



MASSACHUSETTS COASTAL CONDITION ASSESSMENT

QUALITY ASSURANCE PROJECT PLAN


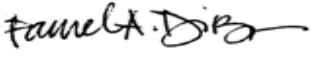


**Quality Assurance Project Plan for the Massachusetts Probabilistic Monitoring
and Assessment Program (MAP2): Coastal Waters**

Document prepared by Massachusetts Bays National Estuary Partnership and
Massachusetts Department of Environmental Protection

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Approval Page

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The Massachusetts Probabilistic Monitoring & Assessment Program (MAP2) is a component of the Massachusetts Department of Environmental Protection (MassDEP) water monitoring strategy and was initialized in 2011 to assist in fulfilling the requirements of the Clean Water Act (CWA) Section 305(b). The goal of MAP2 is to provide a comprehensive assessment of the condition of “waters” in Massachusetts through the implementation of probabilistic sampling designs. With completion of the wadeable rivers and streams (2010-2015) and lakes (2016-2018) probabilistic surveys, MAP2 will focus on coastal waters from 2020 to 2023.

The Massachusetts Bays National Estuary Partnership (MassBays) is dedicated to protecting, restoring, and enhancing the estuarine ecosystems of Ipswich Bay, Massachusetts Bay and Cape Cod Bay. As part of its mission, and as mandated by Section 320 of the CWA, MassBays monitors the status and trends of water quality conditions in estuarine waters of those Bays. Considering the shared needs and responsibilities between the two programs, MassDEP and MassBays formed a partnership to conduct a probabilistic Massachusetts Coastal Condition Assessment (MCCA) that meets the needs and responsibilities of both programs.

The purpose of this Quality Assurance Project Plan (QAPP) is to document the project data quality objectives and quality assurance/quality control measures that will be implemented in order to ensure that the data collected meets those needs. The plan contains elements of the overall project management, data quality objectives, measurement and data acquisition, and information management for the MCCA survey. **This document is adapted from the Quality Assurance Project Plan developed and followed in the 2015 National Coastal Condition Assessment conducted by USEPA (USEPA, 2014).**

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1. PROJECT PLANNING AND MANAGEMENT

1.1 Introduction

The goal of the Massachusetts Coastal Condition Assessment (MCCA) is to monitor and assess all coastal waters of the Commonwealth of Massachusetts. The primary objectives of the MCCA include:

- Determine the percent of coastal waters that are supporting aquatic life use;
- Determine if key stressors are impairing aquatic life use in coastal waters.

The MCCA is designed to be completed during the period of June through the end of August each year between 2020 and 2023. The Field Crew collects a variety of measurements and samples from 90 probabilistically selected sampling sites that are located at specific coordinates. 15 sites will be visited monthly during 2020 (pilot year) while 25 sites will be sampled monthly during each of the succeeding years – 2021, 2022, and 2023.

From each site, in situ water quality conditions will be measured. Water samples will be collected for analyses of chlorophyll-a and nutrients. Sediment samples will be collected to describe sediment characteristics and measure sediment chemistry and toxicity. Benthic macroinvertebrates will be collected to assess the composition and health of benthic communities in estuaries and in coastal areas.

1.2 Scope of the Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPP) addresses the data acquisition efforts of MCCA which focuses on monitoring Massachusetts coastal and estuarine conditions between 2020 and 2023. A comprehensive quality assurance (QA) program is in place to ensure data integrity and provide support for the reliable interpretation of the findings from this project.

1.3 Project Organization

Overall, the project is coordinated by the Massachusetts Department of Environmental Protection (MassDEP) with Massachusetts Bays National Estuary Partnership (MassBays). MassBays is responsible for coordinating sample collection and analyses. MassBays is hosted by the Massachusetts Office of Coastal Zone Management. James Meek (MassDEP) and Prassede Vella (MassBays) have each identified a Project Co-Lead. The Project Co-Leads will coordinate the MCCA, including planning and preparing for implementation of the survey, overseeing the work of the contractor, and conducting overall data management, analysis and report writing. James Meek (MassDEP) will serve as the overall QA Officer for the project. Prassede Vella (MassBays) will serve as the Field Auditor.

Contractor support for the field work and laboratory work is provided by Normandeau Associates, Inc. (Normandeau). The contractor and its sub-contractors (laboratories) will provide support for

implementing the survey, sampling and laboratory processing. For the purpose of this document, Project Manager and Field Crew will refer to the lead staff person and the Field Crew respectively, as identified by Normandeau. Sub-contracting laboratories include Alpha Analytics and Enthalpy Analytical. Alpha Analytics will be conducting water sample analysis for chlorophyll-a and nutrients, and sediment grain size and contaminant analysis. Enthalpy Analytics will be responsible for the sediment toxicity tests. Normandeau will be directly responsible benthic infauna sorting and identification.

1.4 Project Design

The MCCA is designed to be completed during the index period of June through the end of August 2015. A probabilistic survey design was used to randomly select 90 sites along the coasts of Massachusetts. The Field Crew will collect a variety of measurements and samples from the 90 sampling locations (located with a set of coordinates) over a period of four years (2020-2023). See map of coastal sites in Figure 1.1.

