3	16	46.1	15	46.9	14	1689.0	16	23.6	11
1996	553.1	19	453.2	17	150.5	11	57.2	11	2281.1	20	47.1	24
1997	305.9	29	199.6	11	49.2	10	24.3	10	761.1	18	10.3	18
1998	371.2	36	225.6	13	178.4	12	102.8	13	1184.4	16	90.2	20
1999	336.8	23	114.1	8	57.0	9	32.5	9	295.2	22	15.2	20
2000	414.5	32	82.6	13	54.9	15	27.9	15	59.4	16	13.8	26
2001	320.9	27	52.6	8	13.3	7	8.2	7	27.0	11	9.4	20
2002	256.3	32	28.0	8	34.6	11	20.9	11	91.0	17	16.4	22
2003	419.3	21	73.6	5	38.3	8	13.4	8	496.7	12	37.4	15
2004	375.6	12	84.2	10	40.5	13	18.1	13	287.9	16	33.0	11
2005	249.0	17	257.1	15	71.0	13	19.9	14	88.2	21	23.2	9
2006	222.3	15	147.1	19	78.6	20	40.3	20	180.1	33	14.2	10
2007	58.1	11	51.4	8	26.8	8	15.0	8	134.0	25	11.8	12
2008	87.7	16	55.5	11	31.4	11	17.2	11	292.1	37	23.9	13
2009	88.8	10	112.7	10	41.8	10	29.8	10	290.6	39	23.4	13
2010	277.2	11	100.9	11	36.6	11	29.6	11	380.5	35	15.6	13
2011	64.4	20	143.0	7	60.8	7	35.2	7	736.4	29	21.5	14
2012	84.2	16	71.7	16	20.7	16	15.0	16	404.4	28	14.8	11

BWSC IDDE Program and Consent Decree

While the BWSC does not have water quality monitoring program the outfalls discharging to the river and estuary do play a major role in overall water quality conditions. The two main influences coming from BWSC outfalls come in the form of untreated stormwater pollution and the existence of illicit connections to the storm-drain system that can contribute significant amounts of untreated sewage to the river and estuary.

The BWSC has long been working on the problems associated with illicit connections discharging to the Neponset, as well as the Charles and Mystic Rivers. More recently though, the BWSC has been subject to a Consent Decree with USEPA, CLF and MassDEP that has more clearly defined IDDE Protocols and investigation procedures and timelines.

Under the Consent Decree the BWSC has been given a more regimented path to elimination of illicit connections with the goal of complying with the Clean Water Act and ultimately improving water quality of waters the BWSC discharges to. The BWSC was tasked with inspecting all outfalls during dry weather and sampling all those with flow by May 31, 2013. Additionally, wet weather sampling of all outfalls not exhibiting flow during dry weather was also set to be completed by May 31, 2013 (CLF and USA 2012). The BWSC has completed these inspections in early 2013 as required. The BWSC will repeat outfall inspections during dry weather yearly and sample outfalls that have flow during dry weather.

Also under the Consent Decree, the BWSC was required to prioritize catchments for further investigation. All investigations of sub-catchment areas discharging to, or near, Constitution Beach were completed within 12 months of the start of the Decree (August 2012) and investigations of all sub-catchment areas discharging to, or near, Malibu and Tenean Beaches will be completed within 24 months of the start of the Decree (CLF and USA 2012). Under this initial priority time table the investigations for sub-catchments associated with Tenean Beach are slated to be complete by August 2014.

The investigation of all sub-catchments needs to be completed within a 7 year time frame and 35% of these sub-catchments should have investigations completed by August of 2015 (CLF and USA 2012).

Priority catchments for the Neponset include those discharging to outfalls 13L090, 12L296 (MassDOT) and 12L092 which are in the Very High priority level associated with Tenean Beach (CLF and USA 2012)(Fig. 4). These sub-catchment areas are set to have initial investigations completed by August, 2014. According to recent reports much of this work has already been completed (BWSC 2013a, BWSC 2013b). There are catchments in the High priority level in the estuary itself and there are several High priority catchments just upstream of the Baker Dam along the main-stem of the Neponset River that are thought to have problems with illicit connections and are undoubtedly having an impact on water quality further downstream (Guenther 2010). These High priority catchments include 07H285 and 07H105 in Mattapan and 08G108, 06G109, 06G110, 05G115, 06G165 and 04F204 in Hyde Park (Tables 8-9, Fig. 4).

Table 8: BWSC priority ranking of outfalls discharging to the Neponset River and its estuary under the Consent Decree. Data collected during 2012 inspections.

Wet/Dry Screening	Outfall/Catchment ID	Street Location	Residual Chlorine (ppm)	Surfactants (ppm)	Ammonia (ppm)	Type of Bacteria	Result (CFU/100mL)	Priority Ranking
Dry	13L090	Victory Rd.	0	3	5	Enterococci	4,500	1
Dry	12L092	Pine Neck Creek	0	1.5	10	Enterococci	180	1
Dry	12L096	Conley St.	0	1.5	10	Enterococci	60	1
Dry	04F204	Truman Hwy @ Chitick Rd.	0	3	10	E. Coli	>80,000	2
Dry	06G109	River Ter.	0.4	0	10	E. Coli	>80,000	2
Dry	07H285	Blue Hill Bridge	0.1	0	0	E. Coli	52,000	2
Dry	07H105	10 Edgewater Dr.	0.1	1	10	E. Coli	20,000	2
Dry	06G165	Truman Pkwy.	0.4	0	0.4	E. Coli	19,000	2
Dry	06G108	River St. at Wood Ave.	0.2	0	2	E. Coli	17,000	2
Dry	06G110	Easement/West St. Extension	0	0	5	E. Coli	12,000	2
Dry	05G115	Fairmount Ave Bridge (North Bank)	0	0	0.4	E. Coli	5,500	2

Investigations have already begun in all of the Very High (1) and High (2) priority sub-catchment areas as part of previous IDDE investigations by the BWSC and current IDDE investigations set in motion by the Consent Decree (Table 8-9). At least 63% of each Very High and High priority catchments have been investigated by number of manholes in the catchment already (Table 8-9). Investigations are slated to be complete in August of 2014 for sub-catchments 13L090, 12L092 and 12L296, which is a MassDOT outfall with stormwater contribution from BWSC owned storm drains, while sub-catchments discharging to outfalls 04F204, 06G109, 07H285, 07H105, 06G110, 05G115, 06G165 and 06G108 are scheduled to fall within the 35% of sub-catchments required to be investigated by year three of the Consent Decree, August, 2015 (CLF and USA 2012)(Table 8).

