BOSTON HARBOR
2004 - 2008 WATER QUALITY ASSESSMENT REPORT

COMMONWEALTH OF MASSACHUSETTS
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2004 - 2008 WATER QUALITY ASSESSMENT REPORT

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Massachusetts Water Resources Authority (MWRA)
Office of Coastal Zone Management (CZM)

Federal
National Oceanic and Atmospheric Administration (NOAA)
United States Environmental Protection Agency (US EPA)

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List of Acronyms and Abbreviations

BGY	billion gallons per year
BPJ	best professional judgment
BWSC	Boston Water and Sewer Commission
cm	centimeter
CN	control number
CSO	combined sewer overflow
CWA	Clean Water Act
CWIS	cooling water intake structure
CZM	Office of Coastal Zone Management
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DMF	Division of Marine Fisheries
DO	Dissolved Oxygen
DWM	Division of Watershed Management
EPA	United States Environmental Protection Agency
FDA	United States Food and Drug Administration
FWB	Friends of Wollaston Beach
GPM	gallons per minute
ISQG	Interim Sediment Quality Guidelines
LC_{50}	Lethal Concentration 50%
LLC	limited liability corporation
MA DCR	Massachusetts Department of Conservation and Recreation
MA DFG	Massachusetts Department of Fish and Game
MA DPH	Massachusetts Department of Public Health
MassDEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Geographic Information System
MBDC	Morrissey Boulevard Drainage Conduit
ME	Maine
MGD	million gallons per day
NDA	No Discharge Area
MGH	Mass General Hospital
µg/L	micrograms per liter
mg/L	milligrams per liter
mi^2	square miles
mL	milliliter
MS4	Municiple Separate Storm Sewer Systems
MWRA	Massachusetts Water Resources Authority
n	number of (e.g., data points)
NDBST	North Dorchester Bay [CSO] Storage Tunnel
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OSI	Organism Sediment Index
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
PDF	portable data format
PEL	Probable Effect Levels
RPD	redox potential discontinuity
sp.	species (singular)
SPI	Sediment Profile Imagery
spp.	species (plural)
SSO	sanitary sewer overflow
SWQS	Surface Water Quality Standards
TMDL	total maximum daily load
TOC	Total Organic Carbon
TN	total nitrogen
TP	total phosphorus
TPD	tons per day
TRC	total residual chlorine
WCP	Wetlands Conservancy Program
WET	Whole Effluent Toxicity
WWTP	wastewater treatment plant

List of Common and Scientific names

Common name	***Scientific name***	**Common name**	***Scientific name***
American/Atlantic lobster	*Homarus americanus*	a polychaete cornuta	*Chaetozone setosa*
Blue mussel	*Mytilus edulis*	Purple-spined sea urchin	*Arbacia punctulata*
gammarid anthropods	*Ampelisca* spp.	rod-shaped anaerobic bacteria	*Clostridium perfringens*
a gammarid amphipod	*Leptocheirus pinguis*	Shorthorn sculpin	*Myoxocephalus scorpius*
Inland silverside	*Menidia beryllina,*	Softshell clam	*Mya arenaria*
mud/shell worm	*Polydora cornuta*	a spionid worm	*Streblospio benedicti*
a mysid shrimp	*Mysidopsis bahia*	Winter flounder	*Pseudopleuronectes americanus*

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Executive Summary

BOSTON HARBOR 2004-2008 WATER QUALITY ASSESSMENT REPORT

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which surface waters in the state shall be protected. The assessment of current water quality conditions is a key step in the successful implementation of the Watershed Approach. This critical phase provides an assessment of whether or not the designated uses are supported or impaired, or not assessed, as well as basic information needed to focus resource protection and remediation activities later in the watershed management planning process.

This report presents a summary of current water quality data/information for Boston Harbor (including Winthrop Bay, the Inner Harbor, Pleasure Bay, Dorchester Bay, Quincy Bay, Hingham Bay and Hull Bay) used to assess the status of the designated uses as defined in the SWQS. The designated uses, where applicable, include: *Aquatic Life, Fish Consumption, Shellfishing, Primary and Secondary Contact Recreation and Aesthetics*. Each use, within a given assessment segment, is individually assessed as ***support*** or ***impaired***. When too little current data/information exists or no reliable data are available the use is ***not assessed***. However, if there is some indication of water quality impairment, which is not considered to be "naturally-occurring", the use is identified with an "Alert Status".

The summary of the assessments for the *Aquatic Life, Fish Consumption, Shellfishing, and Primary and Secondary Contact Recreation* uses for Boston Harbor and its bays defined as segments in this report are illustrated in Figures 1 through 5, respectively. Since all segments are not assessed for the *Aesthetic Use*, no figure is provided in this report for that use. MA DPH has issued a fish consumption advisory for Boston Harbor which for assessment purposes is broadly defined to include all coastal waters that drain into it, therefore all estuarine segments in this report are affected by the advisory.

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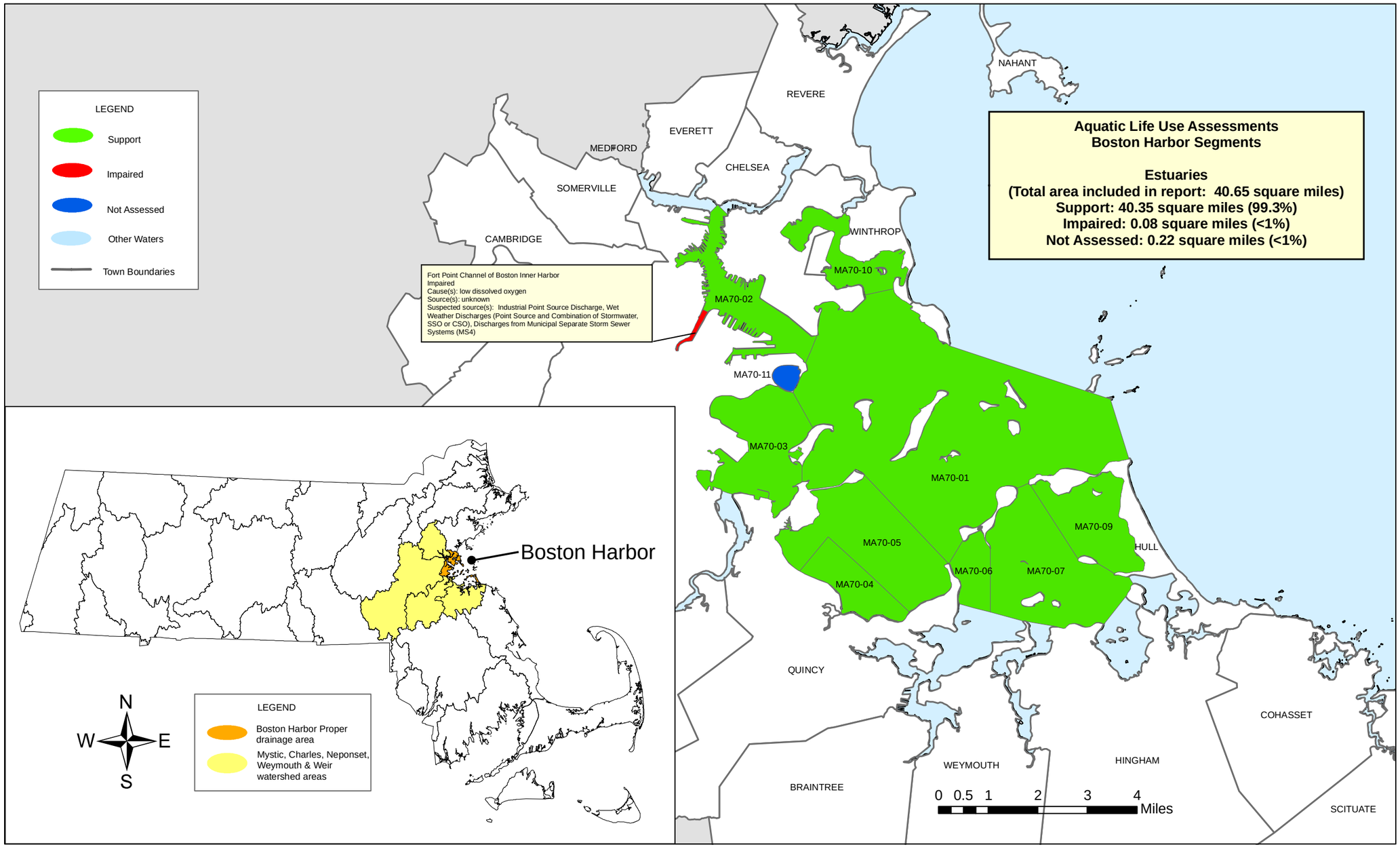

Figure 1. *Aquatic Life Use* assessment summary for Boston Harbor. Note: The *Aquatic Life Use* is supported when suitable habitat (including water quality) is available for sustaining a native, naturally diverse, community of aquatic flora and fauna. Impairment of the Aquatic Life Use may result from anthropogenic stressors that include point and/or non-point sources of pollution and hydrologic modification. Causes and/or sources of impairments, when known, are noted in the callouts. Not Assessed includes current segments and not assessed other waters (river or lakes not assigned assessment segments).

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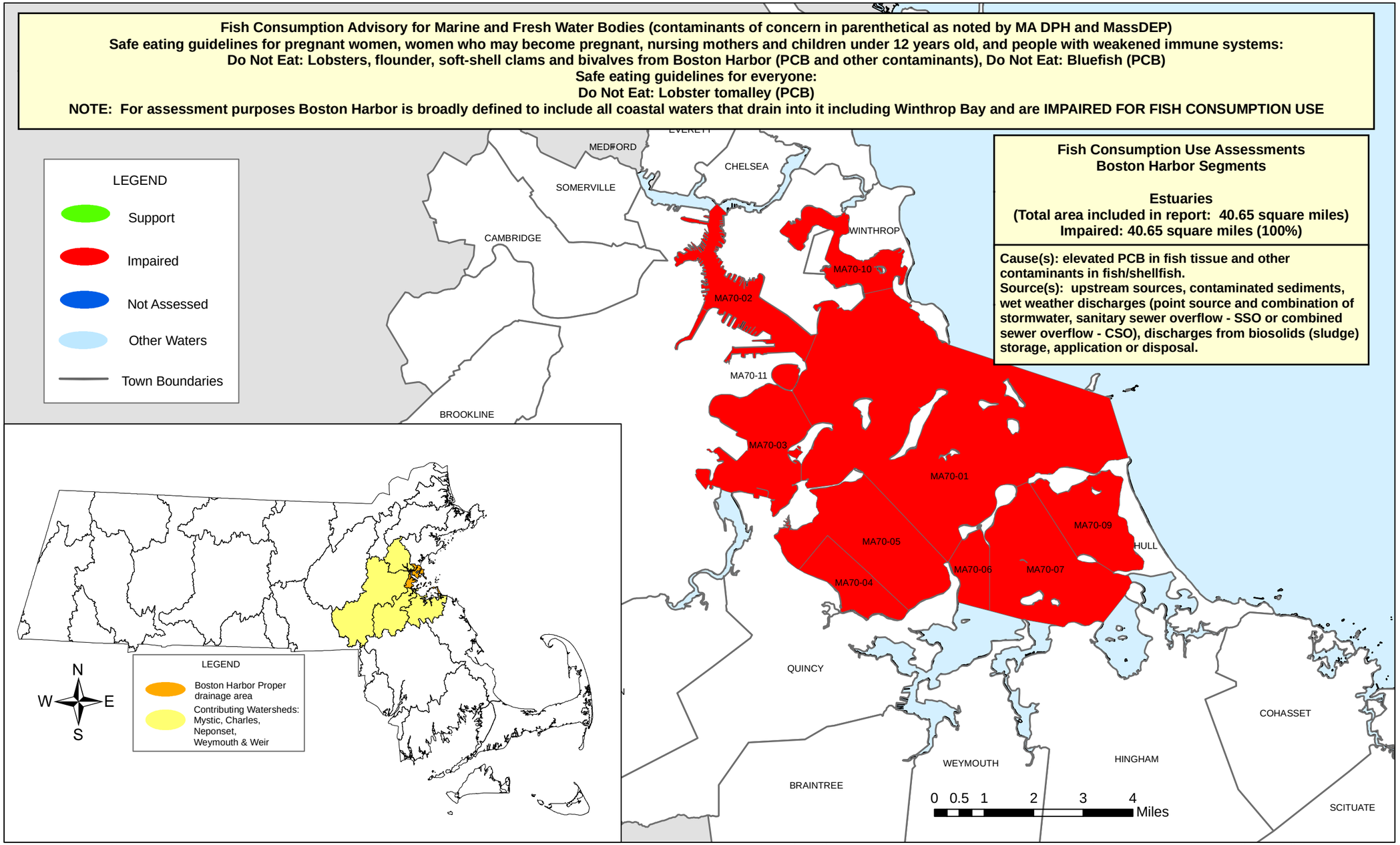

Figure 2. *Fish Consumption Use* assessment summary for Boston Harbor. Note: The *Fish Consumption Use* is supported when there are no unacceptable concentrations of pollutants in edible portions of fish, other aquatic life or wildlife for human consumption. The assessment of the *Fish Consumption Use* is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (MA DPH). The MA DPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater/marine species pose a health risk for human consumption; hence, the Fish Consumption Use is assessed as impaired in these waters.

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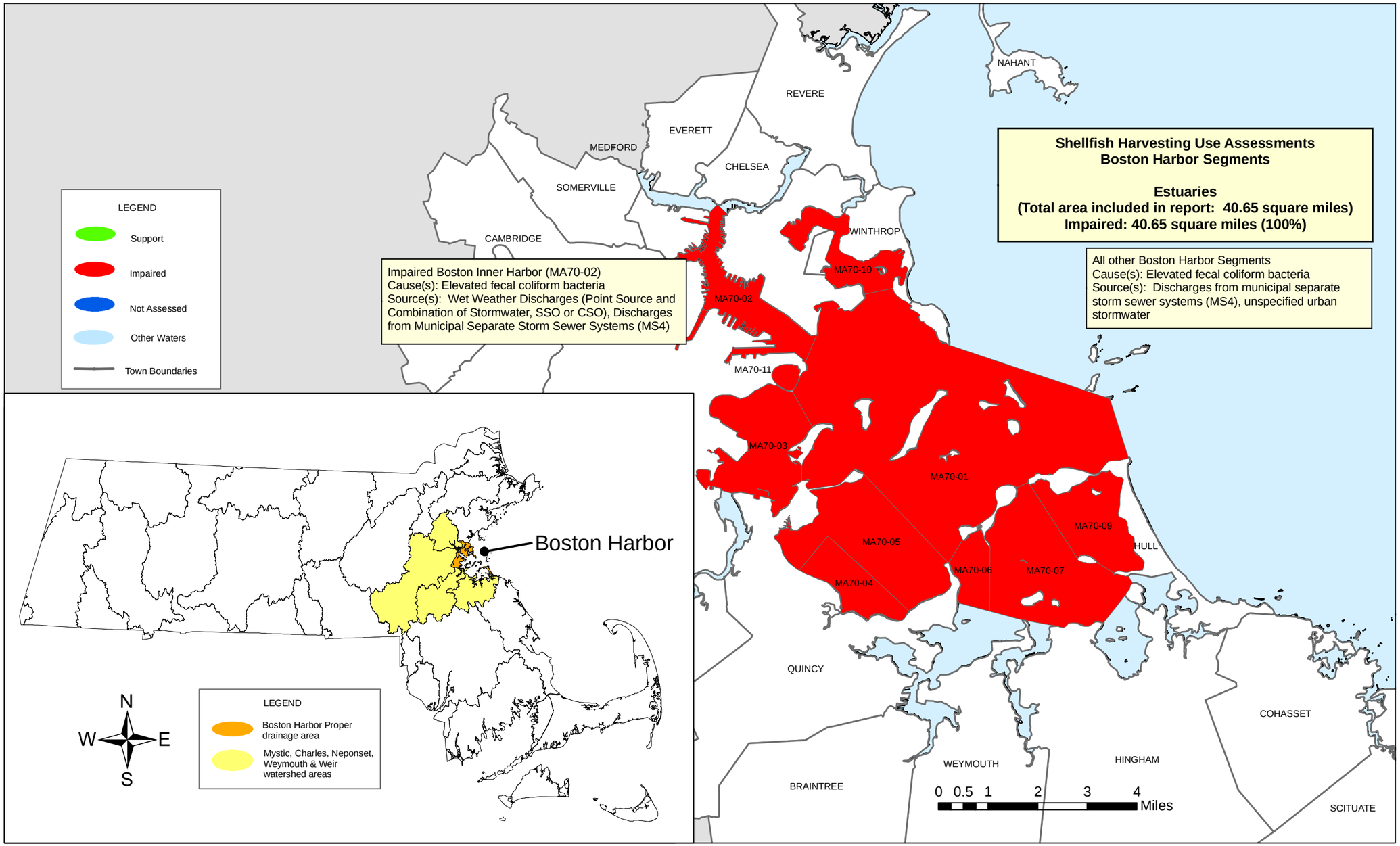

Figure 3. *Shellfish Harvesting Use* assessment summary for Boston Harbor. Note: The *Shellfish Harvesting Use* is supported when MA Department of Fish and Game classifies a shellfish growing area as Approved, Conditionally Approved, or Restricted (SB waters only). SB waters that are classified by DMF as Conditionally Restricted or Prohibited are assessed as impaired for the *Shellfish Harvesting Use*.