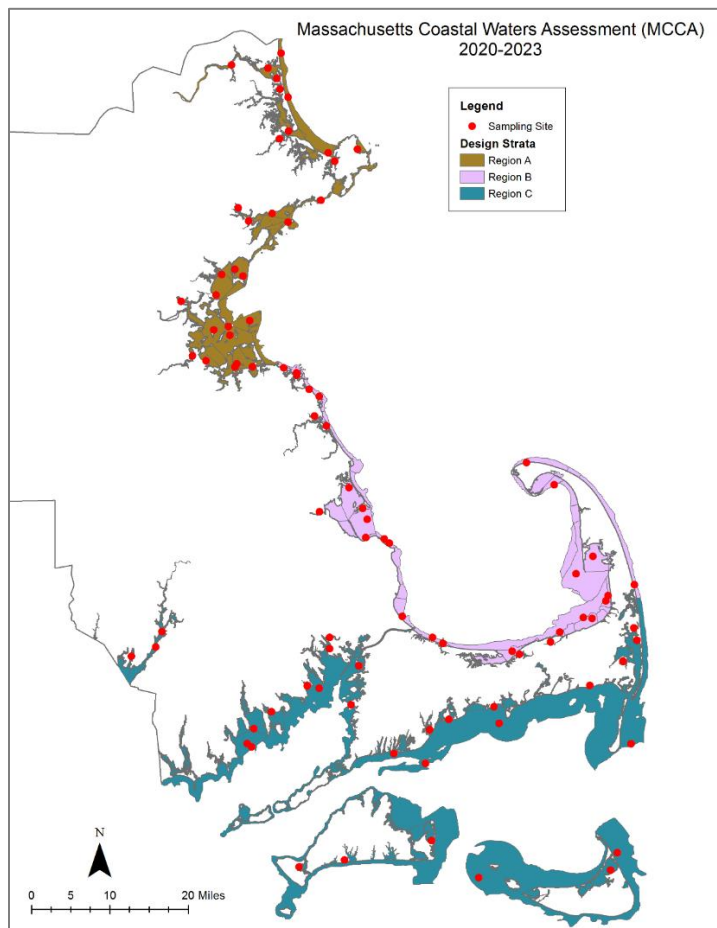


Figure 1.1: Map of sampling sites (2020-2023)

1.5 Project Schedule

Field sampling associated with the MCCA survey will be conducted between June and August of each year between 2020 and 2023. Sample processing and data analyses will be completed by December of each year and interim reports for each year will be prepared by January of the following year. Final reports will be completed by mid-2024 to address the respective needs of MassDEP and MassBays. Table 1 gives an overview of the major tasks leading up to the final report.

Table 1.1. Schedule of activities for the MCCA survey (2020-2023)

	2019		2020		2021-2023		2024	
	A*	B**	A	B	A	B	A	B
Design & planning								
Implementation: Manuals								
Pilot year (2020)								
Field work								
Lab work								
Data analysis								
Interim report								
2021-2023								
Field work								
Lab work								
Data analysis								
Interim reports								
Draft reports								
Peer review								
Final reports								

*A = January – June

** B = July – December

1.6 Overview of Field Work

Field data acquisition activities are implemented for the MCCA survey based on the National Aquatic Resources Surveys (NARS) and guidance developed by the U.S. Environmental Protection Agency (EPA). Survey preparation was initiated with selection of the sampling locations. Each site is given a unique ID which identifies it throughout the pre-field, field, lab, analysis, and data management phases of the project. The Project Co-Leads provide the list of sampling locations to the contractor. The Field Crew begins site reconnaissance on the primary sites and alternate replacement (oversample) sites via desktop evaluation, conducting field visits when needed. Specific procedures for evaluating each sampling location and replacing non-sampleable sites are provided in the Site Evaluation Guidance. The Field Crew will use standard field equipment and supplies as identified in the MCCA Field Operations Manual.

Upon arrival at a site, the Field Crew implements the site verification protocol to verify the location. The Field Crew collects samples and measurements for various parameters as specified in the Field Operations Manual. All methods are described in detail in the MCCA Field Operations Manual. Field communications will be through Project Co-Leads and may involve regularly scheduled conference calls.

Standardized field data forms are the primary means of data recording. Field forms are available to the Field Crew in electronic version. On completion, the data forms are reviewed by a person other than the person who initially entered the information. Prior to departure from the field site, the Field Crew leader reviews all forms and labels for completeness and legibility and ensures that all samples are properly labeled and packed.

Field data and sample information must be recorded completely, legibly, accurately, and consistently. Chain of custody forms must be included in every cooler/box which contains samples being shipped to the labs and must also be submitted to the Project Co-Leads electronically. All samples need to be identified and tracked and associated information for each sample must be recorded.

To assist with sample tracking, sample ID numbers are provided by the Project Co-Leads for use on all field sheets, bottle labels and contract lab chain of custody forms. A MCCA sample ID is created by taking the last three digits of the site ID (e.g. MAP2E-023) and adding a unique 4-digit number on the end (e.g. 023-0001). It is recommended using sequential numbers for the 4-digit suffix to ensure the sample ID is unique. This sample ID will be recorded on the field sheets, bottle labels and chain of custody forms.

The field operations phase is completed with collection of all samples. Following the field season, the Project Co-Leads and the contractor Project Manager will hold debriefings with the Field Crew and other project staff to cover all aspects of the field program and solicit suggestions for improvements.

1.7 Overview of Laboratory Work

Holding times for surface water samples vary with the sample types and analyte. The Field Crew begins some analytical measurements during sampling (e.g., in situ measurements) while other analytical measurements are made in the laboratory. When available, standard methods listed in the Field Operations Manual are used.