Table 9: List of sub-catchments and the current level of investigational completeness by number of manholes investigated in the Very High and High priority levels of the Consent Decree with BWSC as of July, 2013. Data collected during 2012 round of investigations. Data table adapted from BWSC Compliance Report, September 1, 2013.

Sub-Catchment Area[1]	Total # Storm Drain + Common Manholes	Total # Storm Drain + Common Manholes Inspections Performed[2]		Total # Storm Drain + Common Manholes Inspected/Completed[5]		% Investigated/Complete by Manholes	
		Reporting Period[3]	To Date[4]	Reporting Period[3]	To Date	Reporting Period[3,6]	To Date[7]
13L090 (B)	942	22	236	20	790	2%	84%
12L092 (B)	165	28	28	0	165	0%	100%
12L096 (B)(DOT)	49	0	13	0	31	0%	63%
04F204	71	0	67	0	61	0%	86%
06G109	30	4	15	0	30	0%	100%
07H285	330	0	165	0	234	0%	71%
07H105	482	5	153	1	458	0%	95%
06G165	6	2	6	1	6	17%	100%
06G108	176	7	128	2	150	1%	85%
05G115	13	0	1	0	13	0%	100%

[1](B) indicates a highest priority beach area; * indicates that there are no storm drain or common manholes located in the sub-catchment area.
[2]Total number of manhole inspections performed includes all inspection records for manholes. Some manholes may have been inspected more than once.
3ReportingPeriod is February1, 2013 through July 31, 2013
[4]"To Date" includes data from 11/10/2004 through the end of the reporting period (07/31/13).
[5]Total number of manholes investigated/completed is based on a manual review process which analyzes the number of manholes that fall within the areas designated as complete, therefore it includes manholes that are inferred to be void of contamination based on downstream manhole inspections and/or dye tests.
[6]The % complete estimate for the reporting period is calculated as the % complete to date minus the % complete calculated based on the manual review conducted for the Compliance Report for the period of August 1, 2012 through January 31, 2013.
[7]The % complete estimate to date is calculated as the total number of storm drain and common manholes investigated/completed to date divided by the total number of storm drain and common manholes within each drainage area.
DOT: Department of Transportation owned outfall with catchment area owned and operated by BWSC

Department of Conservation and Recreation (Tenean Beach)

The Department of Conservation and Recreation, with help from the MWRA, samples five urban beaches within Boston Harbor, daily, for bacteria during the bathing season. Tenean Beach, which is near the mouth of the Neponset River, falls within this monitoring program (Fig. 3). Data are available dating back to 2001 for daily samples analyzed for enterococci bacteria (Tables 10-11). Similar to results from the MWRA's Harbor Monitoring Program in the Neponset River estuary, the DCR Beach sampling data show that primary contact recreation standards are often met during dry weather yet repeatedly fail WQSs during wet weather (Tables 10-11, Fig. 10). For the period since 2001, yearly geometric means of all samples under dry weather conditions (without regard for single sample exceedances) pass primary contact standards every year. Similar analysis of yearly geometric means for wet weather conditions shows that Tenean Beach fails WQSs for primary contact recreation (without regard for single sample exceedances) in six of the thirteen years (Tables 10-11).

Average bacteria concentrations are significantly higher during wet weather as compared to dry, and it appears that average wet weather bacteria concentrations may be increasing since 2007, though the trend is not entirely clear (Tables 10-11). As previously suggested, illicit connections in the drainage system discharging to the former Commercial Point CSO (BWSC outfall 13L090) could be influencing water quality in this area. It is also possible that there are remaining SSOs in this catchment area or that unidentified illicit connections in either the Commercial Point outfall or the Pine Neck Creek outfall may be contributing too wet weather concerns.

Another counterintuitive observation is that a greater percentage of samples fail the single sample criteria for primary contact standards during dry weather than wet weather (Tables 10-11). This might be a function of illicit connection problems. Also, since the sampling at Tenean Beach is conducted daily, some of the failures during dry weather could in fact be the delayed effect of stormwater flows, since the storm drain catchment areas in the vicinity of Tenean Beach are very large and it may take considerable time for stormwater from particularly large rain events to fully leave the system.

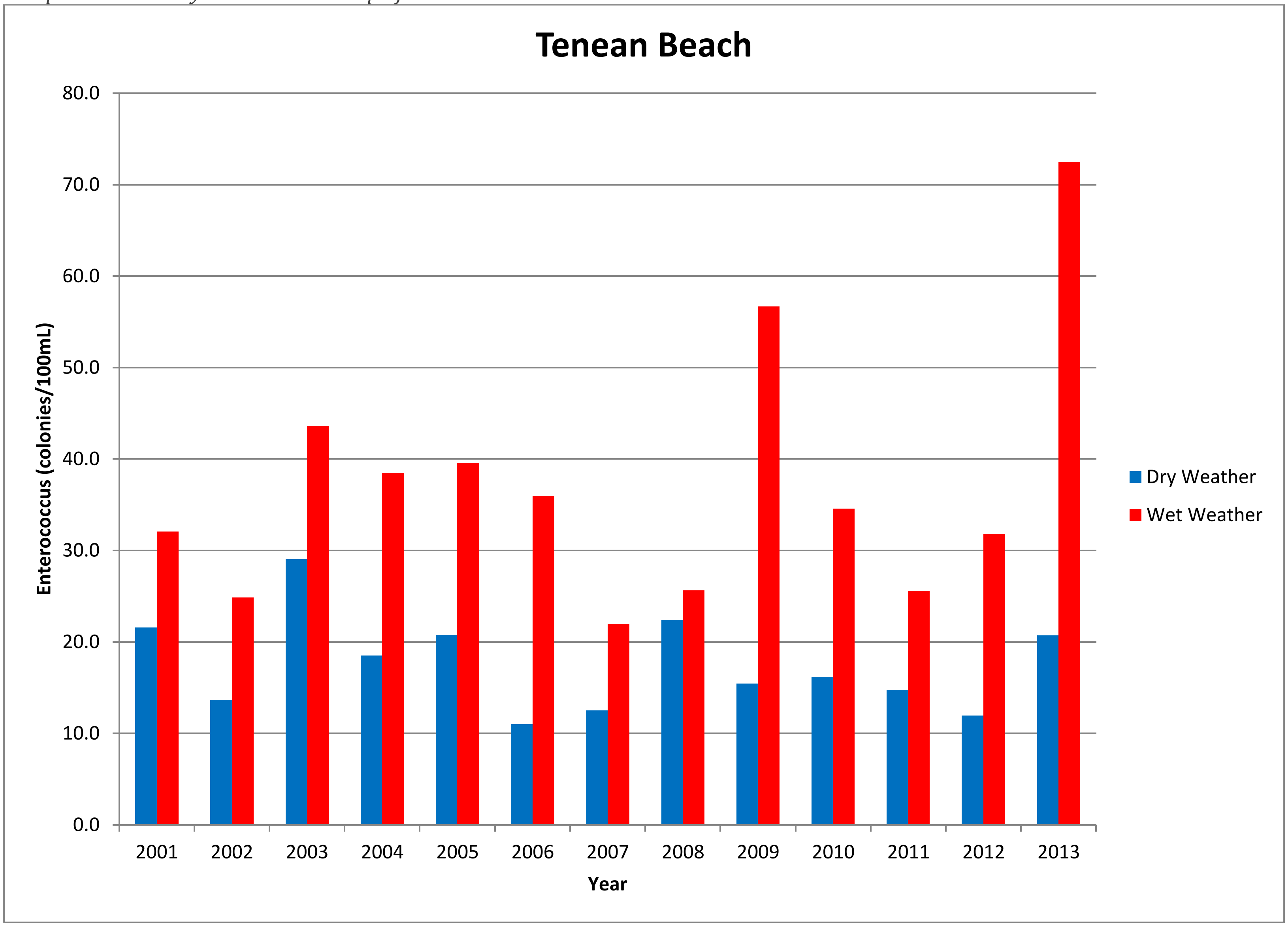
Table 10: Annual geometric mean of Enterococci samples for all dry weather samples taken during the bathing season at Tenean Beach. Data collected by DCR with the help of MWRA. Geometric mean may not exceed 35 CFU/100mL.