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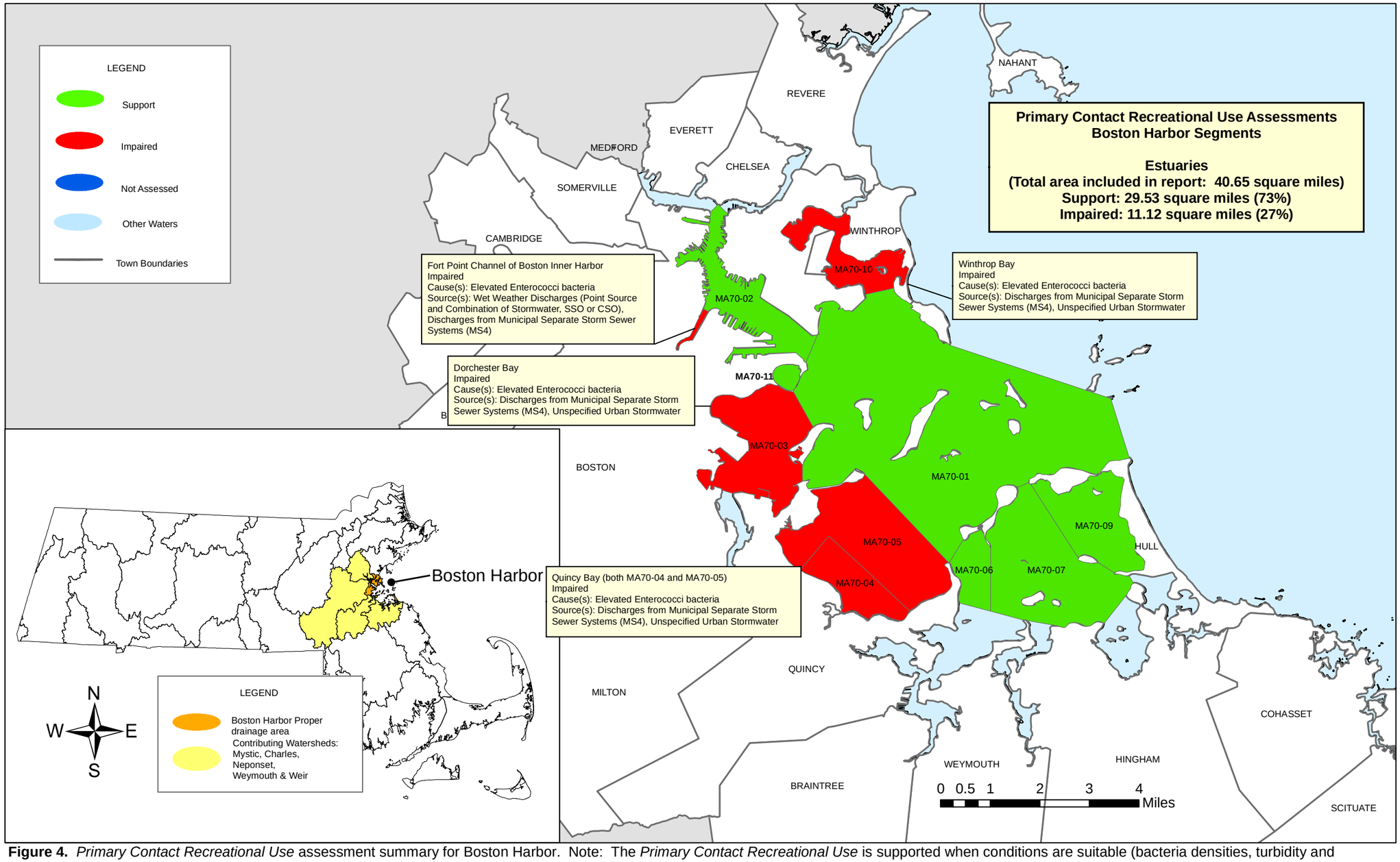

Figure 4. *Primary Contact Recreational Use* assessment summary for Boston Harbor. Note: The *Primary Contact Recreational Use* is supported when conditions are suitable (bacteria densities, turbidity and aesthetics meet the SWQS and/or the MA DPH Bathing Beaches State Sanitary Code and/or guidance) for any recreational or other water related activity during which there is prolonged and intimate contact with the water and there exists a significant risk of ingestion. Activities include, but are not limited to, wading, swimming, diving, surfing and water skiing. Causes and/or sources of impairments, when known, are noted in the callouts.

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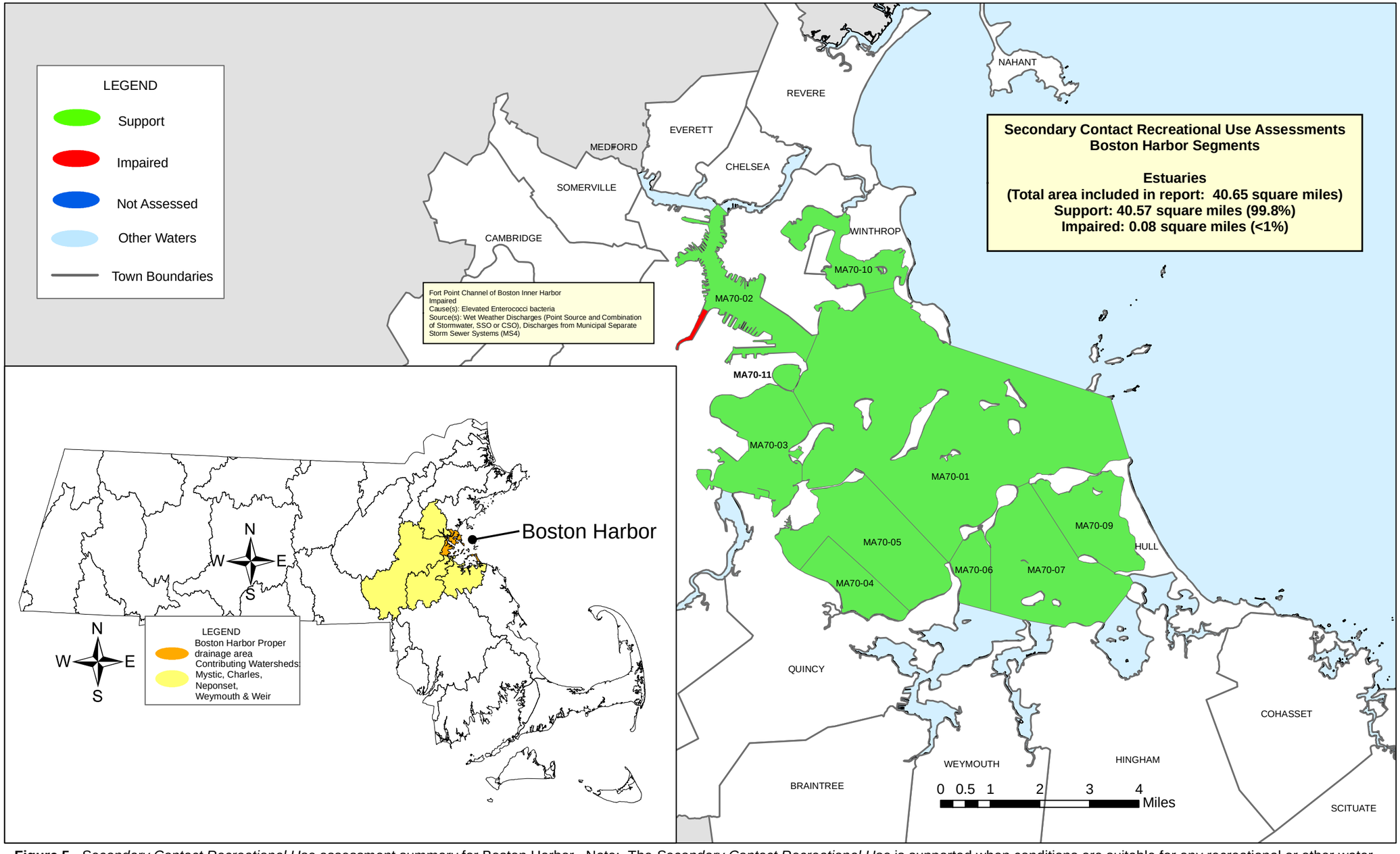

Figure 5. *Secondary Contact Recreational Use* assessment summary for Boston Harbor. Note: The *Secondary Contact Recreational Use* is supported when conditions are suitable for any recreational or other water use during which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact related to shoreline activities. Causes and/or sources of impairments, when known, are noted in the callouts.

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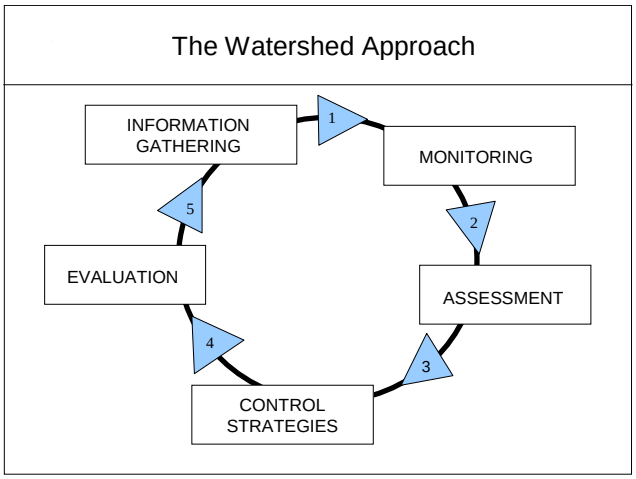
Introduction

The goal of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). To meet this objective, the CWA requires states to develop information on the quality of the Nation's water resources and report this information to the U.S. Environmental Protection Agency (EPA), the U.S. Congress, and the public. Together, these agencies are responsible for implementation of the CWA mandates. Under Section 305(b) of the Federal Clean Water Act, every two years MassDEP must submit a statewide report which describes the status of water quality in the Commonwealth to the EPA. Until 2002 this was accomplished as a statewide summary of water quality (the 305(b) Report). States are also required to submit, under Section 303(d) of the CWA, a list of impaired waters requiring a total maximum daily load (TMDL) calculation. In 2002, however, EPA required the states to combine elements of the statewide 305(b) Report and the Section 303(d) List of Impaired Waters into one "Integrated List of Waters" (Integrated List). This statewide list is based on the compilation of information for the Commonwealth's 27 watersheds. Massachusetts has opted to write individual watershed surface water quality assessment reports and use them as the supporting documentation for the Integrated List. The assessment reports utilize data compiled from a variety of sources and provide an evaluation of water quality, progress made towards maintaining and restoring water quality, and the extent to which problems remain at the watershed level. Quality assured biological, habitat, physical/chemical, toxicity data and other information are evaluated to assess the status of water quality conditions. This analysis follows a standardized process described in Appendix A (Assessment Methodology) of this report.



This report presents the current assessment of water quality conditions for Boston Harbor (including Winthrop Bay, the Inner Harbor, Pleasure Bay, Dorchester Bay, Quincy Bay, Hingham Bay and Hull Bay). The assessments are based on information researched and developed primarily by the Massachusetts Water Resources Authority (MWRA), although other external data sources (see Acknowledgements) used to make use assessment decisions are also provided.

The MWRA provides sewer services to 43 communities in and around Boston (MWRA 2010). Combined Sewer Overflow (CSO) and sewerage infrastructure brought partially and untreated wastes into the harbor for centuries, resulting in a much-degraded environment; excerpts from Maciolek *et al.* (2008d) provide a chronology of the history of pollution and restoration efforts in the Boston Harbor area:

> *Boston Harbor has had a long history of anthropogenic impacts dating back at least to colonial times (Loud 1923). In addition to the damming of rivers and the filling of salt marshes and shallow embayments to create the present footprint of the city, the direct discharge of waste products has had a profound impact on the composition of the biological communities in the harbor. Prior to the 1950s, raw sewage was discharged into Boston Harbor primarily from three locations: Moon Island, Nut Island, and Deer Island. In 1952, the Nut Island treatment plant became operational and began treating sewage from the southern part of Boston's metropolitan area. The Deer Island treatment plant was completed in 1968, thus providing treatment for sewage from the northern part of the area. (The third location, Moon Island, was relegated to emergency status at that time and not used routinely thereafter.) The effluent was discharged continuously from both plants; an annual average of 120 million gallons per day (MGD) from Nut Island and 240 MGD from Deer Island. Storm events caused up to 3.8 billion gallons per year (BGY) of additional material to be occasionally discharged to the harbor through the system of combined sewer overflows (CSOs) (Rex et al. 2002).*
>
> *Sludge, which was separated from the effluent, was digested anaerobically prior to discharge. Digested*

sludge from Nut Island was pumped across Quincy Bay and discharged through an outfall near Long Island on the southeastern side of President Roads. Sludge from Deer Island was discharged through that plant's effluent outfalls on the northern side of President Roads. Sludge discharges were timed to coincide with the outgoing tide, under the assumption that the tide would carry the discharges out of the harbor and away offshore. Unfortunately, studies have shown that the material from Nut Island often was trapped near the tip of Long Island and carried back into the harbor on incoming tides (McDowell et al. 1991).

In 1972, the Federal Clean Water Act (CWA) mandated secondary treatment for all sewage discharges to coastal waters, but an amendment allowed communities to apply for waivers from this requirement. The metropolitan Boston area's application for such a waiver was denied by the US Environmental Protection Agency (EPA), partly on the basis of the observed degradation of the benthic communities in Boston Harbor. In 1985, in response to both the EPA mandate to institute secondary treatment and a Federal Court order to improve the condition of Boston Harbor, the Massachusetts Water Resources Authority (MWRA) was created. The MWRA instituted a multifaceted approach to upgrading the sewage treatment system, including an upgrade in the treatment facility itself and construction of a new outfall pipe to carry the treated effluent to a diffuser system in Massachusetts Bay located 9.5 mi offshore in deep water.

In 1989, discharge of more than 10,000 gallons per day of floatable pollutants comprising grease, oil, and plastics from the Deer Island and Nut Island treatment plants was ended. Sludge discharge ceased in December 1991, marking the end of one of the most significant inputs of pollutants to Boston Harbor. In 1995, a new primary treatment plant at Deer Island was completed, increasing the system's overall capacity and the effectiveness of the treatment. In August 1997, the first phase of secondary treatment was completed, increasing the level of solids removal to 80%. For the first time, the MWRA's discharge met the requirements of the CWA (Rex et al. 2002).

In July 1998, a new screening facility at Nut Island became operational, with sand, gravel, and large objects being removed from the wastewater flow prior to transport via tunnel to Deer Island for further processing. In October 1998, the old Nut Island plant was officially decommissioned, ending more than 100 years of wastewater discharges to the shallow waters of Quincy Bay. By 2000, the average effluent solids loading to the Harbor had decreased to less than 35 tons per day (TPD), reduced from the 138 TPD discharged through the 1980s. On September 6, 2000, all wastewater discharges were diverted to the new outfall in Massachusetts Bay, and in early 2001, the final battery of secondary treatment became operational.

Ongoing MWRA pollution abatement projects for Boston Harbor involve reducing the number and discharge volumes from Combined Sewer Overflows (CSOs). In 1988, 88 CSOs discharged a total of about 3.3 billion gallons per year (BGY). By 1998, 23 CSOs had been closed, and pumping improvements reduced discharges to about 1 BGY, of which about 58% is screened and disinfected. By 2008, ongoing projects will reduce the number of CSO outfalls to fewer than 50, with an estimated discharge of 0.4 BGY, of which 95% will be treated by screening and disinfection (Rex et al. 2002).

MWRA monitoring efforts utilized in this report are briefly described below:

MWRA instituted a benthic monitoring program in 1992 to assess the quality of the seafloor environment at stations near the former CSO and wastewater treatment plant (WWTP) discharge points, as well as the relocated Deer Island WWTP effluent discharge point. Sediment Profile Imagery (SPI), a multibeam seafloor mapping system that generates a highly detailed map of seafloor topography and substrate type, was used to assess the soft-bottom benthic infaunal communities throughout Boston Harbor and Massachusetts Bay (Maciolek *et al.* 2005, Maciolek *et al.* 2006a, 2006b, Maciolek *et al.* 2008a, 2008b, 2008c, 2008d, Maciolek *et al.* 2009). SPI monitoring provides a nonintrusive method for evaluating the quality of the benthic habitat through an estimation of: sediment compaction (prism penetration); the depth to which sediments are oxidized (apparent color redox potential discontinuity layer - RPD); grain size distribution; and surface and subsurface features such as biota, bioturbation, bed forms, shells, detrital layers, gas voids, sediment lenses, et cetera (Williams *et al.* 2005, 2006). Reported measurements include Organism Sediment Index (OSI), apparent color RPD, successional stage of benthic infauna, and number and density of amphipod tubes.