Laboratories will be subcontracted by Normandeau. Alpha Analytics will perform water and sediment chemistry, and Enthalpy Analytics will perform the sediment toxicity tests. Identification of benthic invertebrates will be conducted by Normandeau. All relevant reviewed and approved QAPPs and Standard Operating Procedures (SOPs) are made available to the Project Co-Leads by the entities responsible for the analyses.

This QAPP is only intended to cover field operations. Laboratory operations will be covered by the QAPPs of the respective analytical entities. All laboratory QAPPs are included in Appendices C-F. A comprehensive list of SOPs will be made available to MassDEP and MassBays upon request. Such information may include the following:

- Signed Quality Assurance Project Plan;
- Valid Accreditation or Certification;
- Laboratory's Quality Manual and/or Data Management Plan;
- Method Detection Limits (MDL);
- Results from inter-laboratory comparison studies;
- Analysis of performance evaluation samples; and
- Control charts and results of internal QC sample or internal reference sample analyses to document achieved precision, bias, accuracy.

1.8 Data Analysis

General processes are summarized in the indicator-specific sections of this QAPP. Validated data will be transferred to MassDEP's external data portal and EPA's Water Quality Exchange (WQX) for storage. Information management activities are discussed further in Section 4. Additionally, MassBays and MassDEP will maintain all electronic and paper files provided by contractors. The data collected for the MCCA will be analyzed and evaluated primarily using methodology outlined in technical reports from 2010 and 2015 (when available) NCCA projects and Massachusetts surface water quality standards and assessment methodology (EPA 2014; MassDEP 2018). The Data Analysis Plan is described in Section 7 of this QAPP.

2. DATA QUALITY OBJECTIVES

Data Quality Objective (DQOs) are qualitative and quantitative statements that clarify study objectives, define the appropriate types of data, and specify the tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. DQOs are typically expressed in terms of acceptable uncertainty associated with a point estimate at a desired level of statistical confidence. The DQO process is used to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study. In general, performance criteria represent the full set of specifications needed to design a data or information collection effort such that, when implemented, they generate data that are of sufficient quality and quantity to address the project's goals. Acceptance criteria are specifications intended to evaluate the adequacy of one or more existing sources of information or data as being acceptable to support the project's intended use (EPA 2006B).

Method detection and reporting limit information is based on the latest determinations by MassDEP and EPA. In all cases, suitable method detection limits (MDLs) and reporting limits (RLs) are required for all analyses (e.g., RLs < applicable criteria). The data quality concepts of precision, accuracy, representativeness, completeness, and comparability (PARCC) are discussed below, along with other data quality issues, such as holding time, sensitivity and detection limits. While more commonly associated with quantitative chemical data, these concepts can also be applied to qualitative/quantitative physical and biological data, as applicable.

2.1 Data Quality Objectives for the MCCA

MCCA has established target DQOs for assessing the current conditions of coastal and estuarine waters and aquatic resources in Massachusetts based on DQOs used by EPA (EPA 2014) and CZM. (CZM 2006). For each indicator of condition, the proportion of Massachusetts estuaries and coastal waters in degraded condition within a 15% margin of error and with 95% confidence, is estimated. DQOs for each indicator are listed and described in the respective subsections under Section 5.

2.2 Accuracy

Accuracy is determined by how close a reported result is to a true or expected value and the degree to which bias is avoided or minimized.

Laboratory accuracy will be determined by following the policy and procedures provided in the laboratory's QAPP and analyte-specific SOPs. These generally employ estimates of percent recoveries for known internal standards, matrix spikes and performance evaluation samples, and evaluation of blank contamination. Depending on the analyte, specific accuracy objectives can be concentration-based (e.g. ± 0.010 mg/l @ $< .05$ mg/l and $\pm 20\%$ @ $> .05$ mg/l) or can be defined in terms of percent recovery percentages (e.g. 80-120 % recovery of matrix spike/PE sample).

Accuracy for multi-probe measurements is tested prior-to-use and after use against standards. A NIST-certified thermometer is used to periodically check thermometer accuracy. Lower limit accuracy for dissolved oxygen (DO) is checked using a zero DO standard (when and where low DOs are expected). The post-sampling checks ensure that the readings taken during the survey were within QC acceptance limits for each multi-probe analyte.

Accuracy assessment for macroinvertebrate identifications usually entails confirmation of voucher specimens and/or random samples by expert peer(s). Accuracy of taxonomy are qualitatively evaluated through specification of target hierarchical levels and the specification of appropriate technical taxonomic literature or other references (e.g., identification keys, voucher specimens). A reference collection will be compiled as the samples are identified.

2.3 Precision

Precision is a measure of the degree of agreement among repeated measurements and is estimated through sampling and analysis of replicate (e.g., duplicate, triplicate) samples.

Laboratory precision of laboratory duplicates will be determined by following the policy and procedures provided in the laboratory's QAPP and SOPs. This typically involves analysis of same-sample lab duplicates and matrix spike duplicates.

Overall precision objectives using relative percent difference (RPD) of field duplicate samples vary depending on the parameter and typically range from 10-25% RPD. Precision estimates based on small numbers can result in relatively high RPDs (due to small number effect). Precision of the multi-probe measurements can be determined by taking duplicate (via a second placement of the unit) readings at the same station location. Multi-probe precision objectives generally range from 5-10 % RPD depending on the parameter.