Year	Annual Geometric Mean	# of Single Sample Violations	N	% of Single Samples Violating
2001	21.6	7	60	11.7
2002	13.7	1	51	2.0
2003	29.0	9	43	20.9
2004	18.5	4	37	10.8
2005	20.7	10	38	26.3
2006	11.0	3	52	5.8
2007	12.5	5	67	7.5
2008	22.4	12	52	23.1
2009	15.4	8	60	13.3
2010	16.2	7	68	10.3
2011	14.7	5	60	8.3
2012	11.9	2	63	3.2
2013	20.7	11	67	16.4
	Total	84	718	8.5

Table 11: Annual geometric mean of Enterococci samples for all wet weather samples taken during the bathing season at Tenean Beach. Data collected by DCR with the help of MWRA. Geometric mean may not exceed 35 CFU/100mL.

Year	Annual Geometric Mean	# of Single Sample Violations	N	% of Single Samples Violating
2001	32.1	4	15	26.7
2002	24.9	1	9	11.1
2003	43.6	4	13	30.8
2004	38.4	4	16	25.0
2005	39.5	5	10	50.0
2006	36.0	6	22	27.3
2007	22.0	3	13	23.1
2008	25.6	5	25	20.0
2009	56.7	9	24	37.5
2010	34.6	6	16	37.5
2011	25.6	7	20	35.0
2012	31.8	3	14	21.4
2013	72.4	6	15	40.0
	Total	63	212	3.4

Figure 10: Annual geometric means for enterococcus bacteria sampling conducted during the bathing season at Tenean Beach, Dorchester, MA. Samples collected by DCR with the help of the MWRA



Division of Marine Fisheries (Shellfish Sanitation Monitoring)

The Division of Marine Fisheries is tasked, among other things, with monitoring and maintaining appropriate openings and closures of shellfish beds throughout the Commonwealth. Currently shellfish beds within the Neponset estuary and those associated with Buckleys's Bar at the mouth of the Neponset are classified as Prohibited and closed to all shellfishing activities due to elevated bacteria levels. The only shellfishing that is allowed by law in Greater Boston Harbor is the harvest of softshell clams (*Mya arenaria*) for depuration from areas classified as Conditionally Restricted and in an Open Status by state-licensed, commercial shellfishermen, however the beds are also home to Blue Mussels (*Mytilus edulis*) and Razor Clams (*Ensus directus*). While thought to historically occur in the Neponset estuary the American Oyster (*Crassostrea virginica*) no longer persists and it is unknown if remnant populations currently exist in the Neponset estuary. Over the years, DMF has sampled at numerous locations throughout the estuary and Buckley's Bar, monitoring bacteria levels with different levels of effort depending on available resources and agency objectives (Fig. 5).

According to the National Shellfish Sanitation Program all areas designated for shellfishing, fecal coliform levels shall not exceed a geometric mean of 88 fc/100mL, nor shall more than 10% of the samples exceed 163 fc/100mL (FDA 2011). Recently, DMF sampling has been conducted at areas associated with Buckley's Bar and the results have been encouraging. According to the most recent sampling conducted over the last three years bacteria levels are improving at sampling locations C-34, C-35 and C-36. Samples taken from sites C-34, C-35 and C-36 have passed both the geometric mean standard as well as single sample standards for fecal coliform bacteria for the last two years (Tables 12-14).

Table 12: Geometric mean and single sample failures for site C-34 located on Buckley's Bar at the mouth of the Neponset River. Data provided by DMF.

Year	Geometric Mean	# over 163 CFU/100mL	% of samples over 163 CFU/100mL	N
2011	64.3	4	27%	15
2012	10.8	0	0%	17
2013	7.3	0	0%	9

Table 13: Geometric mean and single sample failures for site C-35 located on Buckley's Bar at the mouth of the Neponset River. Data provided by DMF.

Year	Geometric Mean	# over 163 CFU/100mL	% of samples over 163 CFU/100mL	N
2011	28.4	2	13%	15
2012	10.8	1	6%	17
2013	5.1	0	0%	9

Table 14: Geometric mean and single sample failures for site C-36 located on Buckley's Bar at the mouth of the Neponset River. Data provided by DMF.