The activity of benthic infauna (mostly by annelid worms) e.g., burrowing, ingestion/defecation of sediment particles, movement of grains for gallery construction/management/infilling, result in the biologically-based mixing and aeration of the top layer of sediment. The rate of this bioturbation is affected by the number and type of infaunal species and population diversity. Bioturbation influences sediment oxygen levels i.e., the greater the bioturbation, the greater the level of oxygen in the sediment, and the greater the depth of the oxygenated layer. The sediment oxygen concentration in turn affects the rate of composition of organic detritus, biomass, and return of nutrients to the ecosystem (Maciolek *et al.* 2006a). Thus, the measure of bioturbation can provide an estimate of benthic habitat quality. According to Maciolek *et al.* (2005),"*Ampelisca spp. has been considered a key organism in following the status of the infaunal community of Boston Harbor, partly because members of this genus are considered by some to be indicative of clean environments."*

SPI was conducted at 61 stations throughout and just outside of Boston Harbor. Improvements in benthic habitat quality were observed between 1992 and 2008, along an inner to outer harbor gradient, associated with the large reduction in organic inputs to Boston Harbor resulting from the infrastructure changes/improvements noted above. There were increases in deeper, bioturbating species, which likely increased trophic complexity (Maciolek et al. 2009).

The MWRA instituted a fish and shellfish monitoring program in 1991-1992 in selected locations throughout Boston Harbor and Massachusetts Bay. According to Nestler *et al. (*2007):

> *"The objective of the fish and shellfish monitoring is to define the condition of three indicator species: winter flounder (Pseudopleuronectes americanus), lobster (Homarus americanus), and blue mussel (Mytilus edulis). Measured parameters include length, weight, biological condition, the presence of external or internal disease, and inorganic and organic contaminant tissue concentrations. Data have been collected for these organisms since 1991 for* [caged] *mussels, and 1992 for flounder and lobster. The 2006 data represent the sixth year of monitoring after the start up of the Massachusetts Bay outfall in September of 2000. The core monitoring program was conducted annually until 2003, and sampling is now done every third year, except for flounder morphology and histopathology, which remain on an annual schedule. This characterization of the health of winter flounder, lobster, and mussel in Boston Harbor, Massachusetts Bay, and Cape Cod Bay (hereafter: Boston Harbor and the Bays) forms the basis for assessing changes resulting from the relocation of the outfall discharge."*

The MWRA has reported the results of flounder and lobster monitoring at four stations (the Deer Island Flats site in the Boston Harbor assessment study area in recent years (Pala *et al.* 2003; Moore 2003; Moore *et al.* 2004; Moore 2006; Nestler *et al.* 2007; Nestler *et al.* 2008; Moore *et al.* 2009; Moore *et al.* 2010). One component of this annual monitoring program includes the collection of 50 sexually mature (>30 cm) flounder, which are measured for age, length, weight, external condition, and liver histology and disease (Maciolek *et al.* 2008e). Over the course of the study, the percentage of females has been generally greater than 50%, and has increased at all stations through 2009. Standard length and mean weights have also increased from 1992 to 2006, which may be associated with the increasing prevalence of females (which tend to be bigger than males). A study of shorter duration has examined the prevalence of blind side ulcers in flounder, which were first observed in the study area in 2001 (Moore 2003). According to Moore *et al.* (2010),

> *"The prevalence of blind-side ulcers in the western portion of Massachusetts Bay increased markedly beginning in 2003 (Moore 2003). Extensive pathology and microbiology studies have been unable to determine a cause of the ulcers (Moore et al. 2004). Additional surveys conducted throughout 2004 and 2005 established that ulcer prevalence peaked in late winter to early spring, with evidence of healed ulcers and lower ulcer prevalence into early summer (Moore 2006). This apparent recovery sequence suggests that these lesions may be a non-lethal seasonal condition. Ulcer prevalence in the 2009 survey suggests a continuing decrease over recent years… The highest prevalence observed was the first year it was recorded (2004)."*

The MWRA fish and shellfish program also included an overall health assessment and the measurement of pollutant concentrations in the edible tissues of flounder and lobster (Pala *et al.* 2003; Moore 2003; Moore *et al.* 2004; Moore 2006; Nestler *et al.* 2007; Moore *et al.* 2009; Moore *et al.* 2010). Flounder fillets and livers were composited into three replicates of 15 flounder, and for lobster, the meat and hepatopancreas were composited into three replicates of seven lobsters. Measured contaminants included pesticides (n=17), PCBs (n=20), PAHs (n=48) and mercury and lead. Results of the tissue contaminant analyses were compared to the maximum permissible levels established by the U.S. Food and Drug Administration (FDA); there is no FDA action limit for total PAH.

The tissue contamination in caged blue mussels is also a component of the fish and shellfish monitoring program (Kane-Driscoll *et al.* 2008, Nestler *et al.* 2007, Lefkovitz *et al.* 2004, Pala *et al.* 2003). Blue mussels were collected from a reference location in Stover's Point, ME (n=1200). A subset of four replicates of 25 mussels (soft tissue, including fluids only; Nestler *et al.* 2007) were analyzed for baseline chemistry, then 110 mussels were deployed for 60 days at each of five locations in Boston Harbor and Massachusetts Bay. Measured contaminants included pesticides (n=17), PCBs (n=20), PAHs (n=48) and mercury and lead. As with flounder and lobster, the results were compared to the FDA action limits.

Other pertinent information regarding Boston Harbor

Boston Harbor was designated a No Discharge Area (NDA) on July 24, 2008 (US EPA 2010). Under this program, the Massachusetts Office of Coastal Zone Management (CZM):

> "*provides interested communities with NDA resources and information, assists communities in writing the NDA application, coordinates with EPA, and helps to ensure that the proposed NDA has adequate pumpout facilities. In addition, all NDA applications must be certified by CZM to be consistent with its Enforceable Program Policies (PDF, 191 KB). CZM then officially requests that the Secretary of the Executive Office of Energy and Environmental Affairs designates the proposed waters for EPA approval as an NDA"* (MA CZM 2009).
>
> "*Boat sewage can contain bacteria and viruses, nutrients, and chemicals that can be harmful to water quality and public health. No Discharge Areas, or NDAs, are designated bodies of water where the discharge of all boat sewage, whether treated or not, is prohibited. Governor Patrick's goal is ultimately to make all of the Commonwealth's coastal waters NDAs. The Massachusetts Office of Coastal Zone Management (CZM) is working with coastal communities to develop applications to the U.S. Environmental Protection Agency for no discharge status, and is supporting efforts to increase boat pumpout facilities to make proper sewage disposal more convenient for boaters… the coastal waters of Winthrop, Chelsea, Everett, Boston, Quincy, Milton, Weymouth, Braintree, Hingham, and Hull, including the Charles River in Watertown, Newton, and Cambridge"* are designated as No Discharge Areas.

Objectives

This report summarizes information generated in Boston Harbor since the last water quality assessment report that was published in October 2002 (O'Brien *et al.* 2002). The new assessments are based on the most currently available validated water quality data/information for Boston Harbor (including Winthrop Bay, the Inner Harbor, Pleasure Bay, Dorchester Bay, Quincy Bay, Hingham Bay and Hull Bay). The methodology used to assess the status of water quality conditions the harbor and bays in accordance with EPA's and MassDEP's use assessment methods is provided in Appendix A. Appendix B provides a summary of National Pollutant Discharge Elimination System (NPDES) permitting information for the Boston Harbor Drainage System. Appendix C provides MWRA data summaries of water quality monitoring information collected between 2002 and 2008 (MWRA 2008) for sampling stations within the Boston Harbor segments. Appendix D provides sediment quality data excerpted from Durell *et al*. (2008) for stations located in Boston Harbor segments. These sediment data were then compared to reference concentrations (*Canadian Sediment Quality Guidelines for the Protection of Aquatic Life* in CCME 2002).

The objectives of this water quality assessment report are as follows.

1. evaluate whether or not surface waters in the harbor and bays, defined as segments in the MassDEP/EPA databases, currently support their designated uses (i.e., meet surface water quality standards),
2. identify stressors impairing designated uses and any confirmed sources of those stressors [e.g., water withdrawals (habitat quality/water quantity) and/or major point (e.g., wastewater discharges, storm sewer system) and non-point (e.g., land-use practices, overland runoff, etc.) sources of pollution that may impair water quality conditions],
3. identify the presence of any non-native organisms,
4. identify waters (or segments) of concern that require additional data to fully assess water quality conditions, and
5. recommend additional monitoring needs and/or remediation actions in order to better determine the level of impairment or to improve/restore water quality.

There are a total of 10 segments representing 40.65 mi2 in this report including Winthrop Bay, the Inner Harbor, Pleasure Bay, Dorchester Bay, Quincy Bay, Hingham Bay, Hull Bay, and Boston Harbor. The information/data and assessments for each segment are provided in the following pages of this report.

Winthrop Bay (MA70-10)

Location: From the tidal flats at Coleridge Street, Boston (East Boston) to a line between Logan International Airport and Point Shirley, Boston/Winthrop
AU Size: 1.65 Square Miles
Classification: SB
2008 303(d) List: Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Pathogens).

NPDES Discharges (Appendix B):

MassPort Authority/Logan International Airport (MA0000787) (Table B1)
Boston Water and Sewer Commission (MAS01000) (Table B3, 2 major outfalls, 4 non-major outfalls)
City of Winthrop (MAR041084) (Table B4)

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

MassDEP's Wetland Conservancy Program (WCP) identified the presence of eelgrass bed habitat in Winthrop Bay from historic 1951 black and white aerial photography (Costello 2003). There was an estimated 34.14 acres (~ 3% of the segment area) however confidence was noted as being low. No eelgrass bed habitat has been identified in this segment area since (statewide mapping efforts conducted in 1995 and 2001) (Costello 2008).

Biology

In 2006, the Massachusetts Division of Marine Fisheries (DMF) initiated a restoration and enhancement program for shellfish in three towns (Quincy, Weymouth, Hingham) of Boston Harbor. The program was expanded to five towns (Hull and Winthrop were added to the original three) in 2007 (Shields 2009). The program included enhancement of open, but unproductive areas that were suitable for shellfish habitat by the planting of seed clams (the softshell clam, *Mya arenaria*), as well as the restoration of native clams to appropriate areas with the deployment of clam spat (larva) collectors. In 2007, project efforts in Winthrop Bay included the seeding of 108,000 clams in 6 plots off Court Road, Winthrop, and the seeding (108,000 clams in 6 plots) and spat collector deployment off the west side of Snake Island. Survival of seeded clams at the Court Road site was high (>25 clams survived/ft^2) throughout the 6 sample plots, while survival of seeded clams off Snake Island was mostly high (4 plots), with 1 low (1 to <15 live clams/ft^2) and 1 moderate level of survival (15 to <25 live clams/ft^2). Seeded clams were highly affected by sediment type, tidal currents, and wind- and vessel-driven waves. The clam spat collectors yielded no significant numbers of young of year clams in 43 of 44 sites in the entire project area; however, the one collector where significant numbers were found was located at the site off Snake Island (29 juveniles).

Toxicity Testing

Effluent

One modified acute and chronic whole effluent toxicity test was conducted on a grab sample from Logan International Airport/MassPort Authority Outfall 001B in March 2008 during a wet weather deicing episode. No acute or chronic whole effluent toxicity was detected by *Menidia beryllina* (i.e., LC_{50}=100 and CNOEC =100% effluent) or *Arbacia punctulata* (CNOEC=100% effluent).

Water Chemistry

MWRA has conducted water quality monitoring in Winthrop Bay at one station (130 at Green Can #1) (sampling location in channel between Snake Island and Logan International Airport). Sampling depths at this site ranged from approximately 4.2 to 8.7 m between 2002 and 2008. Dissolved Oxygen (DO) concentrations ranged between 5.95 and 14.65 mg/L (n= 370 samples including both surface and bottom measurements) (MWRA 2008). Saturations were high (>110%) in only five sampling events (~1% samples) although none were above 110% since 2005. In surface water samples collected between 2002 and 2008 (note no samples collected in 2007 and only one sample in 2008) total nitrogen concentrations ranged from 0.053 to 0.574 mg/L while total phosphorus concentrations ranged from 0.015 to 0.085 mg/L (n=126) (MWRA 2008). Chlorophyll *a* results ranged from 0.20 to 17.80 µg/L (n=251 representing both surface and bottom samples) although it should be noted that chlorophyll *a* results were notably lower since 2005 (none were > 5.19 µg/L, n=57). Total suspended solids data collected between 2002 to 2006 ranged from 0.39 to 9.05 mg/L in surface water samples (n=125) and between 0.67 and 12.7 mg/L (n=123) in bottom samples (MWRA 2008).

The *Aquatic Life Use* is assessed as support based primarily on the water quality data (DO, chlorophyll *a*, total suspended solids) and the generally low concentrations of total nitrogen, as well as the good survival of seeded clams and the significant number of clam spat in previously unproductive areas.

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):
***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**
Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:
Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)
Do Not Eat: *Bluefish* (PCB)
Safe eating guidelines for everyone:
Do Not Eat: *Lobster tomalley* (PCB)
NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Winthrop Bay.

The *Fish Consumption Use* is assessed as impaired for Winthrop Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, sanitary sewer overflow - SSO or combined sewer overflow - CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted indicate as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that 38% of this segment is Conditionally Restricted to shellfish harvesting, and 62% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on best professional judgment (BPJ), these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

Winthrop Bay is heavily utilized for recreation, and includes three yacht clubs and four public beaches.

Frequent testing for enterococci bacteria during the swimming season has been conducted at the four public beaches within the Winthrop Bay segment from 2002-2007 (MA DPH 2009a). These beaches include:

Constitution Beach, Boston – Based on the results of daily testing, Constitution Beach experienced the highest number of closures of all four beaches in this segment. The beach was posted as closed greater than 10% of the beach season in 3 of the 6 years (2002, 2005 and 2006) with closures of 13, 43 and 32% respectively.
Donovans and *Grandview Beaches, Winthrop* – From 2003 to 2007, weekly testing was conducted at these two beaches. They were open on all beach days except the 2006 season, with closures of 11%. It should be noted that 2006 experienced a high volume of rainfall between May and September of this year (an estimated 31 inches), according to the National Oceanic and Atmospheric Administration (NOAA 2010).
Pico Beach, Winthrop – From 2003 to 2007, based on the results of weekly enterococci testing at Pico Beach no closures were required.

MWRA has conducted water quality monitoring in Winthrop Bay at one station (130 at Green Can #1) (sampling location in channel between Snake Island and Logan International Airport) (Appendix C). Between 2002 and 2008, the geometric means of enterococci bacteria samples collected at the surface during the primary contact recreation season (1 April to 15 October) each year ranged from 5 to 17 colonies/100 mL (n= 123) (MWRA 2008). The geometric means of enterococci bacteria samples collected at the surface during the secondary contact recreation season (year round) each year ranged from 5 to 17 colonies/100 mL (n= 185). The Secchi

depth ranged from 1.1 to 6.3 m (n=170). Secchi depths were less than 1.2m only three times during this time period (1.8% of measurements) (MWRA 2008).

The *Primary Contact Recreational Use* is assessed as impaired due to the frequency of closures at Constitution Beach, which are associated with elevated levels of enterococci bacteria. It should be noted, however, that conditions at Donovan's, Grandview, and Pico beaches and the bacteria counts at the MWRA sampling station were generally indicative of good water quality conditions that support recreational uses. Based on BPJ, the elevated bacteria counts are assumed to be associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater. The *Secondary Contact Recreational Use* is assessed as support. Too limited data are available, so the *Aesthetics Use* is not assessed.

Winthrop Bay (MA70-10) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		IMPAIRED Cause: Elevated Enterococci bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

Boston Inner Harbor (MA70-02)

Location: From the Mystic and Chelsea rivers, Chelsea/Boston, to the line between Governors Island and Fort Independence, Boston (East Boston) (including Fort Point, Reserved and Little Mystic channels)
AU Size: 2.56 Square Miles
Classification: SB(CSO)
2008 303(d) List: Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Priority organics, Pathogens).

NPDES Discharges (Appendix B):

Boston Water and Sewer Commission (BWSC) (MA0101192) (Table B1): *CSO outfall BOS070 (MWRA internal outfall MRW215) Union Park CSO Treatment Facility*
Exelon New Boston, LLC (MA0004731) (Table B1): Facility closed December 2007, permit terminated June 2009 Exelon now has coverage for stormwater outfalls under the 2008 Multi-Sector General Permit (MSGP) for Stormwater Discharges Associated with Industrial Activities
MGH Institute of Health Professionals (MAG250019) (Table B1)
Atlantic Marine Boston, LLC (MA0040142) (Table B1)
Gillette Company (MA0003832) (Table B1)
MassPort Authority/Logan International Airport (MA0000787) (Table B1)
Massachusetts Port Authority (MA0032751) *(Logan International Fire Training Facility)* (Table B1)
Massachusetts Port Authority (MA0004405) (Table B1)
Massachusetts Water Resources Authority (MAG910128) (Table B1)
Massachusetts Water Resources Authority (MA0103284) (Table B1)*CSO Outfall 203 Prison Point CSO Treatment Facility*
New England Aquarium Corporation (MA0003123) (Table B1)
U.S. Coast Guard Integrated Support Command (MA0090671) (Table B1): permit terminated in December 2006
Massachusetts Turnpike Authority Central Artery Tunnel Project (MA0033928) (Table B1): permit terminated in August 2008
Boston Water and Sewer Commission (MAS01000) (Table B3; 23 major outfalls, 10 non-major outfalls)
City of Chelsea (MAR041077) (Table B4)

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

There are three facilities that withdraw water from Boston Inner Harbor:

MGH Institute of Health Professionals (MAG250019) has an intake in the flooded dry dock #2 in the Charlestown Navy Yard near the MGH facility in Boston Inner Harbor for their 0.864MGD (max daily discharge) of non-contact cooling water. According to the facility's consultant (Markey 2009): "*there are two intake lines that protrude from the dry dock north wall which run down concrete steps about twenty-five feet below the water surface. There are no screens on either line. The lines are cast iron and are approximately six inches in diameter. These two lines correspond to the two seawater pumps located in the seawater pump room. These pumps are able to pump water at a six-hundred gallons per minute (GPM) rate to the heat exchangers. Only one pump operates at any given time.*"

New England Aquarium Corporation (MA0003123) has two water intake pipes which extend about 300 feet out into Boston Inner Harbor from the facility. The intakes are about three feet above the surface bottom and draw water for use in the aquarium's tanks and aquaria. No information regarding the intake screens and/or intake velocity were available in the files. The facility's discharge is 0.15 MGD (million gallons per day, monthly average flow).