In general, assessment of precision for biological samples typically involves comparison of identifications, counts and other measures by the same analyst and/or by separate analysts using same and duplicate samples. To calculate taxonomic precision, 10% of the samples are randomly selected for re-identification by an independent, outside taxonomist or laboratory.

2.4 Representativeness

Representativeness refers to the extent to which measurements characterize the true environmental condition. At one level, representativeness is affected by problems in any or all the other data quality indicators.

At another level, representativeness is affected by the selection of the target surface water bodies, the location of sampling sites within that body, the time when samples are collected, and the time period when samples are analyzed. The probability-based sampling design should provide estimates of condition of surface water resource populations that are representative of the target population. The individual sampling programs defined for each indicator attempt to address representativeness within the constraints of the response design, (which includes when, where, and how to collect a sample at each site). Holding time requirements for analyses ensure analytical results are representative of conditions at the time of sampling. Use of duplicate (repeat) samples which are similar in composition to samples being measured provides estimates of precision and bias that are applicable to sample measurements (EPA 2014)

2.5 Completeness

Completeness refers to the amount of valid data collected using a measurement system. Completeness is established and evaluated from two scales. First, it is expressed as a percentage of the number of valid measurements that should have been collected. For the MCCA the completeness criterion is 80-100%. This assumes that, at most, one event out of five sampling events might be cancelled for some reason that could cause an incomplete dataset with up to 20 % of the planned-on data not obtained. Second, it is expressed as the percentage of the target sample size (90 sites) sampled during the MCCA. The objective for the MCCA is to complete sampling on 95% of the target sample size or 85 sites (included both primary and alternate sites).

2.6 Comparability

Comparability refers to the extent to which the data from a study is comparable to data from past studies or from other areas. For the MCCA, the use of standardized sampling and analytical methods, units of reporting, and site selection procedures help to ensure comparability of data. Review of methods used by EPA for similar efforts was helpful in preparing the sampling design. Efforts to enhance data comparability are made where possible and appropriate.

2.7 Detection Limits

Detection limits define the smallest amount of analyte that can be detected above signal noise and within certain confidence levels. Typically, Method Detection Limits (MDL) are calculated in the laboratory by analyzing a minimum of seven low-level standard solutions using a specific method. Multiplication factors are typically applied to MDL values by laboratories to express Reporting Limits (RL) which define a level above which there is greater confidence in reported values.

2.8 Holding Times

Most analytes have standard holding times (maximum allowed time from collection to analysis) that have been established to ensure analytical accuracy. Where established holding times are exceeded, violations are considered during the data validation process.

2.9 Sensitivity

Sensitivity characterizes the ability of a method or instrument to discriminate between measurement responses. The specifications for sensitivity are unique to each analytical instrument and are typically defined in laboratory QAPPs and SOPs.

2.10 Performance Auditing

Subject to adequate time and resources, field evaluations are conducted to evaluate implementation of field methods, consistency with this QAPP and compliance sampling SOPs. Field evaluations are conducted for each part of the MCCA survey (e.g., water quality, benthic macroinvertebrate, fish, etc.) and every monitoring season, depending on resource capacity.

Sometimes, proficiency testing of laboratory analytical accuracy and precision is performed for several analyte groups (e.g., nutrients, metals, chlorophyll a). These are single and/or double-blind lab QC checks using prepared solutions and purchased QC check samples. All evaluation results are compared to “true” values/results, evaluated against acceptance limit criteria and used to help validate the data. Results are also provided to lab analysts, survey coordinators and data users.

3. SITE SELECTION DESIGN

The overall sampling program for the MCCA project requires a randomized, probability-based approach for selecting coastal sites where sampling activities are to be conducted.

3.1 Probability-based Sampling Design and Site Selection

The MCCA utilizes the Generalized Random Tessellation Stratified (GRTS) design strategy developed principally by EPA, National Health and Environmental Effects Research Laboratory, Western Ecology Division (EPA-NHEERL-WED) in Corvallis, OR. The basic survey design specifics for the MCCA are:

- The target population is all coastal waters within MassDEP and MassBays estuarine assessment units and a nearshore boundary defined by a maximum distance from the Massachusetts shoreline of 3 miles and a maximum depth of 10 meters.
- Stratified into three geographic regions or strata to improve sampling logistics. One region will be targeted and sampled each year from 2021 to 2023. A pilot year of sampling will be conducted in 2020 in multiple strata using a small subset of the selected primary sites to test sampling methodology.
- Unequal probability categories were created based on the area of each polygon/estuary segment to ensure the selection of sites in smaller polygon/estuary segments.
- The target sample size is 90 sites with 30 sites in each region or stratum (primary sites). In addition, 60 oversample sites were selected in each stratum to replace rejected or non-sampleable primary sites.

Additional details of the survey design, selection of target population and sample frame are described in the MCCA Coastal Survey Design (Appendix 1).

3.2 Sampling Frequency and Revisits

Each of the selected sites will be visited three times in the same year, once a month during June, July and August. The primary purpose of these revisits is to allow variance estimates that would provide information on the extent to which the population estimates might vary if they were sampled at a different time. In situ measurements and water chemistry samples will be collected each month. Sediment samples for sediment chemistry and toxicity, as well as benthic infauna will be collected once (July). Eelgrass (*Zostera marina*) monitoring will be conducted once at each site in August which is the peak growing season for eelgrass.