Year	Geometric Mean	# over 163 CFU/100mL	% of samples over 163 CFU/100mL	N
2011	6.9	0	0%	16
2012	8.5	0	0%	18
2013	7.4	0	0%	9

Future Short and Long Term Planning

As previously discussed the restoration alternatives examined here are as follows:

1. Water Quality Improvement
2. Saltmarsh Restoration
3. Anadromous Fish Enhancement
4. Reopening of Shellfish Beds
5. Eelgrass Restoration

Given the information received from the various entities collecting data in the estuary and past projects the following are the short and long term recommendations regarding these major restoration initiatives:

Water Quality Improvement

In order to improve water quality, especially during wet weather, several areas could be focused on moving forward.

- Short Term Initiatives
    - Find and Eliminate Illicit Connections
    - Stormwater Management
        - Promote Better Stormwater Management through Education
        - Promote Better Stormwater Management through Redevelopment Standards
        - Locate Appropriate Areas for Stormwater BMP Retrofits
- Long Term Initiatives
    - Install Stormwater BMP Retrofits
    - Establish TMDLs for Nutrients

Short Term Initiatives

Find and Eliminate Illicit Connections

In the short term work should continue to find and eliminate illicit connections in Boston, Quincy and Milton, MA. IDDE work by the BWSC under the Consent Decree is ongoing and has already begun to identify problems and resolve issues with illicit connections. Under the Consent Decree the BWSC should have investigations completed at area beaches, including Tenean Beach, by August, 2014. While the investigations of the Very High priority level catchments are ongoing the investigations of the High priority catchments has already begun and are slated to be completed by August, 2015. This second wave of investigations and eliminations includes catchments discharging to outfalls 04F204, 06G109, 07H285, 07H105, 06G165 and06G108 (Fig. 4).

While the ability of NepRWA to directly impact these investigations and eliminations is limited it would be useful to monitor the progress of the BWSC IDDE program through limited dry weather monitoring of Very High and High priority catchments. Additionally, NepRWA could work with the City of Quincy and Town of Milton to help them prepare and implement their own IDDE programs as MS4 permit requirements continue to evolve, and periodically monitor outfalls to the Neponset River estuary during dry weather for any illicit connections that may occur in the future.

Stormwater Management

Outside of the influence of illicit connections to storm drains, the most pressing issue from a water quality perspective in the Neponset Watershed, including the estuary, appears to be directly linked to stormwater. In the short term, initiatives aimed toward stormwater pollution education and outreach could be used to help build consensus among area stakeholders that stormwater issues should have an increased priority with regard to funding and implementation. BWSC is already expanding its stormwater education efforts under the consent decree. Milton and Quincy have significant potential to expand their stormwater outreach and education efforts, and in any event will be required to do so under the forthcoming MS4 permit. NepRWA should work with all three communities, but particularly Milton and Quincy, to help them ramp up their stormwater education efforts, wherever possible working on a regional basis with other area communities.

At the present time, none of the three municipalities in the estuary is routinely requiring new development and redevelopment projects to utilize stormwater management BMPs that are effective at reducing bacteria concentrations in urban runoff to levels consistent with the Neponset Pathogen TMDL. Under the Wetlands Act all projects within wetlands jurisdiction are currently required to use BMPs that are consistent with the Pathogen TMDL, and under the forthcoming MS4 permit, these provisions will be extended to upland areas discharging to public drain collection systems. NepRWA has developed recommended stormwater bylaw provisions related to TMDL compliance and recommended guidance documents for determining when a proposed set of BMPs is “consistent” with the TMDL. Given that it will be necessary to deal with new and existing sources of polluted stormwater runoff in order to meet water quality standards, particularly in the upper estuary, NepRWA should work with all three communities to help them incorporate appropriate TMDL provisions into their development and redevelopment rules as soon as possible so that future development helps to reduce rather than increase the magnitude of stormwater pollution problems impacting the Neponset estuary.

Lastly, an in depth look at appropriate areas to locate structural stormwater Best Management Practice retrofits, or BMPs, should be included in a comprehensive approach to better stormwater management. NepRWA has already been a part of collaborative efforts to survey and identify potential areas to locate structural stormwater BMPs with several watershed towns and it is the hope that this work could continue in towns that have not already been surveyed. Once ideal locations for stormwater retrofits have been identified work needs to continue to find funding for the installation of these retrofits.

Promote Better Stormwater Management through Education

Outreach is already being performed by the BWSC as part of the Consent Decree and their work could be duplicated in other watershed towns moving forward. Also, the formation of a Stormwater Collaborative has been discussed by NepRWA, along with several watershed towns, in response to potential future requirements of the NPDES Municipal Separate Storm Sewer System (MS4) General Permit that is likely to be issued in the next few years. Increased requirements for outreach are anticipated to be a part of this future permit and so this should be a large focus of the Collaborative’s agenda in the short term. Any materials created by BWSC, or the Stormwater Collaborative, could also be shared with towns outside these entities to help further the message of the importance of proper stormwater management.

Additionally, NepRWA could work with area conservation commissions and planning boards to ensure new and redevelopment projects are utilizing all of the necessary stormwater treatment available and adequate to treat stormwater volumes of at least a 1" WQv. Workshops with area commissions and also developers might be a useful way to help promote technologies and solutions that are ideal for treating stormwater and, where possible, recharge groundwater.

Locate Appropriate Areas for Stormwater BMP Retrofits

Longer term, efforts should build on the education and outreach steps and work to find and locate proper sites to implement stormwater BMPs. NepRWA has worked previously on doing preliminary surveys for several towns in the watershed aimed at identifying sites with high potential for stormwater retrofits with the lowest barriers to implementation. These "low hanging fruit" situations are a good way to get the ball rolling in terms of implementing better stormwater management and at the same time educating the public on the need for such improvements.

Long Term Initiatives

Install Stormwater BMP Retrofits

As locations are identified the final step in the process will be to obtain funding and actually implement the BMPs at the sites identified through the surveys. To start, funding can be sought through competitive grant programs such as 319 and other state and federal programs. Long term though, funding will need to come more from the municipalities themselves who operate and maintain the stormwater infrastructure. Implementation funds could be taken from general tax revenues but given the fact that most budgets are already stretched it would be highly recommended that communities adopt some sort of stormwater financing outside of current revenue streams.

Stormwater financing, or stormwater utilities, are the necessary progression needed to pay for infrastructure improvements that are essential to both the general public and local ecosystems alike. Long term, NepRWA could help to facilitate the establishment of these financing options through continued education and outreach aimed at highlighting the benefits of stable financing revenue streams and the benefits to communities as well as the watershed. Additionally, partnerships could be created with area towns and the Metropolitan Area Planning Commission, who have been working on a stomwater financing toolkit that aids towns in developing the financing option that best fits their current conditions and funding needs moving forward

Establish TMDL for Nutrients

Ultimately the further development of Total Maximum Daily Loads, or TMDLs, for nutrients will likely be needed to adequately characterize the water quality improvements needed to achieve water quality goals and decrease the effects of eutrophication long term. This process will likely involve the collaboration of several organizations and entities most noteably NepRWA, MassDEP, USEPA and MWRA.