Gillette Company (MA0003832) has a cooling water intake structure (CWIS) in Fort Point Channel seaward of the company's outfalls and the artery tunnel crossing that withdraws 60.1 MGD. The CWIS is currently comprised of four 24" wide by 48" high horizontal tunnels. The inlets are covered with cylindrical stainless steel intake screens. The stationary screens are equipped with an air blower system for debris removal. The rated

flow capacity for each of the four screen assemblies is 15,000 GPM with a maximum through screen velocity of 0.5 fp. The nominal slot opening is 0.375 inches.

As part of the MWRA's benthic monitoring program, in Boston Inner Harbor, sediment profile imaging (SPI) was conducted at three stations from 2002 to 2008: near the New England Aquarium (Station C019, added to the program in 2004 anticipating improvements in CSO infrastructure), north of Commonwealth Pier (R10), and off the mouth of the Reserved Channel (R09) (Maciolek *et al.* 2009). The presence of *Ampelisca* spp. generally increased in an upstream to downstream order. Station C019 did not exhibit any evidence of *Ampelisca* spp. (n=5); tubes were absent at Station R10 since 2000; and absent at Station R09 since 2004 (before which it had been present or dense from 1996 to 2004). These stations were characterized by fine-grained sediments throughout the study period (1991-2008). Station C019 was also sampled for grain size analysis, Total Organic Carbon (TOC), and *Clostridium perfringens* abundance. The TOC content generally decreased over the study period, and although values varied little overall, the lowest value measured in this time frame was observed in 2008. *Clostridium perfringens* abundance at Station C019 increased over time, while decreasing at all other stations (sometimes significantly), in the same period.

Biology

The MWRA conducted studies in 2001, 2002, 2003, and 2006 on contaminant uptake to caged mussels deployed within Boston Inner Harbor near the New England Aquarium for 60 days; a subset was removed and archived at 40 days in the event that too few mussels would survive to 60 days. The survival rate of caged mussels at this station ranged from >95% at 40 days, and $\geq$81.5% at 60 days (Lefkovitz *et al.* 2002, Pala *et al.* 2003, Lefkovitz *et al.* 2004, Nestler *et al.* 2007).

The MWRA has conducted benthic monitoring surveys at numerous stations in Boston Harbor since 1992 (Maciolek *et al.* 2009). In a 1989 study, the benthic infaunal community at Station C019 was dominated (94-96%) by two species, including *Streblospio benedicti* and *Chaetozone setosa,* both annelid worm species commonly found in fine grained sediments; the remainder of the community was distributed among four taxa. *S. benedicti* is noted as "relatively tolerant to elevated levels of sediment organics, a trait that contributes to its success as a pioneering opportunistic species" (Smithsonian Institution 2010). In contrast, from 2004-2008, 48 taxa were observed, with the highest number of species (27) in the 2008 survey. The samples were consistently dominated by *Nephtys cornuta*, but with the increase in other taxa over the years, the percentage of the population represented by this one species has decreased (Maciolek *et al*. 2009).

Toxicity Testing

Ambient

Survival of *Mysidopsis bahia* and *Menidia beryllina* exposed (48-hours) to water collected from Boston Inner Harbor (sampling point located from a floating dock adjacent to the west side of Pier One near the Coast Guard Station at 427 Commercial Street Boston) and used as dilution water in the USCG whole effluent toxicity tests was $\geq$ 95% in the 12 test events conducted between February 2002 and August 2006.

Survival of *Menidia beryllina* exposed (7-day) to water collected from Boston Inner Harbor (location between airport and US Naval Reservation near Ted Williams Tunnel) for use as dilution water in the MassPort Authority/Logan International Airport's whole effluent toxicity tests was $\geq$95% in the March 2008 test event. Survival of *M. bahia* and *M. beryllina* exposed (48-hours) to water collected from this same location for use as dilution water in the Logan International Airport Fire Training Facility's acute whole effluent toxicity tests was 100% in the December 2008 and January 2010 test events.

Water from Boston Inner Harbor (withdrawn through the facility's intake pipes) is used as either the dilution water or as a site control for the New England Aquarium's whole effluent toxicity tests. Survival of *M. bahia* exposed (48-hours) to the Harbor water was $\geq$98% (n=10) while survival of *M. beryllina* exposed (48-hours) was $\geq$75% (n=11) for the tests conducted between February 2002 August 2009.

Water from Boston Inner Harbor (exact location not defined) was collected and used as the dilution water for the Gillette Company whole effluent toxicity tests. Survival of *M. bahia* exposed (48-hours) was $\geq$ 95% in all tests conducted between January 2000 and July 2003 (n=15).

Effluent

No acute whole effluent toxicity to either *M. bahia* or *M. beryllina* was detected in the 12 tests conducted between February 2002 and August 2006 on grab samples from the US Coast Guards outfall 002 (i.e., all LC_{50} $\geq$100% effluent).

One modified acute and chronic whole effluent toxicity test was conducted on a grab sample from Logan International Airport/MassPort Authority Outfall 002B in March 2008 during a wet weather deicing episode. No acute or chronic whole effluent toxicity was detected by *M. beryllina* (i.e., LC_{50}=100 and CNOEC=100% effluent) but the discharge did exhibit chronic whole effluent toxicity to *Arbacia punctulata* (CNOEC=12.5% effluent).

No acute whole effluent toxicity to either *M. bahia* or *M. beryllina* was detected in either of the two tests conducted (December 2008 and January 2010) on the Logan International Airport's Fire Training Facility discharge.

Acute whole effluent toxicity tests were conducted on composite samples from the New England Aquarium Boston Facility discharge between Feburary 2002 and August 2009. No acute whole effluent toxicity was detected by *M. bahia* (n=14) or *M. beryllina* (n=15) with the exception of two *M. bahia* test events (September 2002 and February 2003 with LC_{50}s = 34.8 and <6.25% effluent, respectively). It should be noted that for both toxic episodes, the effluent total residual chlorine (TRC) concentrations were reported to be extremely high (2.7 and 11.0 mg/L, respectively) and the dechlorinated lab controls for the September 2002 tests also exhibited toxicity. One test conducted in February 2007 also indicated acute toxicity to both species however the toxicity was likely associated with TRC since the sample was not dechlorinated.

No acute whole effluent toxicity to *M. bahia* was detected in the 15 tests conducted between January 2000 and July 2003 on the Gillette Company outfall 001 (i.e., all $LC_{50} \geq$100% effluent).

Eight acute whole effluent toxicity tests were conducted on composite samples from the BWSC outfall BOS070 (MWRA internal outfall MRW215—Union Park Treatment Facility) between January 2008 and November 2009. No acute whole effluent toxicity has been detected by either *M. bahia* or *M. beryllina* (all LC_{50}'s >100% effluent) with the exception of the January 2008 test event (LC_{50}'s =32 and 35.4% effluent to *M. bahia* and *M. beryllina*, respectively).

Twenty acute whole effluent toxicity tests were conducted on composite samples collected from MWRA's Outfall #203 (Prison Point CSO Treatment Facility) between March 2001 and December 2009 using *M. bahia* and *M. beryllina* as test organisms (24-hour tests). With the exception of only two *M. bahia* tests (March 2002 and April 2006 with LC_{50s} = 10.2 and 45.2% effluent, respectively) no acute whole effluent toxicity was detected.

Water Chemistry

MWRA has conducted water quality monitoring at eight stations in Boston Inner Harbor between 2002 and 2008 (see more detailed data in Appendix C). Of these stations, results of DO monitoring from 2002 to 2008 were similar at six stations, with the exclusion of the two stations in Fort Point Channel (Stations 018 and 075). Descriptions of these results are summarized separately below:

Sampling depths in Boston Inner Harbor from the confluence with the Mystic and Chelsea Rivers (Station 015) downstream to Red Buoy #10 at the mouth of the Inner Harbor (Station 24) were all 6.0 m or greater, ranging from 5.9 to 16.6 m between 2002 and 2008. DO concentrations ranged between 4.8 and 14.42 mg/L, with only one measurement <5.0 mg/L (n= 2,392, including both surface and bottom measurements) (MWRA 2008). Saturation was high (>110%) in 73 of the surface water measurements (as high as 143.3%) representing 3% of all measurements taken.

Conditions in the Fort Point Channel varied from the other Boston Inner Harbor stations between 2002 and 2008, and a gradient was observed between the two Fort Point Channel stations as well. Depths measured in the upstream end of Fort Point Channel (Station 075 at Broadway Street) ranged from 0.8 to 3.1 m. DO concentrations ranged between 2.01 and 12.76 mg/L at Broadway (n= 280 samples including both surface and bottom measurements); approximately 21% of the measurements were < 5.0 mg/L (MWRA 2008). It is notable however that half (n=30) of the measurements below 5.0 mg/L DO occurred in the surface and bottom measurements taken between 24 June and 9 October 2008. Saturation was high (>110%) in three measurements (maximum saturation 115.1%).

Further out in Fort Point Channel, depths at Summer Street (Station 018) ranged from 5.4 – 10.7m between 2002 and 2008. DO concentrations ranged between 3.72 and 14.14 mg/L (n= 459 samples including both surface and bottom measurements) (MWRA 2008). DO was < 5.0 mg/L in seven of the bottom measurements and one surface measurement since 2005 (~ 1.7% of measurements). Saturation was high (>110%) in six surface water

samples and three bottom samples (maximum saturation 133.7%), or approximately 2% of all measurements taken.

Samples were collected for total phosphorus (TP), total nitrogen (TN), and chlorophyll-*a* at two stations in Boston Inner Harbor between 2002 and 2008: off the New England Aquarium (Station 138); and near the mouth of the Inner Harbor, at Red Buoy #10 (Station 024). Total nitrogen concentrations ranged from 0.042 to 0.858 mg/L while total phosphorus concentrations ranged from 0.010 to 0.101 mg/L (n=389) (MWRA 2008). Chlorophyll *a* results ranged from 0.24 to 31.60 µg/L (n=388 representing both surface and bottom samples). Total suspended solids data collected between 2002 to 2006 ranged from 0.24 to 18 mg/L in surface water samples (n=382) and between 0.22 and 19.7 mg/L (n=378) in bottom samples (MWRA 2008).

Sediment Chemistry

In 2006, sediment collected near the mouth of Fort Point Channel in Boston Inner Harbor (sampling station C019 with a mean water depth of 7.9m) was comprised primarily of fines (~97%), (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 3.2% (Durell *et al*. 2008, see Appendix D). To assess the overall sediment quality the sum of the ratios that exceeded a value of 1.0 (concentration/guidance) for both Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL) guidelines were calculated (see Appendix A, *Aquatic Life Use* sediment chemistry guidance). This sum is noted as the total factor over the ISQG and/or PEL. The concentrations of contaminants in the top 2 cm of sediment at the mouth of Fort Point Channel exceeded ISQGs by a factor of 198.5 while the PELs were exceeded by a factor of 15.4. Total DDD and the estimated total PCB concentration (calculated as 2 times the sum of the 20-congener PCB concentration data reported by MWRA) were each slightly over 2 times their respective PELs (see Appendix D).

The *Aquatic Life Use* is assessed as impaired in the 0.08 mi^2 area of Fort Point Channel because of the seasonally frequent and prolonged low dissolved oxygen conditions in the shallow inward-most area of the channel. DO concentrations were much improved midway in the channel near Summer Street. The remaining 2.48 mi^2 area of Boston Inner Harbor is assessed as support for the *Aquatic Life Use* based on the good survival of caged mussels and test organisms exposed to water from the Inner Harbor and good DO conditions. There were also notable improvements in the number of taxa and individuals in the benthic community noted at the mouth of Fort Point Channel. It should be noted, however, that there were occasional indications of enrichment throughout the Inner Harbor (i.e., supersaturation, elevated chlorophyll *a* concentrations, slightly elevated total nitrogen concentrations) as well as degraded sediment quality at the mouth of Fort Point Channel so this use is identified with an Alert Status.

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):

***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)

Do Not Eat: *Bluefish* (PCB)

Safe eating guidelines for everyone:

Do Not Eat: *Lobster tomalley* (PCB)

NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Boston Inner Harbor.

As part of the MWRA's fish and shellfish monitoring program, the levels of tissue contaminants in deployed blue mussels have been measured since 1991 (Kane-Driscoll *et al.* 2008, Nestler *et al.* 2007, Lefkovitz *et al.* 2004, Pala *et al.* 2003). Mussels suspended in cages in Boston Inner Harbor generally contained the highest tissue concentrations of contaminants of all five stations throughout the monitoring program (1991- 2006), including mercury and lead, PCBs, total DDT's, total chlordane and dieldrin.

The Food and Drug Administration (FDA) has established maximum permissible levels of contaminants in edible fish and shellfish tissues to protect human health. Results of studies conducted by the MWRA indicate that the FDA limits for lead, mercury, chlordane, 4,4'-DDE and PCBs were not exceeded in all tissues and stations monitored in 2003 (Lefkovitz *et al.* 2004) or in 2006 (Kane-Driscoll *et al.* 2008). There is no FDA action limit for total PAH.

The *Fish Consumption Use* is assessed as impaired for Boston Inner Harbor as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted indicate as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that <1% of this segment is Conditionally Restricted to shellfish harvesting, and >99% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), discharges from municipal separate storm sewer systems (MS4).

Primary and Secondary Contact Recreational and Aesthetics Uses

MWRA conducted monitoring at eight stations in Boston Inner Harbor between 2002 and 2008 (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at each station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
015	near the confluence with the Mystic and Chelsea Rivers	6 – 13 (n=108)	7 – 16 (n=149)	0.7 – 4.2 (3 measurements <1.2 m, n=129)
014	near the mouth of the Charles River at the Coast Guard Base	7 – 25 (n=113)	7 – 20 (n=157)	1.0 – 5.9 (2 measurements <1.2 m, n=132)
138	off of New England Aquarium	8 – 16 (n=115)	9 – 15 (n=188)	1.5 – 5.6 (n=193)
019	off the mouth of Fort Point Channel	9 – 33 (n=153)	11 – 30 (n=205)	1.0 – 4.9 (1 measurement <1.2 m, n=163)
075	in Fort Point Channel at Broadway Street	40 – 4622 (n=119)	258 – 4113 (n=179)	0.2 – 2.3 (6 measurements <1.2 m, n=30)
018	in Fort Point Channel at Summer Street	15 – 173 (n=179)	21 – 152 (n=261)	0.4 – 5.2 (7 measurements <1.2 m, n=134)
022	in the middle of Reserved Channel	9 – 22 (n=131)	10 – 17 (n=180)	1.2 – 5.6 (n=161)
024	at the mouth near R. Buoy 10	Not sampled	Not sampled	1.1 – 6.4 (1 measurement <1.2 m, n=357)

*Primary contact recreation season: April 1 – October 15
**Secondary contact recreation season: calendar year

The *Primary and Secondary Contact Recreational Uses* are assessed as impaired in the 0.08 mi^2 area of Fort Point Channel because of elevated enterococci bacteria. The remaining 2.48 mi^2 area of Boston Inner Harbor is assessed as support for these uses based on the acceptable levels of bacteria and generally good Secchi depths. Due to the lack of available data, the *Aesthetics Use* is not assessed.

Boston Inner Harbor (MA70-02) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT* 2.48 mi^2 area Boston Inner Harbor IMPAIRED 0.08 mi^2 area Fort Point Channel Cause: low DO Source: Unknown Suspected Sources: Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Discharges from Municipal Separate Storm Sewer Systems (MS4), industrial point source discharge
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Discharges from Municipal Separate Storm Sewer Systems (MS4)
Primary Contact		SUPPORT 2.48 mi^2 area (all segment less Fort Point Channel) IMPAIRED 0.08 mi^2 area of Fort Point Channel Cause: Elevated Enterococci bacteria Source: Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Discharges from Municipal Separate Storm Sewer Systems (MS4)
Secondary Contact		
Aesthetics		NOT ASSESSED

* Alert Status issues identified, see details in use assessment

RECOMMENDATIONS

Modifications to the MGH Institute of Health Professionals (MAG250019) cooling water intake structure (e,g., intake screens, reduce intake velocity to <0.5 ft/sec) should be implemented to reduce/eliminate impingement and/or entrainment.