4. INFORMATION MANAGEMENT

Environmental monitoring efforts that amass large quantities of information present unique and challenging data management opportunities. Information management is an integral part of all aspects of the MCCA project from initial selection of sampling sites through the dissemination and

reporting of final, validated data. This approach helps increase the quality and relevance of the data gathered.

MassDEP and MassBays manage data and information generation, compilation and storage. Information management includes site selection and logistics information, sample labels and field data forms, tracking records, map and analytical data, data validation and analysis processes, and reports. Information management includes both hardcopy and electronic methods of generating, storing, organizing and archiving data.

4.1 Roles and Responsibilities

All participants in the MCCA project have an integral part in information management. Table 4.1 provides a summary of roles and responsibilities.

Table 4.1 Roles and responsibilities

Group	Role	Responsibility
Project Co-Leads (MassDEP & MassBays)	Overall coordination of the project	<ul style="list-style-type: none"> • Develop project plan and conduct overall coordination • Develop sampling design (MassDEP) • MassBays - Field contract management and liaison with Field Project Manager • Develop QAPP (MassBays)
Field Project Manager (Normandeau)	Coordinates Field Crew and oversight. Coordinate lab work oversight and submission of lab data	<ul style="list-style-type: none"> • Review all field data forms. sample tracking forms and electronic lab data transmittal files for completeness and accuracy. • Submits field and sample tracking forms and lab datafiles to Project Co-Leads so information can be integrated into a database. • Monitor and track samples from field collection, through shipment to appropriate laboratory. • Monitor instrument and analytical quality control information. • Ensures participating labs follow specified methods and QA activities take place. • Ensures data are submitted within the specified timelines. • Maintains data tracking documentation for lab submissions to Project Co-Leads. • Maintain open communications with Project Co-Leads regarding any data issues.
Field Crew	Acquire in-situ measurements and prescribed list of biotic/abiotic samples at sampling site.	<ul style="list-style-type: none"> • Complete and review field data forms and sample tracking forms for accuracy, completeness, and legibility. • Provide data as specified in Field Operations Manual to Normandeau Field Project Manager.
Analytical Labs	Analyze samples received from field teams in the manner appropriate to acquire biotic/abiotic	<ul style="list-style-type: none"> • Review all electronic data transmittal files for completeness and accuracy. • Submit completed sample tracking forms to Normandeau Field Project Manager

Group	Role	Responsibility
	indicators/measurements requested.	<ul style="list-style-type: none"> • Provide all datafiles and metadata to Normandeau Project Leader.
QA Officer (MassDEP)	Review and evaluate the relevancy and quality of information/data collected and generated.	<ul style="list-style-type: none"> • Develop/update field data forms. • Plan and implement electronic data flow and management processes to MassDEP/MassBays. • Receive, scan, and conduct error checking of field data forms received from Normandeau. • Receive data submission packages (analytical results and metadata) from Normandeau. • Receive verified, validated, and final indicator data files from QA reviewers. • Implement backup and recovery support for database.
Field Audit Coordinator (MassBays)	Conducted field audit	<ul style="list-style-type: none"> • Develop field audit data sheets and coordinates field visit with Field Crew Lead. • Evaluate results stemming from field audit. • Investigate and take corrective action, as necessary, to mitigate any data quality issues. • Issue guidance for qualifying data when quality standards are not met or when protocols deviate from plan.
Data Management, Analysis and Reporting (MassDEP & MassBays)	Provide the data analysis and technical support for MCCA reporting requirements. Same for reporting requirements for MassBays under its Comprehensive and Conservation Management Plan (CCMP).	<ul style="list-style-type: none"> • Provide data integration, aggregation and transformation support as needed for data analysis. • Provide supporting information necessary to create metadata. • Investigate and follow-up on data anomalies identified data analysis activities. • Produce estimates of extent and ecological condition of the target population of the resource. • Provide written background information and data analysis interpretation for report(s). • Document in-depth data analysis procedures used. • Provide mapping/graphical support. • Document formatting and version control.

4.2 Data and Information Formats

The MCCA project will accumulate large quantities of observational and laboratory analysis data. To appropriately manage this information, it is essential to have a documented approach for acquiring, storing, and summarizing the data. Communication between the Project Co-Leads, the Project Manager, and the various data generators (e.g., Field Crew, and laboratories) is vital for maintaining an organized, timely, and successful flow of information and data.

Data are captured or acquired from four basic sources including field data transcription, laboratory analysis reporting, automated data capture, and submission of external data files (e.g., GIS data), encompassing an array of data types: site characterization; biotic assessment; sediment and tissue contaminants; and water quality analysis. Data capture generally relies on the transference of

electronic data to a central database developed for this project. However, some data must be transcribed by hand in order to complete a record.

Data repository or storage provides the computing platform where raw data are archived, partially processed data are staged, and the final data are stored. This allows the Project Co-leads to QA/QC data. The final data format becomes the primary source for all statistical analysis and data distribution.

Standard Coding Systems

Sampling Site: Latitude and Longitude in decimal degrees (+/- 7.4)
Negative longitude values (west of the prime meridian).
Datum used must be specified (e.g., NAD83, NAD27)
Chemical Compounds: Chemical Abstracts Service (CAS 1999)
Species Codes: Integrated Taxonomic Information System (ITIS 1999).