While the MWRA currently has an enormous amount of valuable water quality data pertaining to the estuary and NepRWA has similar data sets pertaining to the freshwater portions of the watershed these data would likely need to be augmented through the establishment of new monitoring stations within the estuary for nutrients as well as increased sampling frequency to adequately document current conditions and make recommendations for water quality goals long term.

Saltmarsh Restoration

Since the Neponset estuary is the location of the largest marshes remaining in Boston Harbor it stands to reason that salt marsh restoration would be a high priority. In fact, some work has already been completed and it is this work that is hoped to be built upon moving forward.

The short and long term recommendations to advance salt marsh restoration in the Neponset River estuary are as follows:

- Short Term Initiatives
  - Evaluate Past Restoration Projects
  - Identify and Prioritize Potential Restoration Sites
- Long Term Initiatives
  - Determine Potential Barriers to Restoration Success at Potential Sites
  - Obtain Funding to Implement Prioritized Projects

Short Term Initiatives

Evaluate Past Restoration Projects

Initially, the evaluation of past restoration efforts completed by DCR will be key in informing future marsh restoration priorities. Both formal and informal evaluations and surveys will help to guide future site identification and prioritization throughout the estuary. Informal partnerships and site visits with DCR, EPA and DER could help to guide more formal evaluation projects aimed at quantifying the successes and failures of past projects. These informal site visits and meetings would also be useful in categorizing and inventorying the proper parameters that would need to be evaluated to prioritize future projects. Eventually though, more formal evaluations of past projects and lessons learned should take place to look more closely at potential barriers to salt marsh restoration success moving forward.

Identify and Prioritize Potential Restoration Sites

Once the more informal process has been completed, an in depth inventory of all possible marsh restoration and enhancement projects should be completed. This process should look at all possible sites and utilize criteria developed through the more informal process to identify and prioritize each restoration site. Key factors in the prioritization process would include the evaluation of salinity levels, the current level of invasion of Phragmites and the potential for reinvasion post marsh restoration and evaluation of the potential impacts of sea level rise, among others. These formal investigations and prioritizations could be completed by NepRWA but would also lend themselves to partnerships with DER and UMASS Boston researchers and students where appropriates.

Long Term Initiatives

Determine Potential Barriers to Restoration Sites

Once sites have been prioritized a review of individual sites and evaluation of the potential barriers to the success for each project should be done. This Cost/Benefit analysis would help to ensure that project goals are elucidated up front and are reasonably attainable should a specific project move forward. Barriers such as re-invasion of Phragmites, proper salinity levels and future sea level rise should all be included and discussed for each potential restoration site. This process should produce information and evaluation that would help guide the search for implementation funding either through state or municipal funding or individual grant programs.

Obtain Funding and Implement Prioritized Projects
Once the surveys, prioritization and evaluation of possible barriers to restoration success have been properly vetted and evaluated the search for funding should begin.

Anadromous Fish Enhancement
There are a number of potential actions which could enhance anadromous fish populations utilizing the Neponset River. These alternatives can generally be divided into those meant to enhance existing populations of rainbow smelt, and efforts to enhance and restore upstream runs of river herring and American Shad. There are both short and long term initiatives that would benefit Rainbow Smelt populations utilizing the river and decidedly longer term alternatives relating to river herring and American Shad.

- Rainbow Smelt Enhancement
    - Short Term Alternatives
        - Improve Fish Passage at Squantum Street
            - Identify restoration endpoint and obtain permission to proceed
            - Evaluate and redesign culvert
            - Install/Retrofit culvert
    - Long Term Alternatives
        - Improve Water Quality
        - River discharge evaluations
        - Fish passage at the Baker Dam
- Herring and American Shad Enhancement
    - Fish Passage at the Baker and T&H Dams
    - Improve Water Quality

Rainbow Smelt Enhancement

Short Term Alternatives

Improve fish passage at Squantum Street
The potential exists for restoration and improvement of the culvert at the intersection of Christopher Drive and Squantum Street in Milton, on Gullivers Creek/Unquity Brook, which has the potential to increase spawning habitat for rainbow smelt (Fig. 7). This location has been previously identified by DMF as a top priority for smelt restoration (Chase 2006).

Identify restoration end point and obtain permission to proceed
At this location there are two restoration alternatives that could be explored, both requiring owner permission to proceed. One restoration alternative would be to modify/retrofit the existing culvert to allow fish passage further upstream and a second alternative would be full removal of the culvert and daylighting of the stream in addition to modifications of the culvert.

Prior to evaluation of these two restoration end points it would be important to clarify ownership of both the culvert and any associated properties upstream, and meet with those owners to discuss these two possible restoration alternatives leading ultimately, to a decision on what the most feasible course of action would be moving forward. At this time it is not known if the culvert itself is owned by the Town of Milton or State of Massachusetts (MassDOT). Additionally, the culverted extension passes underneath the parking area for at least one private property owner which has not been investigated at this time (Fig. 7). A partnership between NepRWA, DMF and DER might be beneficial to help inform and educate property owners, not only of the need for this restoration work but also the benefits that could be foreseen to smelt populations under each restoration outcome. Obtaining this owner buy-in up front could help to alleviate concerns over any potential change in hydraulics that might occur post-restoration and would also help to build consensus for the importance of the restoration from the beginning.

Evaluate and Redesign Culvert

Once owner permission and buy-in has been obtained the evaluation and redesign of the culvert can take place. The level of redesign necessary for project completion would depend on the restoration end point that was chosen. Regardless of the restoration endpoint chosen, a coalition of partnerships between NepRWA, DMF, DER and property owners would be beneficial. At present, the culvert is acting as a barrier to fish passage further upstream. Visual observations made in 2011 indicate that smelt are able to get to the mouth of the culvert but the lip of a concrete pad in front of the culvert mouth prevents fish from accessing the culvert and continuing upstream. It would be important to review and evaluate all restoration end points for this location from a simple modification of the concrete pad all the way to culvert removal and daylighting of the brook. These evaluations should take into account ease of implementation, the need for special permits and overall project cost when attempting to determine the best possible solution for this location.