Reduce acute testing for Prison Point CSO discharge (MWRA NPDES Permit MA0103284 Outfall 203) to *M. bahia* only (the more sensitive test organism).

New England Aquarium Whole Effluent Toxicity (WET) tests consider dropping to *M. bahia* if consistently more sensitive. The TRC concentrations in the effluent were extremely high (in one case 11 mg/L which is an order of magnitude higher than the 1.0 mg/L max daily permit limit). In addition, three episodes of acute whole effluent toxicity were associated with high TRC concentrations in the discharge. It is unclear whether or not these toxic events were caused by the thiosulfate used to dechlorinate the effluent prior to testing because the thiosulfate control also exhibited toxicity. Therefore it is recommended that disinfection methods used by the New England Aquarium be evaluated to improve the control of final effluent TRC concentrations. Additional information needs to be obtained for the Aquarium's water intake structure (e.g., description of intake screens, intake velocity calculations) to evaluate whether or not any system modifications should be implemented to reduce/eliminate impingement and/or entrainment.

Careful evaluation of the impingment/entrainment and thermal monitoring information should be conducted to develop appropriate limits and monitoring requirements for the next Gillette Company NPDES permit (MA0003832).

Pleasure Bay (MA70-11)

Location:	A semi-enclosed bay, the flow restricted through two channels between Castle and Head islands, Boston
AU Size:	0.22 Square Miles
Classification:	SB
2008 303(d) List:	Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Priority organics, Pathogens).

NPDES Discharges (Appendix B):
Massachusetts Water Resources Authority (MAG910128) (Table B1)

DESIGNATED USE ASSESSMENT
Aquatic Life Use
No recent water quality data are available so the *Aquatic Life Use* is not assessed for Pleasure Bay.

Fish Consumption Use
MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):
***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**
Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:
Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)
Do Not Eat: *Bluefish* (PCB)
Safe eating guidelines for everyone:
Do Not Eat: *Lobster tomalley* (PCB)
NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Pleasure Bay.

The *Fish Consumption Use* is assessed as impaired for Pleasure Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use
The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that >99% of this segment is Conditionally Restricted for shellfish harvesting, and <1% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses
Frequent testing for enterococci bacteria during the swimming season has been conducted at MA Department of Conservation and Recreation's (DCR) Pleasure Bay Beach, Boston (at Broadway) from 2002-2007 (MA DPH 2009a). The beach was posted as closed greater than 10% of the beach season only once during the six years sampled; in 2006 the beach was posted 13.7% of the time. It should be noted that 2006 experienced a very high volume of rainfall between May and September (approximately 31 inches at Logan International Airport) (NOAA 2010). Two major projects, The Pleasure Bay Stormwater Relocation Project completed in 2006 and the North Dorchester Bay Storage Tunnel completed in 2008, should also result in much improved water quality conditions (bacteria).

According to the Boston Harbor Association (2009a) *"Pleasure Bay is one of the most popular and well-utilized swimming and sunning beaches in the City. Beachgoers will enjoy sinking their toes into the new sand at Pleasure Bay. Foot showers and water fountains are located on-site. Because the bay is fully enclosed by the man-made Head Island Causeway, water and sediment quality are consistently high. The causeway located behind the beach provides a great walk way for strolling around Pleasure Bay. It is owned and operated by the Department of Conservation and Recreation…Castle Island, adjacent to Pleasure Bay, offers a wide range of recreational opportunities such as sailing, shaded picnic areas, and tot lots, as well as spectacular views of Boston Harbor."*

The *Primary and Secondary Contact Recreational Uses* are assessed as support for Pleasure Bay based on the generally acceptable levels of enterococci bacteria expressed in terms of beach closures. The *Primary Contact Recreational Use* is identified with an Alert status because of occasional beach closures although the major stormwater related projects that have recently been completed should result in improved conditions. The *Aesthetics Use* is not assessed.

Pleasure Bay (MA70-11) Use Summary Table

Designated Uses		Status
Aquatic Life		NOT ASSESSED
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		SUPPORT*
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

* Alert Status issues identified, see details in use assessment

Dorchester Bay (MA70-03)

Location: From the mouth of the Neponset River, Boston/Quincy to the line between Head Island and the north side of Thompson Island and the line between the south point of Thompson Island, Boston and Chapel Rocks, Quincy.
AU Size: 3.46 Square Miles
Classification: SB
2008 303(d) List: Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Priority organics, Pathogens, Suspended solids, Turbidity).

NPDES Discharges (Appendix B):

University of Massachusetts-Boston (MAG250004) (Table B1)

Boston Water and Sewer Commission (BWSC) (MA0101192) (Table B1) Outfalls BOS 081 – 087 discharge to South Boston beaches. There are four major infrastructure projects to abate CSO's from these outfalls which when the work is complete will eliminate the CSO discharges for all storms up to and including a 25-year storm event (regulator structures will remain open to relieve the system for larger events; secondary benefit is stormwater will also be collected and diverted from the beaches for all storms up to a five-year event):

North Dorchester Bay Storage Tunnel--completed 12/09
Pleasure Bay Storm Drain Improvements--completed 3/06
Morrissey Blvd. Storm Drain--completed 6/09
Conley Terminal Pump Station and Odor Control Facility--to be completed in May 2011
Excert from BWSC online [i] "*The Morrissey Boulevard Drainage Conduit Project (MBDC) is being undertaken by the Boston Water and Sewer Commission (Commission) on behalf of the Massachusetts Water Resources Authority (Authority) in conjunction with the Authority's North Dorchester Bay CSO Storage Tunnel Project (NDBST). This work will help improve water quality in North Dorchester Bay. The MBDC was included in the Authority's 2004 Supplemental Facilities Plan and Environmental Impact Report on the Long-Term CSO Control Plan for North Dorchester Bay and Reserved Channel and is part of the court-ordered cleanup of Boston Harbor. The MBDC and NDBST will enable the BOS087 outfall located near Mother's Rest to be eliminated. Stormwater flows generated from smaller storms will be conveyed to the NDBST while stormwater flows generated from larger storms will be redirected to the MBDC. Along the northbound (in-bound) Frontage Road of Morrissey Boulevard, all stormwater flows will be conveyed to the MBDC. Construction of the MBDC began in September 2007 and was completed in July 2009. Stormwater monitoring of the MBDC will be conducted for 2 years following the completion of the MWRA's North Dorchester Storage Tunnel Project which is currently scheduled to be completed in May 2011".*

Massachusetts Water Resources Authority (MA0103284) (Table B1): CSO outfall 209 Fox Point via BOS088/089: Eliminated in 2007 as result of sewer separation work in South Dorchester Bay.

Boston Water and Sewer Commission (MAS01000) (Table B3, 3 major outfalls, 1 non-major outfall)

City of Quincy (MAR041081) (Table B4)

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

Sea water is withdrawn by a single 10' deep, 7'2" wide cooling water intake structure (CWIS) on the southwest side of Columbia Point peninsula in Savin Hill Cove at the UMass Boston campus. The CWIS is fully submerged at low tide (dredging has been conducted to allow clear passage to the CWIS). There is a 5' high baffle wall at the mouth of the intake that was inserted to discourage benthic organisms (e.g., lobsters) from entering the intake. Sea water is withdrawn through a traveling screen filter (operated for 15 minutes once every 8 hours) and over a 4' high fiberglass baffle before passing up the pump shaft and through a strainer (with a pore size of 1/16th inch) to the heat exchanger by one of four single speed pumps. After the sea water passes through the heat exchanger, it joins flow from any other pumps operating and is discharged through a single 36" underground pipe which extends approximately 2 m out from the Columbia Point shore and is nearly exposed at low tide. Fish impinged on the traveling screens are washed off the screens with a spray wash of unknown pressure and shunted into a fish return system that joins with the heated discharge water. The discharge water moves through a pipe which is about 1/3 of a mile long to the point of discharge.

In Dorchester Bay (Boston), SPI was conducted at six stations from 2002 to 2008: south of the City Point Beach (R40); west of Thompson Island (R14, R15); east of Harbor Point (R42); east of Columbia Point (R41); and south of Savin Hill Cove (T04) (Maciolek *et al.* 2009). According to Maciolek *et al*. (2009), Station T04 is "located in a depositional area considered to be a focus area for accumulation of sediment and contaminants entering Boston Harbor". Sediments at all six stations were generally silty. *Ampelisca* spp. were mostly absent at these stations since 2002, and only present at 2 stations in 2008 (R40, R41). Station T04 was also sampled for grain size analysis, Total Organic Carbon (TOC), and *Clostridium perfringens* abundance. The TOC content at Station T04 was consistently the highest measured among the harbor stations, and the 2008 value was near the median observed in this 18-year period. *Clostridium perfringens* abundance decreased at StationT04 during this time period.

Biology

Results of twelve separate impingement samples, each three hours in duration, have been reported for the UMass Boston intake. Impingement rates ranged from zero fish per three hours (3 events) to 10 fish per three hours, with a mean of about 1.3 fish per hour. The fish with the highest frequency of impingement was winter flounder (*Pseudopleuronectes americanus*) which comprised 25 of the 46 total fish caught (about 54%); this was followed by the shorthorn sculpin (*Myoxocephalus scorpius)* which comprised 24% of the total (Kent 2010).

The MWRA has conducted benthic monitoring at Station T04 in Dorchester Bay since 1992 (Maciolek *et al.* 2008b). A minor increase in the richness of benthic infaunal species was observed here over the study period, where *Streblospio benedicti* was the most abundant species in 2008.

Toxicity Testing

Ambient

Water was collected off of the UMass research boat dock at the Boston Columbia Point Campus in Savin Hill Cove of Dorchester Bay for use as dilution water in the facility's acute whole effluent toxicity test. Survival of *M. bahia* exposed (48-hours) was 100% in the test conducted in January 2001.

Effluent

No acute whole effluent toxicity to *M. bahia* was detected in the test conducted in January 2001 to the UMass Boston non-contact cooling water discharge.

Fourteen acute whole effluent toxicity tests were conducted on composite samples collected from MWRA's Outfall #209 (Fox Point CSO) between March 2001 and September 2007 using *M. bahia* and *M. beryllina* as test organisms (24-hour tests). All LC_{50s} were >100% effluent. *M. bahia* was the more sensitive test organism.

Water Chemistry

The MWRA has conducted water quality monitoring for dissolved oxygen (DO) at seven stations in Dorchester Bay, as noted in the table below. In the study area, depth ranged from 1.1 m (off Carson Beach bathhouse) to 11 m (Columbia Point/Savin Hill Cove). DO concentrations ranged between 3.83 and 14.65 mg/L (n= 2,303 samples including both surface and bottom measurements), with 17 measurements below 5.0 mg/L (MWRA 2008). Saturations were high (>110%) in 20 sampling events (<1% samples). Nutrients and other water chemistry data were collected at two stations, northern Dorchester Bay (038) and Columbia Point/Savin Hill Cove (140) from 2002 to 2008. In surface water samples, total nitrogen concentrations ranged from 0.049 to 0.765 mg/L while total phosphorus concentrations ranged from 0.013 to 0.288 mg/L (n=340) (MWRA 2008). Chlorophyll *a* results ranged from 0.18 to 27.40 µg/L (n=678 representing both surface and bottom samples). Total suspended solids ranged from 0.24 to 20.4 mg/L in surface water samples (n=330) and between 0.24 and 48 mg/L (n=327) in bottom samples (MWRA 2008).

MWRA Study	Station ID	Location Description
CSORWM	033	DORCHR, CARSON BCH OFF L ST.
CSORWM	036	DORCHR, CARSON BCH OFF BATHHOUSE
CSORWM	038	NORTHERN DORCHESTER BAY
CSORWM	040	DORCHR, MALIBU BAY
CSORWM	039	DORCHR, FOX POINT @ UMASS DOCK
BHWQM	140	COLUMBIA POINT/SAVIN HILL COVE
CSORWM	084	NEPONSET COLUMBIA PT @ BUOY 12

Sediment Chemistry

In 2006, sediment collected off of Fox Point in Dorchester Bay (sampling station T04 with a mean water depth of 3.2m) was comprised primarily of fines (~96%), (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 3.8% (Durell *et al*. 2008, see Appendix D). To assess the overall sediment quality the sum of the ratios that exceeded a value of 1.0 (concentration/guidance) for both ISQG and PEL guidelines were calculated (see Appendix A, *Aquatic Life Use* sediment chemistry guidance). This sum is noted as the total factor over the ISQG and/or PEL. The concentrations of contaminants in the top 2 cm of sediment off of Fox Point in Dorchester Bay exceeded ISQGs by a factor of 352.4 while the PELs were exceeded by a factor of 34.4. Several PAHs including anthracene, phenanthrene, fluoranthene, pyrene, benz(a)anthracene, benzo(a)pyrene, total DDD and the estimated total PCB concentration (calculated as 2 times the sum of the 20-congener PCB concentration data reported by MWRA) were each between 2 and 4.9 times their respective PELs (see Appendix D).

The *Aquatic Life Use* for Dorchester Bay is assessed as support based on the generally good water quality conditions (i.e., dissolved oxygen, total nitrogen, total phosphorus, and chlorophyll *a* concentrations). While there were some indications of improvements in benthic community attributes (slight increase in the number of benthic taxa at Savin Hill Cove sampling location as well as the presence of *Ampelisca* spp. throughout most of the bay), it should be noted that degraded sediment quality, particularly in southern Dorchester Bay (off Fox Point), is of concern so this use is identified with an Alert Status.

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):

***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)

Do Not Eat: *Bluefish* (PCB)

Safe eating guidelines for everyone:

Do Not Eat: *Lobster tomalley* (PCB)

NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Dorchester Bay.

The *Fish Consumption Use* is assessed as impaired for Dorchester Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that 6% of this segment is Conditionally Restricted to shellfish harvesting, and 94% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

Dorchester Bay is heavily used for water-based recreation with four yacht clubs and six public beaches. Frequent testing for enterococci bacteria during the swimming season was conducted at these beaches from 2002-2007 (MA DPH 2009a). Closure data for individual Dorchester Bay beaches are summarized below:

> *City Point Beach, Boston* - The City Point Beach was posted as closed greater than 10% of the beach season in two of the six years sampled (2003, 2006), with closures of 18.3 and 33% respectively. It should be noted that 2006 experienced a high volume of rainfall between May and September of that year (approximately 31 inches at Logan International Airport) (NOAA 2010). Closures ranged from 0 to 7% during the other four bathing seasons.

M Street Beach, Boston – Closures in three of the six years sampled exceeded 10% of the bathing season (2003, 2005 and 2006). Closures ranged from 0 to 5.1% during the other three bathing seasons.
Carson Beach, Boston – Closures exceeded 10% in four of six years at Carson Beach, ranging from 11% (2007) to 42% (2006). The 2004 bathing season had the fewest days in which swimming was prohibited (~4%).
Malibu Beach, Boston – The beach was closed greater than 10% of the beach season in 4 of the 6 years sampled, with closures of 19.7% (2002), 30% (2003), 10% (2005), and 34% (2006). Closures ranged from 0 to 1.3% during the other two bathing seasons.
Savin Hill Beach, Boston – Although adjacent to Malibu Beach, the Savin Hill Beach experienced fewer days of beach closures. Closures exceeded 10% in two of the six years sampled (31% in 2003 and 17% in 2006). Closures ranged from 0 to 3.9% during the other four bathing seasons.
Nickerson Beach, Quincy – Nickerson Beach was posted as closed greater than 10% of only one beach season (16% in 2003). Closures ranged from 0 to 3.6% during the other five bathing seasons.

MWRA conducted monitoring at seven stations in Dorchester Bay between 2002 and 2008 (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at each station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
033	Carson Beach off L St., Boston	6 – 14 (n=141)	6 – 14 (n=185)	0.7 – 3.8 (8 measurements <1.2 m, n=160)
036	Carson Beach off bathhouse, Boston	5 - 20 (n=152)	5 – 20 (n=199)	0.7 – 4.0 (8 measurements <1.2 m, n=161)
038	Northern Dorchester Bay, Boston	5 – 11 (n=107)	5 – 12 (n=171)	1.0 – 4.0 (3 measurement <1.2 m, n=172)
040	Malibu Bay, Boston	7 – 12 (n=72)	7 – 13 (n=134)	0.7 – 2.5 (18 measurements <1.2 m, n=113)
039	Fox Point at UMass Dock, Boston	14 – 26 (n=131)	9 – 36 (n=179)	0.6 – 3.6 (21 measurements <1.2 m, n=173)
140	Columbia Point/ Savin Hill Cove, Boston	10 – 23 (n=113)	12 – 20 (n=183)	0.6 – 4.4 (23 measurements <1.2 m, n=190)
084	[south of] Columbia Point at Buoy 12, Boston	6 – 18 (n=120)	7 – 21 (n=157)	0.9 – 3.3 (7 measurements <1.2 m, n=133)
*Primary contact recreation season: April 1 – October 15 **Secondary contact recreation season: calendar year				

The *Primary Contact Recreational Use* is assessed as impaired based on the frequency of beach closures at four of the six public beaches in this segment associated with elevated levels of enterococci bacteria from storm events; the frequency of Secchi disk depths below the swimming criterion in the southern Dorchester Bay is also of concern. However, it should be noted that none of the geometric means of the enterococci bacteria data at any of the seven MWRA monitoring stations throughout Dorchester Bay violated water quality standards for either *Primary* or *Secondary Contact Recreational* uses and few beach closures were necessary at Nickerson Beach (Squantum Point in Quincy). The *Secondary Contact Recreational Use* is assessed as support based on the acceptable enterococci bacteria levels and generally good Secchi depths. Pollution abatement projects that have been and are being implemented in this area should result in improved water quality conditions. Due to the lack of available data, the *Aesthetics Use* is not assessed.