4.3 Data Transfer Protocols

The Project Manager will send electronic copies of field forms containing in-situ measurement and event information to the Project Co-Leads as defined in the Field Operations Manual. The Project Manager receives and maintains tracking records for sampling and sample receipt including all records of sampling events, shipment of samples to processing labs, and receipt of samples by the processing labs. The Project Manager will send electronic copies of all sample tracking records to the Project Co-Leads. Electronic data files from the laboratories are submitted to the Project Co-Leads by the Project Manager. The Project Co-Leads receive the lab data and maintain records of the transfer. Examples of software and the associated formats are Microsoft Excel®, Microsoft Access®, SAS®, and R.

All electronic files submitted by the laboratories must be accompanied by appropriate documentation, e.g., metadata, lab reports, QA/QC data and review results. Submitted information shall contain sufficient information to identify field contents, field formats, qualifier codes, etc. Labs may send files periodically, before all samples are analyzed. Laboratory data files must be accompanied by text documentation describing the status of the analyses, any QA/QC problems encountered during processing, and any other information pertaining to the quality of the data.

Following is a list of general transmittal requirements when packaging data for electronic transfer to the Project Co-Leads:

- Provide data in row/column data file/table structure. Further considerations:
 - Include sample id provided on the sample container label in a field for each record (row) to ensure that each data file/table record can be related to a site visit.
 - Use a consistent set of column labels.
 - Use file structures consistently.
 - Use a consistent set of data qualifiers.

- Use a consistent set of units.
- Include method detection limit (MDL) as part of each result record.
- Include reporting limit (RL) as part of each result record.
- Provide a description of each result/QC/QA qualifier.
- Provide results/measurements/MDL/RL in numeric form.
- Maintain result qualifiers.
- Use a separate column to identify record-type. For example, if QA or QC data are included in a data file, there should be a column that allows the MCCA IM staff to readily identify the different result types.
- Include laboratory sample identifier.
- Include batch numbers/information so results can be paired with appropriate QA/QC information.
- Include “True Value” concentrations, if appropriate, in QA/QC records.
- Include a short description of preparation and analytical methods used either as part of the record or as a separate description for the test(s) performed on the sample. For example, EPAxxxx.x, ASTMxxx.x, etc. Provide a broader description, e.g., citation, if a non-standard method is used.
- Include a short description of instrumentation used to acquire the test result (where appropriate). This may be reported either as part of the record or as a separate description for each test performed on the sample. For example, GC/MSECD, ICP-MS, etc.
- Ensure that data ready for transfer are verified and validated, and results are qualified to the extent possible.
- Data results must complement expectations (analysis results).
- Identify and qualify missing data (why are the data missing).
- Submit any other associated quality assurance assessments and relevant data related to laboratory results (i.e., chemistry, nutrients). Examples include summaries of QC sample analyses (blanks, duplicates, check standards, matrix spikes) standard or certified reference materials, etc.), results for external performance evaluation or proficiency testing samples, and any internal consistency checks conducted by the laboratory.

A list of laboratory electronic data elements is provided in Appendix 2 (MassDEP 2005a; MassDEP 2005b).

4.4 Data Quality and Results Validation

Data received by the Project Co-Leads are examined for completeness, format compatibility, and internal consistency. Field QC samples (duplicates and blanks) are evaluated to check compliance with relevant DQO. Field collected data quality is evaluated using a variety of automated and other techniques. Analytical results are reviewed by subject matter experts. Any changes (deletions, additions, corrections) are recorded. Explanations for data changes are included in the record history.

All laboratory QA information is examined to determine if the laboratory met the predefined data quality objectives described in the QAPP. All questionable data will be corrected or qualified through the Project Co-Leads with support of the Project QA coordinator.

4.6 Records Management

MassDEP and MassBays will maintain scanned and paper field sheets, site evaluation spreadsheets and electronic data fields from laboratories at both the MassDEP office (Worcester) and MassBays offices (Boston).

4.7 Information Management Operations

Data collected as part of the MCCA will be submitted by the Project Co-Leads to MassDEP's external data portal and EPA's Water Quality Exchange (WQX) for storage as applicable. Details regarding the data submittal guidelines and external data review process for MassDEP's external data portal can be found at online at <https://www.mass.gov/guides/external-data-submittals-to-the-watershed-planning-program>.

5. INDICATORS

This section of the QAPP provides summary information on laboratory and field performance and quality control measures for the MCCA indicators. Additional details are described in the MCCA Field Operations Manual. A description of the MCCA indicators is found in Table 3.

Table 5-1. Description of MCCA indicators

Indicator	Description	Location of Sampling
In Situ measurements: salinity, temperature, DO, depth, and pH	Measurements taken to detect extremes in condition that might indicate impairment and depth at location.	One set of measurements taken at the index site; readings are taken on a profile through the water column at the index site
Secchi depth	Measurements to look at clarity	Measured at the index site
light measurements PAR	Measurements to look at clarity/transparency	Measured at the index site
Water chemistry for dissolved inorganic NO ₂ NO ₃ , NH ₄ , PO ₄ ; Total N and P	Water chemistry measurements will be used to determine nutrient enrichment/eutrophication	Collected from a depth of 0.5 m at the index site
Chlorophyll-a	Chlorophyll-a is used to determine algal biomass in the water.	Collected from a depth of 0.5 m at the index site
Benthic invertebrate assemblage	Benthic invertebrate community information is used to assess the biological health of estuarine waters. Measure attributes of the overall structure and function of the benthic community, diversity, abundances, etc. to evaluate biological integrity.	Collected from a sediment grab at the index site
Sediment Chemistry	Measurement to determine contaminant levels in sediment	Collected from a sediment grab at the index site
Sediment toxicity	Measurement to determine contaminant levels in sediment	Collected from a sediment grab at the index site

Eelgrass	Measures taken for presence/absence and % cover.	Imagery taken at index site with a camera deployed on a 0.25m ² frame
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5.1 In Situ Measurements

The first activities that should be conducted by Field Crew upon arriving onsite are those that involve water column measurements; these data need to be collected before disturbing bottom sediments.