A full removal of the culvert and daylighting of the stream would be the ideal solution chosen for this location from an environmental point of view however the variables of ownership ease of implementation and potential cost may make this solution infeasible. More likely, the base of the concrete pad could be modified in such a way as to allow fish to access the culvert and continue upstream. Additionally, modifications upstream, such as debris removal and substrate enhancement might be necessary to further enhance the spawning potential upstream of the culvert.

NepRWA, along with the culvert owner(s), should look to partner and work with both DER and DMF to evaluate each restoration alternative. Partnering and involving DER and DMF from the onset would help to ensure that any restoration end-point chosen for this location would be environmentally sound. Once a restoration end-point has been identified a consultant would be needed to properly design and engineer any structures or enhancements needed to reach project goals. This would include initial conceptual designs as well as final design specifications needed to construct and implement the chosen restoration alternative.

Install/Retrofit Culvert

Once the best possible restoration alternative has been chosen and final designs have been obtained the actual permitting, installation and construction of that alternative would take place. Should the restoration end point of full culvert removal and daylighting of the stream be chosen the project would likely be competitive to receive grant funding from either state or federal grant sources, however, a simple modification of the concrete pad and smaller substrate enhancements would likely need to be funded locally.

Long Term Alternatives

Improve Water Quality

Further enhancement of smelt spawning in the Neponset could take place through the improvement of water quality in and around spawning areas. Restoration goals previously discussed under the "Water Quality Improvement" section, both short and long term, would be beneficial, specifically; the promotion of better stormwater management and the establishment of Nutrient TMDLs.

Elevated nutrient levels are thought to contribute to the excessive growth of nuisance algae that can degrade smelt spawning habitat. It has been recommended by DMF that municipalities address this through the adoption of policies that reduce the consumption and transport of nutrients used in domestic and municipal applications (Chase 2006). Additionally, excessive sedimentation, due to stormwater influences can negatively impact these spawning habitats by decreasing the surface area of spawning substrates increasing egg crowding and fungal growth (Chase 2006). Additional recommendations by DMF are to properly maintain and evaluate the performance of stormwater conveyances to spawning habitats. Taking this one step further it is NepRWA's recommendation that improved stormwater BMPs be evaluated for areas discharging directly to these priority spawning habitats and that the feasibility of retrofits, specifically for BMPs meant to treat TSS, be evaluated long term.

River Discharge Evaluations

Additionally, DMF recommends that more information is needed on the relationship between river discharges and anadromous fish spawning habitat. These investigations would help to develop minimum flow requirements to better promote anadromous fish spawning (Chase 2006). Also, DMF suggests that the spawning requirements of anadromous fish in the Neponset be investigated and an interagency evaluation be made in order to incorporate these requirements into future water withdrawal permits (Chase 2006).

Fish Passage at the Baker and T&H Dams

Finally, the full removal of the Baker and T&H dams would increase access to additional spawning habitat. This ongoing effort is discussed briefly below.

Herring and American Shad Enhancement

Long term, the major restoration initiatives benefiting herring and shad would be the improvement of water quality discussed above for the Neponset mainstem and the removal of the T&H Dam and modification of the Baker Dam. A longstanding multi-agency effort to restore fish passage at the Baker and T&H Dams is ongoing. The details of this program are beyond the scope of this report, however the next steps include:

- DEP to name responsible parties for PCB contamination in the Neponset mainstem
- DCR to authorize DFG to submit community approved fish passage options for MEPA review

Shellfish Restoration

The two main shellfish restoration initiatives in the Neponset Estuary examined were native oyster reintroduction and the potential for reclassification of shellfish beds around Buckley's Bar from Closed to Conditionally Restricted. At present, the reintroduction of native oysters is not considered a viable restoration alternative due to several factors. In general, Marine Fisheries does not support oyster planting activities that create new, self -sustaining populations in Prohibited or Restricted waters due to the risk of attractive nuisance and other enforcement and public health concerns. Without a municipal contaminated area management plan in place, these activities are not allowed (Hickey et al. 2011).

Since the reintroduction of oysters is not a restoration alternative at this time, the main focus for shellfish restoration in the Neponset estuary should be the re-classification of shellfish beds around Buckley's Bar from Closed to Conditionally Restricted fisheries. At present, DMF is continuing to evaluate water quality conditions but long term, a Sanitary Survey would be necessary to reclassify this area.

- Short Term Initiatives
    - Water Quality Monitoring
- Long Term Initiatives
    - Sanitary Survey

Short Term Initiatives

Water Quality Monitoring

The reclassification of shellfish beds on Buckleys Bar, and possibly elsewhere in the estuary, is a restoration goal that requires further investigation. DMF is currently collecting water samples for fecal coliform analyses in the Dorchester Bay/Buckley's Bar area. Current data from the past three years suggest that Buckley's Bar may already meet water quality standards required to reclassify this area as Conditionally Restricted however due to limited sampling frequency these data are considered inconclusive(Tables 12-14). Additional dry and wet weather sampling will be targeted for this area by DMF, as their resources allow. Due to limited budgets and staffing conditions at DMF, it is unclear if the areas suggested for reclassification will be able to be sampled in the short term with enough frequency to properly evaluate the potential for reclassification. Due to these limitations, an opportunity exists for DMF to partner with organizations such as NepRWA and possibly the MWRA, to help collect the necessary samples and possibly even defray some of the costs associated with analyses at properly certified laboratories.

Long Term Initiatives

Sanitary Survey

Should water quality data further indicate that these beds have the potential for reclassification, a Sanitary Survey would be required prior to official reclassification (FDA 2011). The Sanitary Survey is a written evaluation report of all environmental factors, including actual and potential pollution sources which have a bearing on water quality in a shellfish growing area (FDA 2011). The Sanitary Survey would incorporate data and information from a shoreline survey, a survey of the bacteriological quality of the water, an evaluation of the effect of any meteorological, hydrodynamic and geographic characteristics on the growing area, an analysis of the data from the shoreline survey, bacteriological, hydrodynamic, meteorological and geographic evaluations concluding in the determination of the appropriate growing area classification (FDA 2011).

It should be noted that softshell clam populations in Greater Boston Harbor have dropped drastically over the last decade (DMF pers. Comm.). The cause for these declines is likely linked to contributing factors such as over harvest, poor recruitment and disease. Due to the cyclic nature of softshell clam sets and the recent decline in the *Mya* populations throughout Boston Harbor, a population survey, at this time, might be informative for determining harvest levels.