Dorchester Bay (MA70-03) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		IMPAIRED Cause: Elevated enterococci bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

* Alert Status issues identified, see details in use assessment

Recommendations

Additional monitoring and information is necessary to develop the individual NPDES permit for UMass Boston. More information from the permittee needs to be obtained on the following under current and proposed (after expansion) operations: pressure of spray wash used on the intake screens; rates of impingement, rates of entrainment, the potential for operation of heat exchanges without the 1/16-inch mesh strainers; water velocity at the face of the intake screen; delta temperature of intake water prior to and after heat exchangers; travel time of fish from point of release into the screen wash water to point of discharge into Dorchester Bay.

Quincy Bay (MA70-04)

Location: From Bromfield Street near the Wollaston Yacht Club, northeast to N42 17.3 W71 00.1, then southeast to Houghs Neck near Sea Street and Peterson Road (formerly referred to as the "Willows"), Quincy.
AU Size: 1.52 Square Miles
Classification: SA
2008 303(d) List: Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Priority organics, Pathogens).

NPDES Discharges (Appendix B):

City of Quincy (MAR041081) (Table B4)

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

In Quincy Bay, SPI was conducted at one station (R36 in Quincy), from 2002 to 2008 (Maciolek *et al.* 2009). There were no observations of *Ampelisca* spp. (n=16) at this site at any time during this monitoring program.

Biology

In 2006, the Massachusetts Division of Marine Fisheries (DMF) initiated a restoration and enhancement program for shellfish in three towns (Quincy, Weymouth, Hingham) of Boston Harbor, which was expanded to five towns (Hull and Winthrop were added to the original three) in 2007 (Shields 2009). The program included enhancement of open but unproductive areas that were suitable for shellfish habitat by the planting of seed clams (the softshell clam, *Mya arenaria*), as well as the restoration of native clams to appropriate areas with the deployment of clam spat (larva) collectors. In 2007, project efforts in Quincy Bay included the seeding of 108,000 clams in six plots off Terne Road, Quincy in July, and another 108,000 clams in six plots off Post Island Road, Quincy in August. Survival of seeded clams at all six plots off Terne Road was high (>25 clams survived/ft^2), while survival off Post Island Road was mixed, with three plots high, two moderate (15 to <25 live clams/ft^2), and one low (1 to <15 live clams/ft^2). Seeded clams were affected by sediment type, tidal currents, and wind- and vessel-driven waves throughout the project area. The project also included the deployment of spat collectors at both of these sites; however, spat collection efforts did not yield numbers of young of year clams above levels expected in unproductive shellfish beds throughout the Boston Harbor restoration area.

Water Chemistry

The MWRA conducted water quality monitoring from 2002 - 2008 at two locations in this segment, including Wollaston Beach at Sachem Street (Station 047) and off Merrymount Park (077) (see Appendix C for more detailed data presentation). Depth at these locations ranged from 1.1 (Station 047) to 6.1 m (Station 077) during the study period. Of 372 measurements taken at these locations, DO was consistently above 6.0 mg/L (including both surface and bottom measurements) for all but eight measurements (~2%), with the minimum = 5.44 mg/L (MWRA 2008). Saturations were high (>110%) in only six sampling events (<2% samples) off Merrymount Park (none at Wollaston Beach) (maximum 120.2%) although none were above 110% since 2005. In surface water samples collected in Quincy Bay off Merrymount Park (Station 077) between 2002 and 2008 (note no samples collected in 2007 and only one sample in 2008) nutrient concentrations (n=124) were low (total nitrogen and total phosphorus concentrations ranged from 0.136 to 0.414 mg/L and 0.014 to 0.142 mg/L, respectively (MWRA 2008). Chlorophyll *a* concentrations at this site ranged from 0.12 to 14.30 µg/L (n=246 representing both surface and bottom samples) although it should be noted that chlorophyll *a* results were notably lower since 2004 (none were > 6.86 µg/L, n=101). Total suspended solids data collected between 2002 to 2008 ranged from 0.97 to 12.9 mg/L in surface water samples (n=122) and between 0.95 and 13 mg/L (n=120) in bottom samples (MWRA 2008).

The *Aquatic Life Use* is assessed as support for this segment of Quincy Bay based primarily on the water quality data that were indicative of generally good conditions (i.e., high DO, low nutrient concentrations, low chlorophyll *a* and suspended solids concentrations), as well as the moderate to high survival of clam restoration efforts. The absence of *Ampelisca* spp. is noted as a concern.

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):

***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)

Do Not Eat: *Bluefish* (PCB)

Safe eating guidelines for everyone:

Do Not Eat: *Lobster tomalley* (PCB)

NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Quincy Bay.

The *Fish Consumption Use* is assessed as impaired for Quincy Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that 37% of this segment area is Conditionally Restricted to shellfish harvesting and 63% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

Quincy Bay is well-used for water-based recreation, and this segment hosts a yacht club and four public beaches. Frequent testing for enterococci bacteria during the swimming season was conducted at these beaches from 2002-2007 (MA DPH 2009a). Closure information for individual Quincy Bay beaches is summarized below:

Wollaston Beach - Based on the results of weekly testing, Wollaston Beach was closed greater than 10% of the beach season in five of the six years sampled (2002, 2003, 2005, 2006, 2007), with closures ranging between 18 and 85% of the season. It should be noted, however, that precautionary closures are posted when rainfall exceeds 0.25 inches and that based upon several years of test data this practice has been shown to be overly conservative. An increase for the precautionary threshold to 0.5 inches or more of precipitation has been proposed (FWB 2009).

Merrymount Beach – Closures were >10% of the beach season only once between 2003 and 2007; in 2003, closures affected 18% of the bathing season.

Chikatawbot Beach – Closures affected more than 10% of the bathing season in three of six years sampled; closures ranged from 1 to 21% and were >10% of the season in 2004 (21%), 2005 (13%), and 2007 (16.7%).

Heron Beach – Beach closures from 2002-2007 did not exceed 10%, and ranged from 0 to 8%.

MWRA has conducted water quality monitoring at two stations in this segment of Quincy Bay between 2002 and 2008: Wollaston Beach at Sachem Street (047); and off Merrymount Park (077), (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at each station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
047	Wollaston Beach at Sachem St., Quincy	5 – 10 (n=53)	5 – 10 (n=71)	0.6 – 3.4 (3 measurements <1.2 m, n=44)
077	Off Merrymount Park, Quincy	5 - 5 (n=71)	5 – 7 (n=116)	0.5 – 4.3 (7 measurements <1.2 m, n=125)
*Primary contact recreation season: April 1 – October 15 **Secondary contact recreation season: calendar year				

The *Primary Contact Recreational Use* is assessed as impaired based on the frequency of beach closures at two of the four public beaches (Wollaston and Chikatawbot beaches) in this segment associated with elevated levels of enterococci bacteria from storm events. However, it should be noted that none of the geometric means of the enterococci bacteria data at either of the two MWRA monitoring stations in this segment of Quincy Bay violated water quality standards for either *Primary* or *Secondary Contact Recreational* uses. The *Secondary Contact Recreational Use* is assessed as support based on the acceptable enterococci bacteria levels and generally good Secchi depths. Due to the lack of available data, the *Aesthetics Use* is not assessed.

Quincy Bay (MA70-04) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		IMPAIRED Cause: Elevated fecal coliform Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

Quincy Bay (MA70-05)

Location: Quincy Bay, north of the class SA waters (segment MA70-04), Quincy to the line between Moon Head and Nut Island, Quincy.
AU Size: 4.41 Square Miles
Classification: SB
2008 303(d) List: Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Priority organics, Pathogens).

NPDES Discharges (Appendix B):

City of Quincy (MAR041081) (Table B4)

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

In Quincy Bay, SPI was conducted at seven stations from 2002 to 2008 (Maciolek *et al.* 2009), including six reconnaissance stations (R33, R34, R35, R37, R38, R48) and one traditional station (T07). There was consistently little evidence of *Ampelisca* spp. activity throughout the segment in this time period. Additional sediment analyses were conducted at Station T07. Sediments exhibited a significant increase in fine-grained particles over the course of the program, and consisted of equal parts coarse- and fine-grained material in 2008 (Maciolek *et al.* 2009). The TOC level was relatively low, at approximately the 25th percentile of all TOC values measured here (1992-2008). *Clostridium perfringens* levels exhibited a decrease over the 18-year program span.

Biology

The MWRA has conducted benthic infaunal surveys at numerous stations in Boston Harbor since 1992 (Maciolek 2009). At Station T07 (roughly, south of the southern tip of Long Island), the mean species richness in 2008 was the highest observed here in the length of the program, and exhibited a significant increase over 2007 populations. *Polydora cornuta*, the mud or shell worm, was the most dominant species observed at Station T07 in 2008. This annelid polychaete worm is a native species common throughout the Gulf of Maine, particularly in mud flats of bays and estuaries, known to be a "very vigorous mover" (NIWA 2004).

In 2006, the Massachusetts Division of Marine Fisheries (DMF) initiated a restoration and enhancement program for shellfish in three towns (Quincy, Weymouth, Hingham) of Boston Harbor, which was expanded to five towns (Hull and Winthrop were added to the original three) in 2007 (Shields 2009). The program included enhancement of open but unproductive areas that were suitable for shellfish habitat by the planting of seed clams (the softshell clam, *Mya arenaria*), as well as the restoration of native clams to appropriate areas with the deployment of clam spat (larva) collectors. In 2006, project efforts in Quincy Bay included the seeding of 370,000 clams between July and October at 12 plots off Moon Head Beach, Quincy. However, heavy mortalities occurred at all 12 plots, with no clams remaining by late October; no stocking occurred here in the 2007 season. As this location is highly subject to beach kinetics, including tidal currents, wind-driven waves and vessel wake, it was thought that these factors dislodged the clams from seed beds and washed them away. Additional factors included damage to the predator exclusion netting by recreational fisherman (tears caused by lures), and the resultant access to and predation by crabs. No spat collectors were deployed off Moon Head Beach. Benthic infaunal organisms were identified in the areas where clams were introduced; green and horseshoe crabs were noted, as well as five bivalve, three gastropod, and seven worm taxa.

Water Chemistry

The MWRA conducted water quality monitoring from 2002-2008 at one location in this segment, south of Hangman Island, in Quincy Bay (Station 139) (see detailed data in Appendix C). Sampling depths at this site ranged from approximately 2.5 to 11 m between 2002 and 2008. DO's were all >5.0 mg/L (ranging from 5.6 to 14.67 mg/L, n= 361) (including both surface and bottom measurements) (MWRA 2008). Oxygen saturations were as high as 113% but exceeded 110% on only eight occasions (~2% sampling events), all of which occurred prior to 2006. Total nitrogen and total phosphorus concentrations were low ranging from 0.051 to 0.470 mg/L and 0.009 to 0.393 mg/L , respectively (n=188). Chlorophyll *a* concentrations ranged from 0.20 to 15.20 µg/L (n=376) representing both surface and bottom samples, although average results were all low (≤5 µg/L). Total suspended

solids collected between 2002 and 2008 at both surface and bottom were all low (maximum 10 mg/L, n=372) (MWRA 2008).

Sediment Chemistry

In 2006, sediment collected in Quincy Bay (sampling station T07) was comprised of 80.6% fines, (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 2.42% (Appendix D). To assess the overall sediment quality the sum of the ratios that exceeded a value of 1.0 (concentration/guidance) for both ISQG and PEL guidelines were calculated (see Appendix A, *Aquatic Life Use* sediment chemistry guidance). This sum is noted as the total factor over the ISQG and/or PEL. For those analytes measured in the top 2 cm of sediment in Quincy Bay having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 85.4 while only one PEL (mercury) was exceeded (a factor of 1.1).

The *Aquatic Life Use* is assessed as support for this segment of Quincy Bay based primarily on the water quality data that were indicative of excellent conditions (i.e., high DO, low nutrient concentrations, low chlorophyll *a* and suspended solids concentrations). Benthic monitoring also indicated increasing species richness, low TOC content, and decreasing levels of *C. perfringens.*

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):

***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)

Do Not Eat: *Bluefish* (PCB)

Safe eating guidelines for everyone:

Do Not Eat: *Lobster tomalley* (PCB)

NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Quincy Bay.

The *Fish Consumption Use* is assessed as impaired for Quincy Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA DMF Shellfish Status Report of October 2009 states that 19% of this segment is Conditionally Restricted to shellfish harvesting, and 81% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

Quincy Bay is well-used for water-based recreation, and hosts a yacht club and three public beaches along the shoreline of this segment in Quincy. Frequent testing for enterococci bacteria during the swimming season (April 1 – October 15) has been conducted at these beaches from 2002 through 2007 (MA DPH 2009a). Closure information for individual Quincy Bay beaches on the shoreline of this segment is summarized below:

Orchard Street Beach – Few beach closures were necessary (maximum closure 1.2% of bathing season) in two of six years, none in others.

Wollaston Beach - Based on the results of weekly testing, Wollaston Beach was closed greater than 10% of the season in five of the six years sampled (2002, 2003, 2005, 2006, 2007), with closures ranging from 18 to 85%. It should be noted, however, that precautionary closures are posted when rainfall exceeds 0.25 inches and that based upon several years of test data this practice has been shown to be overly conservative. An

increase for the precautionary threshold to 0.5 inches or more of precipitation has been proposed (FWB 2009).
Parkhurst Beach – Few beach closures were necessary (≤ 2.3% of beach season) in three of six years, none in others.

MWRA conducted monitoring at one station in this segment of Quincy Bay between 2002 and 2008 south of Hangman Island, Quincy (Station 139) (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at this station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
139	South of Hangman Island, Quincy	5 – 10 (n=110)	6 – 10 (n=183)	1 – 6 (2 measurements <1.2 m, n=190)
*Primary contact recreation season: April 1 – October 15 **Secondary contact recreation season: calendar year				

The *Primary Contact Recreational Use* is assessed as impaired based on the frequency of beach closures at one of the three public beaches (Wollaston Beach) in this segment associated with elevated levels of enterococci bacteria from storm events. However, it should be noted that none of the geometric means of the enterococci bacteria data at the MWRA monitoring station in this segment of Quincy Bay violated water quality standards for either *Primary* or *Secondary Contact Recreational* uses. The *Secondary Contact Recreational Use* is assessed as support based on the acceptable enterococci bacteria levels and good Secchi disk depths. Due to the lack of available data, the *Aesthetics Use* is not assessed.

Quincy Bay (MA70-05) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		IMPAIRED Cause: Elevated enterococci bacteria Source: Discharges from municipal separate storm sewer systems, Unspecified urban stormwater
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

Hingham Bay (MA70-06)

Location:	The area north of the mouth of the Weymouth Fore River extending on the west along the line between Nut Island and the south point of West Head, and on the east side along a line from Prince Head just east of Pig Rock to the mouth of the Weymouth Fore River (midway between Lower Neck and Manot Beach), Quincy.
AU Size:	0.96 Square Miles
Classification:	SB
2008 303(d) List:	Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Pathogens).

NPDES Discharges (Appendix B):
City of Quincy (MAR041081) (Table B4)

Other: The "HubLine" Construction during 2002-2003. The HubLine is a 29.4 mile long, 24 to 30" diameter natural gas pipeline buried at least 3' deep that runs from Salem/Beverly to Weymouth. The Massachusetts Division of Marine Fisheries (DMF) was designated as lead agency with responsibility to provide mitigation and/or restoration of aquatic resources and habitat in response to potential HubLine construction impacts.

DESIGNATED USE ASSESSMENT
Aquatic Life Use
Habitat and Flow

Eelgrass bed habitat restoration was conducted by MA DMF from 2004 to 2007 at one location in the southeast cove off Peddocks Island within this segment of Hingham Bay as part of the HubLine mitigation and restoration program. High survival and expansion rates of transplanted eelgrass were observed at this site (Leschen *et al*. 2009).

In Hingham Bay, SPI was conducted at Stations R19 (south of Prince Head on Peddocks Island) and R53 (west of Grape Island) from 2002 to 2008 (Maciolek 2009). *Ampelisca* spp. was absent at Station R19 from 2005-2008, and from R53 since 2002. Ampelisca spp. was patchy prior to this time period (1992-2001) as well.

Water Chemistry

MWRA conducted water quality monitoring in this area of Hingham Bay at one station (080 at Red Buoy #2, Quincy Yacht Club) from 2004 to 2008 (see detailed data in Appendix C). Depth ranged from 2.2 to 8.3 m during this period. DO concentrations ranged between 6.3 and 11.9 mg/L (n= 122 samples including both surface and bottom measurements) (MWRA 2008). Saturations were high (>110%) in only two sampling events (~1% samples) although none were above 110% since 2004.