5.1.1 Introduction

The Field Crew makes in situ measurements using field meters, and data are recorded on standardized data forms. Field Crew will measure dissolved oxygen (DO), pH, salinity, and temperature using a multi-parameter water quality meter. The crew uses a meter to read photosynthetically active radiation (PAR) throughout the photic zone and measures Secchi depth as well.

5.1.2 Sample Collection Methods

Detailed sample collection and handling procedures are described in the MCCA Field Operation Manual.

5.1.3 Field QA/QC Procedures

Equipment used to collect or analyze environmental data should have periodic maintenance and calibration verification performed by manufacturer's representatives or service consultants. These procedures should be documented by date and the signature of person performing the inspection. Examples include:

- CTDs or multiparameter probes - annual (or as needed) maintenance and calibration check by manufacturer or certified service center;
- Light (PAR) Meters - biannual verification of calibration coefficient by manufacturer.

All other sampling gear and laboratory instrumentation must be kept in good repair as per manufacturer's recommendations to ensure proper function.

5.1.3.1 Field Performance Requirements

Measurement DQOs are provided in Table 5.2. General requirements for comparability and representativeness are addressed in Section 2.

Table 5.2. Data Quality Objectives: Water Indicators

Indicator	Max. Allowable Accuracy Goal	Max. Allowable Precision Goal (%RSD)	Completeness
DO	±0.5 mg/L	10%	95%
Temperature	±1 °C	10%	95%
Salinity	±1 ppt	10%	95%
Depth	±0.5 m	10%	95%
pH	±0.3 SU	10%	95%

PAR	0.01 $\mu\text{mol s}^{-1} \text{m}^{-2}$	5%	95%
Secchi Depth	$\pm 0.5 \text{ m}$	10%	95%

5.1.3.2 Field QC Requirements

Field instruments (e.g., multi-probe) must be calibrated, inspected prior to use, and operated according to manufacturer specifications and MCCA Field Operations Manual.

5.1.3.3 Instrumentation

Multiparameter Probes: Multiparameter probes are routinely used in estuarine, deep water or oceanographic surveys to measure and electronically log various water column parameters. For the purposes of the MCCA, the Field Crew will use the instrument to measure DO, temperature, salinity, pH, and depth. The Field Crew will follow the MCCA Field Operations Manual as well as manufacturer's instructions for use of these instruments. For instruments that are factory calibrated and checked, Field Crew must ensure that factory-certified diagnostics have been completed according to manufacturer specifications (preferably conducted immediately prior to the sampling season) and provide documentation copies during assistance visits. Meters such as these do not require the daily calibration steps or the weekly diagnostic/QCS checks. Table 5.3 includes field quality control measures for multiparameter probes.

Table 5.3. Field Quality Control: Multiparameter Meter Indicators

Check description	Frequency	Acceptance Criteria	Corrective Action
Verify performance of temperature probe using wet ice.	Prior to initial sampling, daily thereafter	Functionality = ± 1 °C	See manufacturer's instructions
Verify depth against markings on cable	Daily	$\pm 0.2 \text{ m}$	Re-calibrate
pH - Internal electronic check if equipped; if not check against Quality Check Solution	At the beginning and end of each day	Alignment with instrument manufacturer's specifications; or QCS measurement in ran	AM: Re-calibrate PM: Flag day's data. pH probe may need maintenance.
Salinity (marine only) - internal electronic check if equipped; if not check against Quality Check Solution	At the beginning and end of each day	Alignment with instrument manufacturer's specifications; or QCS measurement in ran	AM: Re-calibrate PM: Flag day's data. pH probe may need maintenance.
Check DO calibration in field against atmospheric standard (ambient air saturated with water)	At the beginning and end of each day	$\pm 0.5 \text{ mg/L}$	AM: Re-calibrate PM: Flag day's data. Change membrane and re-check

LiCOR PAR meter: No daily field calibration procedures are required for the LiCOR meter. There are several field QC measures to ensure taking accurate measurements of light penetration. - The deck sensor must be situated in full sunlight (i.e., out of any shadows). Likewise, the submerged sensor must be deployed from the sunny side of the vessel and care should be taken to avoid

positioning the sensor in the shadow of the vessel. For the comparative light readings of deck and submerged sensors, (ratio of ambient vs. submerged), the time interval between readings should be minimized (approximately 1 sec).

Secchi Disk: No field calibration procedures are required for the Secchi disk. QC procedures include designating a specific crew member as the Secchi depth reader; taking all measurements from the shady side of the boat; and not wearing sunglasses or hats when taking Secchi readings. Duplicate measurements by the same crew member will be taken to verify precision.

Table 5.4 Field Instrument Make/Model

Instrument	Make/Model
Multiparameter sonde	Aqua TROLL 600
Li-COR PAR meter	Li-COR LI-192SA underwater sensor Li-1500G-UW light sensor logger

5.1.5 Data Review

See Table 5.5 for data validation quality control.