Eelgrass Restoration

While the benefits of eelgrass to estuary and saltwater environments are clear, it does not seem feasible or worthwhile to look for reintroduction opportunities in the lower Neponset estuary at this time. Evaluation by DMF, TRC and Battelle and most recently Anchor QEA and data from MWRA suggest that the conditions required for successful eelgrass restoration do not exist in the Neponset River estuary or are such that reintroduction would not necessarily be successful long term (Figs. 11-12) (Battelle 2009, Estrella 2009, Anchor QEA 2010).

Site selection models aimed at identifying the top locations for successful eelgrass transplant and restoration took into account several factors thought to be crucial to successful reintroduction of eelgrass such as light availability, site depth (dessication) and sediment type. Not one single report listed areas in the Neponset estuary as having conditions suitable for eelgrass transplant and restoration nor did evaluation of the site specific parameters within the models point to the Neponset River estuary as a good restoration location (Battelle 2009, Estrella 2009, Anchor QEA 2010).

Areas outside of dessication zones (>0.3m depth) within the Neponset estuary were also areas that have anthropogenic influence in the form of past dredging and channelization which disqualified these locations as potential restoration sites (Estrella 2009). Additionally, light availability derived from Secchi disc readings from MWRA's Boston Harbor Monitoring Program were interpolated in conjunction with depth to determine percent of photosynthetically active radiation (PAR) at depth (Estrella 2009). The Neponset consistently had <10% PAR at depth which translated to a zero rating (lowest) under these site selection models (Battelle 2009, Estrella 2009, Anchor QEA 2010)(Figs. 11-12).

Even if %PAR at depth could be increased through the improvement of water quality, specifically by decreasing turbidity or levels of Total Suspended Solids (TSS), the limited area where restoration could take place combined with the potential for future dredging and/or anthropogenic disturbance would likely eliminate these areas for future restoration consideration.

Figure 11: Comparison of existing and potential eelgrass restoration sites to percent PAR at depth under normal conditions. Map taken from technical memorandum by Anchor QEA evaluating potential eelgrass mitigation sites in Boston Harbor.

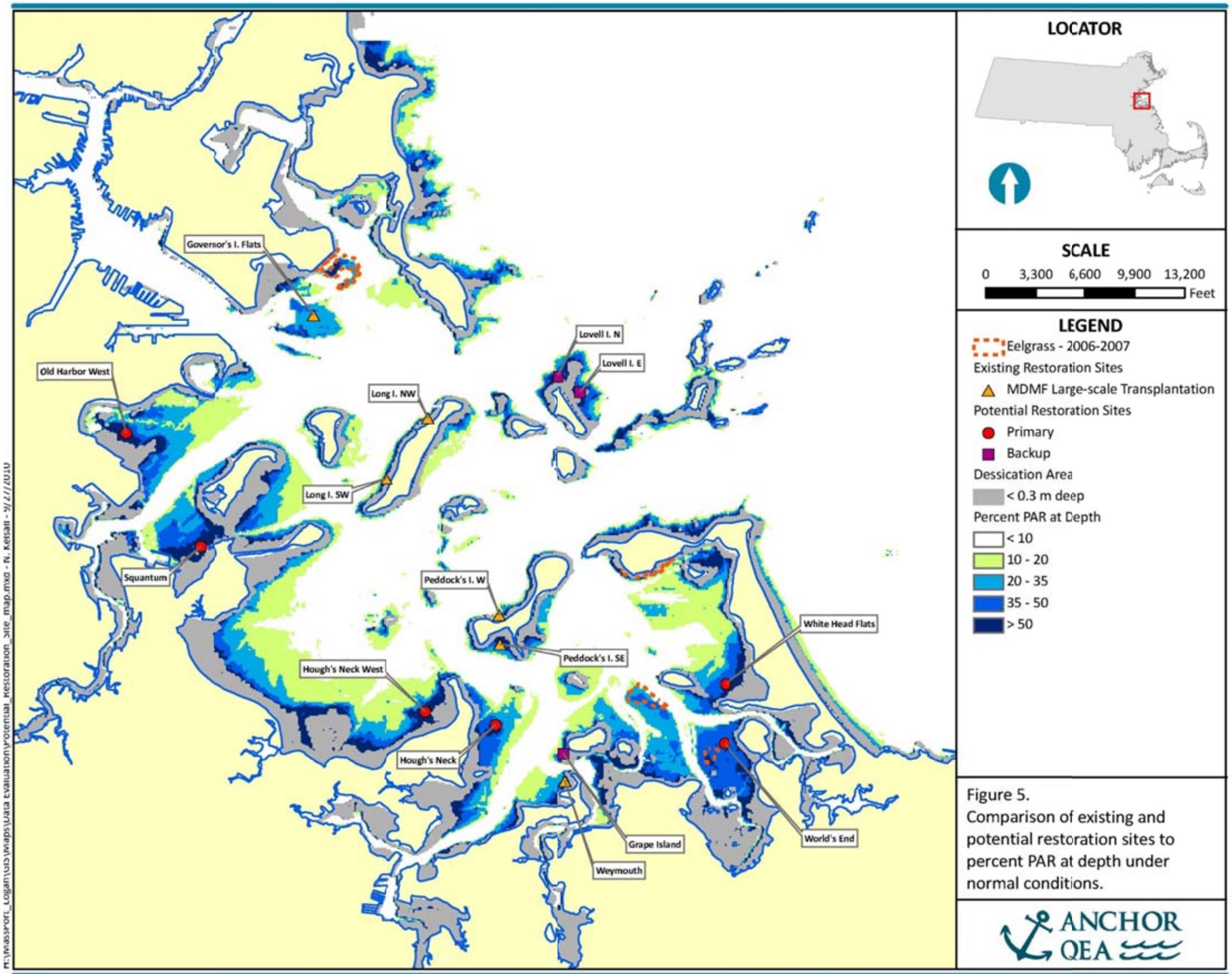
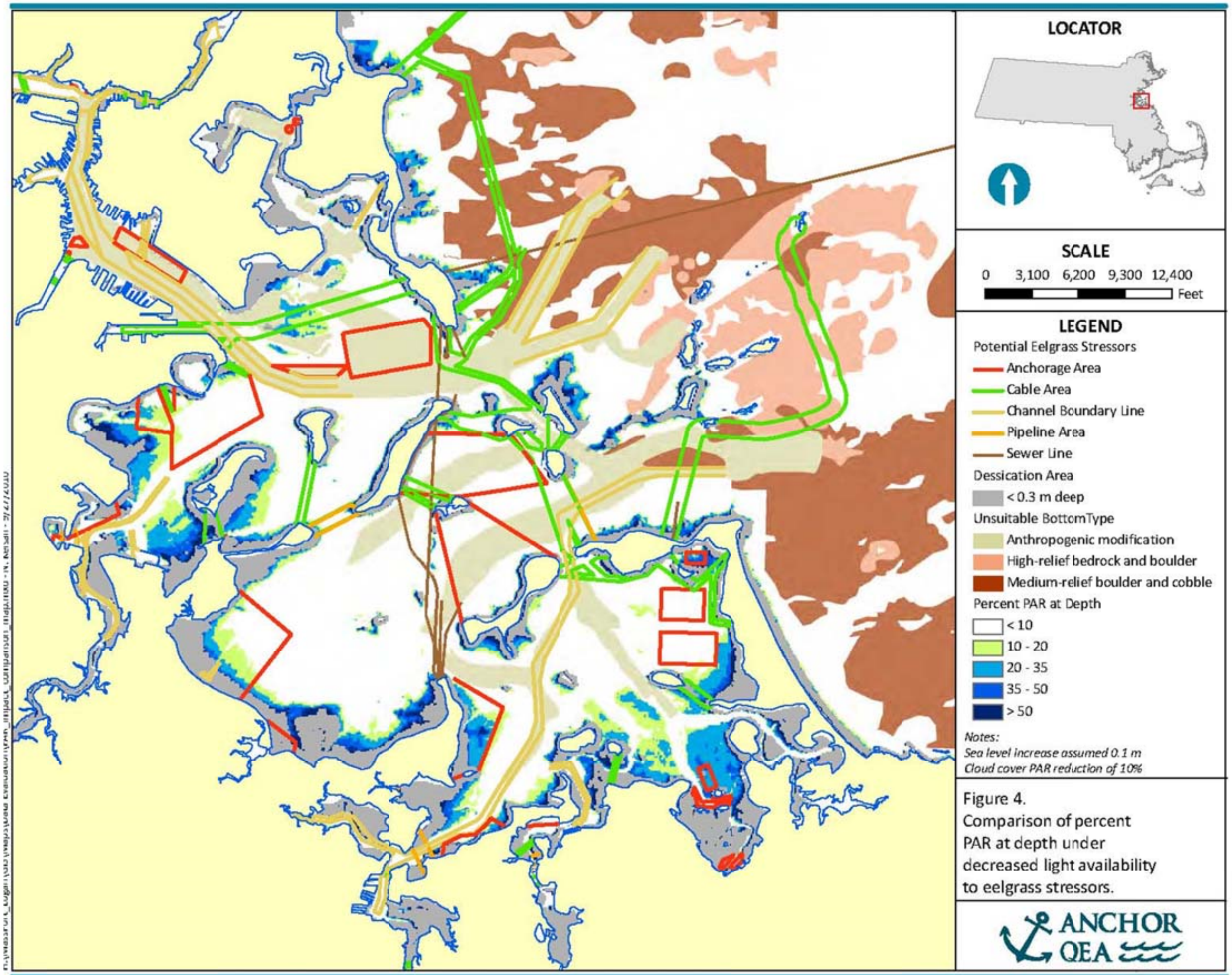