The *Aquatic Life Use* is assessed as support for this segment of Hingham Bay based primarily on the good water quality conditions (high DO) as well as the high survival and expansion of transplanted eelgrass.

Fish Consumption Use
MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):
***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**
Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:
Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)
Do Not Eat: *Bluefish* (PCB)
Safe eating guidelines for everyone:
Do Not Eat: *Lobster tomalley* (PCB)
NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Hingham Bay.

The *Fish Consumption Use* is assessed as impaired for Hingham Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that 1% of this segment is Conditionally Restricted to shellfish harvesting, and 99% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

This area of Hingham Bay hosts a yacht club and a small section of Edgewater Beach within the City of Quincy. Frequent testing for enterococci bacteria during the swimming season (April 1 – October 15) has been conducted at this beach from 2002-2007 (MA DPH 2009a). Closure information for Edgewater Beach in Quincy along the shoreline of this segment is summarized below:

Edgewater Beach, Quincy – This beach was posted in four of the six years as follows: 9% in 2009, 10.4% in 2004, 10.7% in 2005, and 2.4% in 2007. No closures were necessary in 2003 or 2006.

MWRA has conducted water quality monitoring at one station in this segment of Hingham Bay between 2004 and 2008, Quincy Yacht Club, Red Buoy #2, Quincy (Station 080) (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at each station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
080	Quincy Yacht Club, Red Buoy #2, Quincy	5 –10 (n=49)	5 – 10 (n=64)	1.1 – 3.6 (1 measurement <1.2 m, n=43)
*Primary contact recreation season: April 1 – October 15 **Secondary contact recreation season: calendar year				

The *Primary* and *Secondary Contact Recreational* uses are assessed as support for this segment of Hingham Bay based on the Enterococci bacteria data and the generally low frequency of beach closures at Edgewater Beach. The *Aesthetics Use* is not assessed due to the absence of data.

Hingham Bay (MA70-06) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		SUPPORT*
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

* Alert Status issues identified, see details in use assessment

Hingham Bay (MA70-07)

Location:	The area defined between Peddocks Island and Windmill Point; from Windmill Point southeast to Bumkin Island; from Bumkin Island southeast to Sunset Point; from Sunset Point across the mouth of the Weir River to Worlds End; from Worlds End across the mouth of Hingham Harbor to Crow Point; from Beach Lane, Hingham across the mouth of the Weymouth Back River to Lower Neck; and from Lower Neck midway across the mouth of the Weymouth Fore River.
AU Size:	4.8 Square Miles
Classification:	SB
2008 303(d) List:	Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Pathogens).

NPDES Discharges (Appendix B):

Town of Hull (MAR041040) (Table B4)
Town of Hingham (MAR041038) (Table B4)
Town of Weymouth (MAR041070) (Table B4)

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

Eelgrass surveys and analysis of historical data was conducted by the MassDEP Wetlands Conservancy Program (WCP) as part of the Eelgrass Mapping Project. Statewide surveys were conducted in 1995, 2001, and most recently in 2006/2007 as part of this program (MassGIS 2008 and Costello 2008). Additional analysis of available aerial photos from 1951 was used to reconstruct the eelgrass distribution prior to any substantial development of the watershed. The 1951 data were only anecdotally validated, while the 1995, 2001, and 2006 maps were field validated (MassGIS 2008 and Costello 2008). Within this segment of Hingham Bay there was evidence of a large area of eelgrass in the vicinity of Crow Point and Worlds End in 1951 (estimated 223 acres ~7.3% of segment area). In 1995 there were three separate beds, one of which was in a new bed between Bumkin and Grape islands and the eelgrass beds comprised an estimated 142 acres (4.6% segment area). In 2001 two smaller beds comprised an estimated 2.7 acres and in 2006 these two beds had increased to 55 acres (~1.8% of segment area).

In Hingham Bay, SPI was conducted at nine stations from 2002 to 2008 (Maciolek *et al*. 2009), including eight reconnaissance stations (R25, R26, R27, R28, R29, R46, R49, R50 in Hingham and Weymouth) and one traditional station (T08, Hingham). Results showed the presence of *Ampelisca* spp. at most stations since 2002, but generally reduced when compared to results from 1992-2000. Additional sediment analyses were conducted at Station T08. Sediments there consisted of coarse-grained particles throughout the program (Maciolek *et al*. 2009). The TOC level measured at Station T08 in 2008 was the lowest seen at any station, on any survey, during the benthic monitoring program. *Clostridium perfringens* levels exhibited a significant decrease at this station over the 18-year program span.

Biology

The MWRA has conducted benthic infaunal surveys at numerous stations in Boston Harbor since 1992 (Maciolek *et al*. 2009). A large increase in abundance and richness of benthic infaunal organisms was observed at Station T08 in 2008 (Maciolek *et al*. 2009). The higher level of bioturbation observed at this site appeared to be associated with the increasing dominance by the burrow-dwelling amphipod *Leptocheirus pinguis,* a contaminant-sensitive species (Chang *et al*. 1992).

Water Chemistry

MWRA has conducted water quality monitoring in this segment area of Hingham Bay at Crow Point Flats (Station 124) from 2002 to 2008 (see detailed data in Appendix C). Sampling depths at this site ranged from approximately 3.1 to 9.7m between 2002 and 2008 (n=129). DO concentrations ranged between 6.09 and 14.9 mg/L (n= 248 samples including both surface and bottom measurements) (MWRA 2008). Saturations were as high as 113.7% but only twice (<1% samples) above 110% (both prior to 2005). In surface water samples collected between 2002 and 2008, total nitrogen concentrations ranged from 0.057 to 0.466 mg/L while total

phosphorus concentrations ranged from 0.012 to 0.169 mg/L (n=128) (MWRA 2008). Chlorophyll *a* concentrations ranged from 0.34 to 16.90 µg/L (n=256 representing both surface and bottom samples). Total suspended solids data collected between 2002 to 2008 ranged from 1.13 to 9.42 mg/L in surface water samples (n=127) and between 0.94 and 15.0 mg/L (n=126) in bottom samples (MWRA 2008).

Sediment Chemistry

In 2006, sediment collected northwest of Bumkin Island in Hingham/Hull Bay (sampling station T08) was comprised of only 6.34% fines, (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 0.36%. To assess the overall sediment quality the sum of the ratios that exceeded a value of 1.0 (concentration/guidance) for both ISQG and PEL guidelines were calculated (see Appendix A, *Aquatic Life Use* sediment chemistry guidance). This sum is noted as the total factor over the ISQG and/or PEL. For those analytes measured in the top 2 cm of sediment northwest of Bumkin Island in Hingham/Hull Bay having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 10.9 while none of the PELs were exceeded.

The *Aquatic Life Use* is assessed as support based primarily on the biological monitoring information (abundance and richness of benthic taxa including the pollutant-sensitive amphipod *L. pinguis*, presence of *Ampelisca* spp. at most stations) as well as the generally good water quality (i.e., DO, nutrients, total suspended solids) and sediment quality conditions. Although eelgrass beds are present in this segment area, there has been an overall decline in the size of the beds since 1951 so the *Aquatic Life Use* is identified with an Alert status.

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):

***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)

Do Not Eat: *Bluefish* (PCB)

Safe eating guidelines for everyone:

Do Not Eat: *Lobster tomalley* (PCB)

NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Hingham Bay.

The *Fish Consumption Use* is assessed as impaired for Hingham Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (slduge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that 2% of this segment is Conditionally Restricted to shellfish harvesting, and 98% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

This area of Hingham Bay supports water-based recreation including three public beaches along the shoreline: Kimball, Belair and North, in Hingham. Frequent testing for enterococci bacteria during the swimming season (April 1 – October 15) has been conducted at these beaches from 2002-2007 (MA DPH 2009a). None of these three beaches had any closures during this time period.

MWRA conducted monitoring at one station in this segment of Hingham Bay between 2002 and 2008 (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples

collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at each station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
124	Crow Point Flats, Hingham	5 – 10 (n=77)	5 – 10 (n=121)	1.0 – 4.9 (6 measurements <1.2 m, n=129)
*Primary contact recreation season: April 1 – October 15 **Secondary contact recreation season: calendar year				

The *Primary and Secondary Contact Recreational Uses* are assessed as support for this segment of Hingham Bay based on the Enterococci bacteria data and the lack of any beach closures at Kimball, Belair and North beaches in Hingham. The *Aesthetics Use* is not assessed due to the absence of data.

Hingham Bay (MA70-07) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

* Alert Status issues identified, see details in use assessment

Hull Bay (MA70-09)

Location:	The area defined east of a line from Windmill Point, Hull to Bumkin Island, Hingham and from Bumkin Island to Sunset Point, Hull.
AU Size:	2.48 Square Miles
Classification:	SB
2008 303(d) List:	Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Pathogens).

NPDES Discharges (Appendix B):
Town of Hull (MAR041040) (Table B4)

DESIGNATED USE ASSESSMENT
Aquatic Life Use
Habitat and Flow

Eelgrass surveys and analysis of historical data was conducted by the MassDEP Wetlands Conservancy Program (WCP) as part of the Eelgrass Mapping Project. Statewide surveys were conducted in 1995, 2001, and most recently in 2006/2007 as part of this program (MassGIS 2008 and Costello 2008). Additional analysis of available aerial photos from 1951 was used to reconstruct the eelgrass distribution prior to any substantial development of the watershed. The 1951 data were only anecdotally validated, while the 1995, 2001, and 2006 maps were field validated (MassGIS 2008 and Costello 2008). Within Hull Bay there was evidence of three areas of eelgrass in 1951 (estimated 20 acres ~1.3% of segment area). In 1995 there was only one bed south of Spring Street Beach in Hull which comprised an estimated 5.8 acres (0.4% segment area). In 2001 eelgrass habitat was comprised of two smaller beds (3.6 acres) and in 2006 eelgrass bed habitat had increased in this area to an estimated 9.1 acres (~0.6% of segment area).

In Hull Bay, SPI was conducted at three stations, R30, R31, and R32 from 2002 to 2008, in the towns of Hingham and Hull (Maciolek *et al.* 2009). The presence of *Ampelisca* spp. was inconsistent in this segment, with the greatest level of activity seen at Station R30, in the middle of Hull Bay.

Toxicity Testing

Ambient

Survival of *Menidia beryllina* exposed (48-hours) to water collected from Hull Bay (sampling point located off the Pemberton Pier at the tip of Hull) and used as dilution water in the Hull WWTP whole effluent toxicity tests was ≥ 93% in the 25 test events conducted between February 2004 and February 2010.

The *Aquatic Life Use* is assessed as support for Hull Bay based on the good survival of test organisms exposed to bay water, the continued presence and expansion (since 1995) of eelgrass beds and the density of contaminant-sensitive *Ampelisca* spp. This use is identified with an Alert status due to the overall decrease in eelgrass beds since 1951.

Fish Consumption Use
MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):

***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**

Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:

Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)

Do Not Eat: *Bluefish* (PCB)

Safe eating guidelines for everyone:

Do Not Eat: *Lobster tomalley* (PCB)

NOTE: For assessment purposes Boston Harbor is broadly defined to include all coastal waters that drain into it including Hull Bay.

The *Fish Consumption Use* is assessed as impaired for Hull Bay as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source

and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted as part of the Boston Harbor monitoring program indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that 9% of this segment is Conditionally Restricted to shellfish harvesting, and 91% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

Hull Bay is extensively used for water-based recreation, and is home to the Hull Yacht Club and four public beaches: Darcy's, James Ave, A Street Bay Side, and Newport. Frequent testing for enterococci bacteria during the swimming season has been conducted at these beaches from 2002-2007 (MA DPH 2009a). Closure information for individual Hull Bay beaches is summarized below:

Darcy's Beach - Based on the results of weekly testing, Darcy Beach was closed for 2 days each (<3% of the bathing season) in 2005 and 2006; no closures were warranted in 2002, 2003, 2004, or 2007.
James Ave (Spring Street) Beach - Based on the results of weekly testing, the James Ave Beach was closed <3% of the bathing season in 2005 and 2007; no other closures were necessary in any of the other years.
A Street Bay Side Beach - Based on the results of weekly testing, the James Ave Beach was closed <3% of the bathing season in 2004, 2005 and 2006; no other closures were necessary in any of the other years.
Newport Beach – Based on the results of weekly testing, Darcy Beach was closed for 2 days (<3% of the bathing season) in 2005; no other closures were warranted during the period from 2002-2007.

The *Primary and Secondary Contact Recreational Uses* are assessed as support for Hull Bay based on the lack of any frequent or prolonged beach closures. The *Aesthetics Use* is not assessed due the absence of data.

Hull Bay (MA70-09) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

Boston Harbor (MA70-01)

Location:	The area defined by a line from the southerly tip of Deer Island to Boston Lighthouse on Little Brewster Island, then south to Point Allerton; across Hull and West guts; across the mouths of Quincy and Dorchester bays, Boston Inner Harbor and Winthrop Bay (including President Roads and Nantasket Roads).
AU Size:	18.59 Square Miles
Classification:	SB
2008 303(d) List:	Category 5

This segment is on the 2008 Integrated List of Waters in Category 5 - Waters Requiring a TMDL (Priority organics, Pathogens).

NPDES Discharges (Appendix B):

MassPort Authority/Logan International Airport (MA0000787) (Table B1)
Town of Hull Permanent Sewer Commission (MA0101231) (Table B1)
U.S. Department of Homeland Security/U.S. Coast Guard (MA0090433) (Table B1)
Boston Water and Sewer Commission (MAS01000) (Table B2)
Town of Hull (MAR041040) (Table B4)
City of Quincy (MAR041081) (Table B4)
Town of Winthrop (MAR041084) (Table B4)

Other: The "HubLine" Construction during 2002-2003. The HubLine is a 29.4 mile long, 24 to 30" diameter natural gas pipeline buried at least 3' deep that runs from Salem/Beverly to Weymouth. The Massachusetts Division of Marine Fisheries (DMF) was designated as lead agency with responsibility to provide mitigation and/or restoration of aquatic resources and habitat in response to potential HubLine construction impacts.

DESIGNATED USE ASSESSMENT

Aquatic Life Use

Habitat and Flow

Eelgrass surveys and analysis of historical data was conducted by the MassDEP Wetlands Conservancy Program (WCP) as part of the Eelgrass Mapping Project. Statewide surveys were conducted in 1995, 2001, and most recently in 2006/2007 as part of this program (MassGIS 2008 and Costello 2008). Additional analysis of available aerial photos from 1951 was used to reconstruct the eelgrass distribution prior to any substantial development of the watershed. The 1951 data were only anecdotally validated, while the 1995, 2001, and 2006 maps were field validated (MassGIS 2008 and Costello 2008). Within this segment of Boston Harbor there was evidence of one area of eelgrass in 1951 (estimated 47.7 acres ~0.4% of segment area) in the vicinity of Logan. In 1995 the bed was much smaller (0.3 acres) and was slightly larger in 2001 (7.4 acres). In 2006 eelgrass bed habitat had increased in this area to an estimated 52.2 acres (~0.44% of segment area).

Eelgrass bed habitat restoration was conducted by MA DMF from 2004 to 2007 at three locations within this segment of Boston Harbor as part of the HubLine mitigation and restoration program. The restoration sites include two areas on the western shore of Long Island (LIN and LIS), and one area called Portuguese Cove on the western shore of Peddocks Island (PI). High survival and expansion rates of transplanted eelgrass were observed at these sites (Leschen *et al*. 2009).

In Boston Harbor, SPI was conducted at 27 stations from 1992 to 2008 (Maciolek *et al.* 2009), including 22 reconnaissance stations (R02, R03, R04, R05, R06, R07, R08, R11, R12, R13, R16, R17, R18, R20, R21, R22, R23, R24, R39, R43, R44, R45, R47) (Winthrop, Boston, Quincy, Hull) and five traditional stations (T01, T02, T03, T05A, T06) (Boston, Hull). The presence of *Ampelisca* spp. was patchy in this segment, more consistently found on the sheltered side of islands e.g., Deer Island, Long Island, Gallups Island. In 2008, eelgrass was observed at Station R08 at Deer Island Flats, the first time eelgrass was seen here in the history of the benthic monitoring program.

Additional sediment analyses were conducted at Stations T01, T02, T03, T05A and T06. Sediments at Stations T01 and T05A consisted of coarse-grained particles, while T02, T03 and T06 were characterized by a more even mixture of coarse- and fine-grained material (Maciolek *et al.* 2009). The TOC levels measured at these five

stations in 2008 were among the lowest seen in these areas from 1992 to 2008, with a significant decrease at Stations T01, T03 and T06 over the study period; this is consistent with the harbor-wide trend of decreasing TOC content. *Clostridium perfringens* levels exhibited a significant decrease at Stations T02, T05A and T06 over the 18-year program span, with smaller decreases shown at Station T01.