Figure 12: Comparison of percent PAR at depth under decreased light availability to eelgrass stressors. Map taken from technical memorandum by Anchor QEA evaluating potential eelgrass mitigation sites in Boston Harbor.



References

Anchor QEA. 2010. Technical Memorandum RE: Poterntial eelgrass mitigation sites. September.

Batelle, 2009. Hubline Pipeline Project, Eelgrass restoration Site Selection Analysis. Prepared by TRC and Battelle for Spectra Energy. February.

Birnbaum, J and Zink, K. 2009. Draft Technical Memorandum: Northeast Region Bacteria Source Tracking 2008 Results. CN 326.5. 71pp.

Boston Water and Sewer Commission. 2013a. Compliance Report For the Period: August1, 2012 through January 31, 2013. 122 pp.

Boston Water and Sewer Commission. 2013b. Compliance Report for the Period: February1, 2013 through July 31, 2013. 186 pp.

Carr, J., Rousseau, M., Ostrikis, K. 2012. Final Report: Identifying and Prioritizing Opportunities for Coastal Aquatic Habitats in the Massachusetts Bays Region. 51 pp.

Chase, B. 2006. Rainbow Smelt (Osmerus mordax) spawning habitat on the Gulf of Maine coast of Massachusetts. Massachusetts Division of Marine Fisheries Technical Reports. TR-30. 173pp.

Code of Massachusetts Regulations (CMR). Title 314. Massachusetts Surface Water Quality Standards. 4.0.

Estrella, 2009. Hubline Impact Assessment, Mitigation and Restoration. Completion Report of the Massachusetts Division of Marine Fisheries. July.

Guenther, W.B. 2010. Optical Brightener Survey of Three Streams in the Lower Neponset River Watershed: Pine Tree Brook, Mother Brook and Unquity Brook. Technical Report. 31pp.

Hickey, J.M., Shields, T., Kennedy, J., Ford, K., 2011. Shellfish Planting Guidelines. Massachusetts Division of Marine Fisheries. 13pp.

Reback, K.E., P.D. Brady, K.D. McLaughlin, and C.G. Milliken. 2004. A survey of anadromous fish passage in coastal Massachusetts: Part 4. Massachusetts Division of Marine Fisheries Technical Reports. TR-18. 130pp.

Short, F.T., Davis, R.C., Kopp, B.S., Short, C.A., Hurdick, D.M. 2002 Site-selection model for optimal transplantation of eelgrass Zostera marina in the northeastern US. Marine Ecology Progress Series. 227: 253-267.

USEPA. 1999. Protocol for Developing Nutrient TMDLs: First Edition. EPA841-B-99-007. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

USEPA. 2001. Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters. EPA822-B-01-003. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

United States Food and Drug Administration. 2011. National Shellfish Sanitation Program, Guide for the Control of Molluscan Shellfish 2011 Revision. 478 pp.

Conservation Law Foundation and USA v. Boston Water and Sewer Commission and Commonwealth of Massachusetts. 2012. Consent Decree. Civil Action No. 10-10250-RGS.

Appendix

Appendix 1: Neponset Estuary Data Review Questionnaire Matrix: excel file