Biology

The MWRA has reported the results of flounder and lobster monitoring at four stations (the Deer Island Flats site is the only one in this segment) in recent years (Pala *et al.* 2003; Moore 2003; Moore *et al.* 2004; Moore 2006; Nestler *et al.* 2007; Moore *et al.* 2009; Moore *et al.* 2010). One component of this annual monitoring program includes the collection of 50 sexually mature (>30 cm) flounder, which are measured for age, length, weight, external condition, and liver histology and disease (Maciolek *et al.* 2008e). Over the course of the study, the percentage of the community consisting of females has been generally greater than 50%, and has increased at all stations through 2009. Standard length and mean weights have also increased from 1992 to 2006, which may be associated with the increasing prevalence of females (which tend to be bigger than males).

Increased levels of aquatic pollutants, including ammonia, degrade the surface integrity of fin rays, thus the presence and extent of fin rot is used as an indicator of water quality conditions (Moore *et al.* 2010). Of the four stations sampled, the prevalence of fin erosion (44%, n=50) and bent fin ray (34%, n= 50) was highest at the Deer Island Flats monitoring area in 2009, and higher than the other three stations in 14 of 19 annual sampling events (Moore *et al.* 2010). In addition, blind side ulcers were first noted in the study area in the 2003 MWRA fish and shellfish monitoring effort (Moore *et al.* 2004), and subsequent studies recorded the presence of these ulcers throughout western Massachusetts Bay (Moore *et al.* 2010). Results of pathology and microbiology studies have not revealed a cause for these lesions, although 2004 and 2005 studies suggested that the phenomena was highest in late winter/early spring; with lower ulcer prevalence and healed ulcers observed in early summer, it was postulated that these exterior lesions were likely a nonlethal condition. By 2009, ulcer prevalence was shown to decrease since peak levels in 2004, with only 2% of flounder collected at Deer Island Flats exhibiting blind side ulcers.

The MWRA assessed flounder livers for disease and abnormalities since 1992. Centrotubular hydropic vacuolation (CHV), the least severe form of liver lesions and most common noted in the study, was most prevalent (18 of 19 years studied) and most severe in nature (17 of 19 years studied) at Deer Island Flats, although both have generally decreased over the study period. When corrected for age, CHV was again highest in winter flounder collected at Deer Island Flats. In comparison to data collected in Boston Harbor in the 1980's, however, flounder are much healthier. According to the MWRA *State of the Harbor* report (Rex *et al.* 2002): "*the flounder caught near Deer Island have not shown the gross abnormalities, such as fin erosion, that were observed during the mid-1980s… On average, the rate of CHV is about two-thirds of the levels found in the 1980s, although this may be partially explained by the age of the fish: the tested fish from Boston Harbor have been younger, and younger fish tend to have lower CHV levels. Liver tumors, which indicate more serious health effects, have not been observed since 1996."*

The MWRA conducted studies in 2001, 2002, 2003, and 2006 on contaminant uptake to caged mussels deployed within Boston Harbor near the Deer Island Flats/Light for 60 days; a subset was removed and archived at 40 days in the event that too few mussels would survive to 60 days. The survival rate of caged mussels at this station ranged from 90 to 100% at 40 days from 2001 through 2006, and from 86 to 100% at 60 days (Lefkovitz *et al.* 2002, Pala *et al.* 2003, Lefkovitz *et al.* 2004, Nestler *et al.* 2007).

The MWRA also conducted benthic infaunal surveys at numerous stations in Boston Harbor since 1992 (Maciolek *et al.* 2009). A large increase in abundance and richness of benthic infaunal organisms was observed at Stations T01 (Deer Island Flats), T02 (near mouth of Boston Inner Harbor) and T06 (west of mid-Peddocks Island) in 2008, Here, the increase in density of the burrow-dwelling amphipod *Polydora cornuta,* a contaminant-sensitive species (Chang *et al.* 1992), accounted for much of this increase (Maciolek *et al.* 2009). Species abundance also increased at Station T05A; *Ampelisca* spp. were the dominant taxa, which are considered to indicate clean habitat.

The benthic monitoring study focused on Station T01 in particular, as this was the site of the Deer Island WWTP discharge prior to September 2000, after which the discharge was relocated to a diffuser approximately 9.5 miles east of Deer Island, in Massachusetts Bay. Results of monitoring from 1992-2008 indicated that the benthic infaunal communities prior to the relocation differed greatly from communities after, with the greatest changes noted in the 2006-2008 periods. *Streblospio benedicti* dominated Deer Island Flats benthic communities in 1991-

2000 surveys. *S. benedicti* is noted as "relatively tolerant to elevated levels of sediment organics, a trait that contributes to its success as a pioneering opportunistic species" (Smithsonian Institution 2010). Contaminant-sensitive species associated with cleaner, more coarse-grained sediments were more abundant from 2006-2008, including *Leptocheirus pinguis.* In addition to the change in dominant species, results also indicated an increase in diversity in post-relocation communities.

Toxicity Testing

Effluent

No acute whole effluent toxicity to *M. beryllina* was detected in the 25 tests conducted between February 2004 and February 2010 on grab and/or composite samples from the Hull WWTP outfall 001 (i.e., all $LC_{50} \geq 100\%$ effluent).

Water Chemistry

The MWRA has conducted water quality monitoring for dissolved oxygen (DO) at five stations in Boston Harbor, as noted in the table below. In the study area, depth ranged from 2.0 m (off Moon Island Outfall, Quincy) to 16.2m (Green Can #17, north of Long Island Head) (see more detailed data summaries in Appendix C). DO concentrations ranged between 4.97 and 14.69 mg/L (n= 1,301 samples including both surface and bottom measurements), with 1 measurement just below 5.0 mg/L (MWRA 2008). Oxygen saturations were generally good ranging from 65.4 to 120.1% and were >110% for 22 measurements (<2% of total samples). Nutrients and other water quality data were collected at one sampling location (Station 141 off the north end of Peddocks Island) from 2002 to 2008. In surface water samples, total nitrogen concentrations ranged from 0.045 to 0.506mg/L (average = 0.231 mg/L) while total phosphorus concentrations ranged from 0.011 to 0.099 mg/L (n=188, average=0.037 mg/L)) (MWRA 2008). Chlorophyll *a* concentrations ranged from 0.28 to 18.40 µg/L (n=375, average =~3 mg/L) representing both surface and bottom samples). Total suspended solids ranged from 0.29 to 9.88 mg/L in surface water samples (n=367) and between 0.24 and 15.2 mg/L (n=363) in bottom samples (MWRA 2008).

MWRA Study	Station ID	Location Description	Sampling Depth Range (m)
CSORWM	044	Dorchester Bay, Mouth Of, Day Marker #5	3.4 – 9.1
CSORWM	065	Inner, President Roads, R.Buoy#2	Not recorded
BHWQM	106	Long Island - Green Can #17	7.3 – 16.2
CSORWM	048	Quincy Off Moon Island Outfall	2.0 – 5.5
BHWQM	141	Peddocks Island	5.1 – 15.6

Sediment Chemistry

Sediment samples were collected at five stations within this segment of Boston Harbor (see details of sampling information in Appendix D). A brief description of each sampling location is as follows:

Station T02: just outside of Inner Harbor southeast of Logan Airport; mean water depth of 6.8m
Station T01: off of the western side of Deer Island; mean water depth of 4m
Station T03: off of the northwestern side of Long Island; mean water depth of 8.7m
Station T05A: off of the southern tip of Deer Island in President Roads; mean water depth of 17.5m
Station T06: western side of Peddocks Island; mean water depth of 6.6m

In 2006, sediment collected just outside of the Inner Harbor southeast of Logan Airport (sampling station T02) was approximately 84% fines (i.e., sum of %clay and %silt) with a total organic carbon (TOC) content of 1.99%. To assess the overall sediment quality the sum of the ratios that exceeded a value of 1.0 (concentration/guidance) for both ISQG and PEL guidelines were calculated (see Appendix A *Aquatic Life Use* sediment chemistry guidance). This sum is noted as the total factor over the ISQG and/or PEL. For those analytes measured in the top 2 cm of sediment just outside of Inner Harbor southeast of Logan Airport having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 83.2 while none of the PELs were exceeded.

In 2006, sediment collected off of the western side of Deer Island (sampling station T01) was comprised of approximately 41.4% fines, (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 1.02%. For those analytes measured in the top 2 cm of sediment off of the western side of Deer Island having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 63.3 while none of the PELs were exceeded.

In 2006, sediment collected off of the northwestern side of Long Island (sampling station T03) was comprised of approximately 57.3% fines, (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 2.14%. For those analytes measured in the top 2 cm of sediment off of the northwestern side of Long Island having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 89.3 while the PELs were exceeded by a factor of 2.9. Mercury exceed the PEL by a factor of 1.8 and the estimated total PCB concentration (calculated as 2 times the sum20_PCB concentration data reported by MWRA) was 1.1 times its PEL.

In 2006, sediment collected off of the southern tip of Deer Island in President Roads (sampling station T05A) was comprised of only 28.6% fines, (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 0.49%. For those analytes measured in the top 2 cm of sediment off of the southern tip of Deer Island in President Roads having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 80.9 while only one PEL (phenanthrene) was exceeded by a factor of 1.3.

In 2006, sediment collected off the western side of Peddocks Island (sampling station T06) was comprised of approximately 58% fines, (i.e., sum of %clay and %silt), with a total organic carbon (TOC) content of 1.80%. For those analytes measured in the top 2 cm of sediment off the western side of Peddocks Island having ISQG and PEL guidance, the ISQGs were exceeded by a factor of 54.5 while none of the PELs were exceeded.

The *Aquatic Life Use* is assessed as support based primarily on the increase in eelgrass bed habitat (increase in one location as well as the high survival and expansion of three new transplant areas), the good survival of deployed caged mussels, improved benthic community (increased abundance/richness, and generally good water quality conditions (DO, chlorophyll *a*, total suspended solids) and the generally low total nitrogen data. This use is identified with an Alert Status due to the prevalence of fin erosion and bent fin ray, as well as flounder liver disease at Deer Island Flats.

Fish Consumption Use

MA DPH issued the following advisory for Boston Harbor (MA DPH 2009b):
***Fish Consumption Advisory for Marine and Fresh Water Bodies* (contaminants of concern in parenthetical as noted by MA DPH and MassDEP)**
Safe eating guidelines for pregnant women, women who may become pregnant, nursing mothers and children under 12 years old, and people with weakened immune systems:
Do Not Eat: *Lobsters, flounder, soft-shell clams and bivalves from Boston Harbor* (PCB and other contaminants)
Do Not Eat: *Bluefish* (PCB)
Safe eating guidelines for everyone:
Do Not Eat: *Lobster tomalley* (PCB)

The MWRA has conducted numerous studies on the levels of tissue contaminants in flounder fillets and liver, lobster meat and hepatopancreas, and blue mussel (soft tissue only) (Kane-Driscoll *et al.* 2008, Nestler *et al.* 2007, Lefkovitz *et al.* 2004, Pala *et al.* 2003), as summarized below:

Flounder: The highest levels of organic contaminants in both fillets and livers were measured at Deer Island Flats (of four stations) throughout the studies (Kane-Driscoll *et al.* 2008, Nestler *et al*. 2007), although metals concentrations were generally lowest at this location. Overall, chlordane levels have decreased in edible tissues over time, while DDT and PCBs, as well as metals, have remained generally constant.

Lobster: As with flounder, the highest levels of organic contaminants (of three stations) were typically measured in lobster collected at Deer Island Flats (Kane-Driscoll *et al.* 2008, Nestler *et al.* 2007), in both lobster meat and hepatopancreas. Levels were within or near the lowest levels of the historical range of concentrations in edible tissues, with little difference between the three stations (including the harbor outfall site and Eastern Cape Cod Bay). Concentrations of metals varied among stations with no clear trend; values measured in 2006 were within the historical range.

Blue mussel: Since 1995, mussels were deployed in plastic cages at five sites, including a site near Deer Island Light to measure bioaccumulation of pollutants (Kane-Driscoll *et al.* 2008, Nestler *et al.* 2007). Comparisons of results of monitoring conducted from 1998-2000 and 2001-2006 in the soft tissue of mussels deployed at Deer Island Light indicated: a decrease in concentrations in lead, total PAHs, chlordane and 4,4'-DDE; and an increase in mercury and PCBs (Kane-Driscoll *et al.* 2008). None of these were a likely effect of the relocation of the outfall, based on similar results at the reference station in Cape Cod Bay. However, the decrease in chlordane was a likely effect of the relocation. Between 2001 and 2006, concentrations of most

compounds in Deer Island Light mussels were the second-highest in the study, exceeded only by values observed at the Boston Inner Harbor station; high molecular weight PAHs and chlordane were the exceptions, which were significantly higher at the outfall site than at Deer Island Light.

The Food and Drug Administration (FDA) has established maximum permissible levels of contaminants in edible fish and shellfish tissues to protect human health. Results of studies conducted by the MWRA indicate that the FDA action limits for lead, mercury, chlordane, 4,4'-DDE and PCBs were not exceeded in tissue samples or stations monitored in 2003 (Lefkovitz *et al.* 2004) or in 2006 (Kane-Driscoll *et al.* 2008). There is no FDA action limit for total PAH.

The *Fish Consumption Use* is assessed as impaired for Boston Harbor as a result of the current MA DPH fish consumption advisory. Causes of impairment include elevated PCB in fish tissue and other contaminants in fish/shellfish. Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal. It should be noted, however, that recent studies conducted indicate that current tissue concentrations don't exceed FDA action levels.

Shellfishing Use

The MA Division of Marine Fisheries Shellfish Status Report of October 2009 states that <2% of this segment is Conditionally Restricted to shellfish harvesting, <1% Management Close (closed to harvesting as a precaution due to the absence of shellfish data in that area), and 98% is Prohibited (MA DFG 2009).

The *Shellfishing Use* is assessed as impaired because the entire segment is either Conditionally Restricted or Prohibited. Based on BPJ, these restrictions are presumed to be due to elevated fecal coliform bacteria counts associated with stormwater discharges from the municipal stormwater systems, as well as unspecified urban stormwater.

Primary and Secondary Contact Recreational and Aesthetics Uses

Boston Harbor is heavily used for water-based recreation, with numerous yacht clubs and five public beaches along the shoreline of this segment. Frequent testing for enterococci bacteria during the swimming season has been conducted at these beaches from 2002-2007 (MA DPH 2009a). Closure data for individual Boston Harbor beaches are summarized below:

Grandview Beach, Winthrop – A small portion of this beach is along the shoreline of this segment. From 2003-2007, this beach was posted in only one year (2006) for approximately 11% of the bathing season.
Spectacle Island Beach, Boston – This beach was officially opened to the public in June 2006 (Boston Harbor Association 2009b); closure data collected from 2005-2007 ranged from 0 (2005) to <3% (2006-2007).
Camp Harbor View Beach, Long Island, Boston – Camp Harbor View opened to campers in July 2007 (City of Boston 2007); in 2007, the beach was closed <4% of the swimming season.
Helen Street and Lovell Island Beaches, Hull/Boston – These beaches were sampled from 2002-2007; no beach closures were posted.

MWRA conducted monitoring at five stations in this segment of Boston Harbor between 2002 and 2008 (see more detailed data in Appendix C). The range of the annual geometric means of enterococci bacteria data (samples collected at the surface) during the primary and secondary contact recreation seasons, the total number of samples collected at each station during this period (n), and Secchi disk measurements are summarized below:

Station	Description	Geometric means Enterococci bacteria (colonies/100 mL) Primary Contact Season*	Geometric means Enterococci bacteria (colonies/100 mL) Secondary Contact Season**	Secchi disk depth (m)
044	Day Marker #5, Mouth of Dorchester Bay, Boston	5 – 12 (n=143)	5 – 13 (n=187)	0.6 – 4.3 (1 measurement <1.2 m, n=163)
065	Red Buoy #2, Inner President Roads, Boston	5 - 12 (n=114)	5 – 12 (n=146)	Not recorded
106	Green Can #17, Long Island, Boston	5 – 10 (n=110)	5 – 10 (n=179)	1.2 – 6.8 (n=184)
048	Off Moon Island Outfall, Quincy	5 – 10 (n=112)	5 – 10 (n=142)	0.9 – 3.9 (n=121)
141	Peddocks Island, Boston	5 – 10 (n=109)	5 – 10 (n=181)	0.9 – 8.0 (1 measurement <1.2 m, n=187)
*Primary contact recreation season: April 1 – October 15 **Secondary contact recreation season: calendar year				

The *Primary and Secondary Contact Recreational Uses* are assessed as support for Boston Harbor based on the Enterococci bacteria data and the low frequency of beach closures at Grandview, Spectacle Island, Camp Harbor View, Helen Street and Lovell Island beaches in Winthrop and Boston. The *Aesthetics Use* is not assessed due to the absence of data.

Boston Harbor (MA70-01) Use Summary Table

Designated Uses		Status
Aquatic Life		SUPPORT*
Fish Consumption		IMPAIRED Cause: PCB in Fish Tissue, Other (other contaminants in fish, shellfish) Source: Sources include upstream sources, contaminated sediments, wet weather discharges (point source and combination of stormwater, SSO or CSO), discharges from biosolids (sludge) storage, application or disposal
Shellfish Harvesting		IMPAIRED Cause: Elevated fecal coliform bacteria Source: Discharges from municipal separate storm sewer systems, unspecified urban stormwater
Primary Contact		SUPPORT
Secondary Contact		SUPPORT
Aesthetics		NOT ASSESSED

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