Table 5.5 Data Validation Quality Control for In-Situ Indicators.

Procedure	Requirements or Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Correct reporting errors or qualify as invalid
Review data from calibration and field notes	Determine impact and possible limitations on overall usability of data

5.2 Water Chemistry Measurements (Nutrients and Chlorophyll-a)

5.2.1 Introduction

Water chemistry indicators based on field and laboratory methods evaluate estuarine condition with respect to nutrient over-enrichment and eutrophication. Data are collected for a variety of physical and chemical constituents to provide information on the water clarity, primary productivity, and nutrient status. Data are collected for chlorophyll-a to provide information on the algal loading and gross biomass of blue-greens and other algae.

5.2.2 Sample Collection Methods

Detailed sample collection and handling procedures are described in MCCA Field Operation Manual.

5.2.3 Laboratory QA/QC Procedures

The specific quality control procedures used by the laboratory are implemented to ensure that:

- Objectives established for various data quality indicators being met.
- Results are consistent and comparable among all participating laboratories.

Detailed laboratory methods are in the laboratory QAPPs and SOPs. The laboratory will follow the QA/QC procedures outlined in the QAPP.

5.2.3.1 Laboratory Performance Requirements

Table 5.6 summarizes the pertinent laboratory measurement data quality objectives for the water chemistry indicators.

Table 5.6 Data Quality Objectives: Nutrients and Chlorophyll-a

Parameter/ Method	Units	Potential Range of Samples ¹	Method Detection Limit ²	Transition Value ³	Precision ⁴	Accuracy ⁵
Ammonia (NH3) SM 4500-NH3-BH ⁶	mgN/L	0 – 17	0.01	0.1	± 0.01 or ±10%	± 0.01 or ±10% Blank <MDL
Total Nitrogen (TN) SM 4500-N ⁷	mgN/L	0.1 – 90	0.01	0.1	± 0.01 or ±10%	± 0.01 or ±10% Blank <MDL
Total Phosphorous (TP) and Ortho- phosphate SM 4500P-E ⁸	mgP/L	0 – 22 (as total phosphorus)	0.005	0.05	± 0.005 or ±10%	± 0.005 or ±10% Blank <MDL
Nitrate (NO3) SM 4500-NO3-F ⁹	mgN/L	0 – 360	0.01	0.1	± 0.01 or ±10%	± 0.01 or ±10% Blank <MDL
Chlorophyll-a SM 10200H ¹⁰	µg/L	0.7-11,000	1.5	15	± 1.5 or ±10%	± 1.5 or ±10% Blank <MDL

5.2.4 Field QA/QC Procedures

Field data quality is addressed, in part, by application and consistent performance of valid procedures documented in the MCCA Field Operations Manual. The Field Crew will verify that all sample containers are uncontaminated and intact, and that all sample labels are legible and intact. Before leaving the field, the Field Crew will:

- Check the label to ensure that all written information is complete and legible.
- Place a strip of clear packing tape over the label, covering the label completely.
- Record the sample ID number assigned to the water chemistry sample on the Water Sample Collection form.

¹ Estimated from samples analyzed at the EPA Western Ecological Division-Corvallis laboratory between 1999 and 2005 (EPA 2015)

² Determined as a one-sided 99% confidence interval from repeated measurements of a low-level standard across several calibration curves.

³ Value for which absolute (lower concentrations) vs. relative (higher concentrations) objectives for precision and accuracy are used.

⁴ For duplicate samples, precision is estimated as the pooled standard deviation (calculated as the root-mean square) of all samples at the lower concentration range, and as the pooled percent relative standard deviation of all samples at the higher concentration range. For standard samples, precision is estimated as the standard deviation of repeated measurements across batches at the lower concentration range, and as percent relative standard deviation of repeated measurements across batches at the higher concentration range.

⁵ Estimated as the difference between the measured (across batches) and target values of performance evaluation and/or internal reference samples at the lower concentration range, and as the percent difference at the higher concentration range.

⁶ Standard Methods for the Examination of Water and Wastewater 4500-NH3-BH: Nitrogen (Ammonia)

⁷ Standard Methods for the Examination of Water and Wastewater 4500-N: Nitrogen

⁸ Standard Methods for the Examination of Water and Wastewater 4500-P: Phosphorus Ascorbic Acid Method

⁹ Standard Methods for the Examination of Water and Wastewater 4500-NO3-F: Nitrogen (Nitrate) Automated Cd Reduction Method

¹⁰ Standard Methods for the Examination of Water and Wastewater 10200H-Plankton (Chlorophyll)

- Provide comments on the Water Sample Collection form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity.
- Store the samples on wet ice in a cooler.
- Maintain CHLA filters frozen until shipping on wet ice (if filtered on site).
- Recheck all forms and labels for completeness and legibility.

5.2.4.1 Field QC Requirements

See Table 5.7 and Table 5.8 for quality control activities and corrective actions.

Table 5.7 Field Quality Control Activities: Nutrients

QC Activity	Description and Requirements	Corrective Action
Containment and preparation	Rinse collection bottles 3x with ambient water before collecting water samples.	Discard sample. Rinse bottle and refill.
Sample storage	Store samples in darkness at 4°C. Ship on wet ice within 24 hrs. of collection.	Qualify sample as suspect for all analyses

Table 5.8 Field Processing Quality Control: Chlorophyll-a

QC Activity	Description and Requirements	Corrective Action
Chlorophyll-a Containers and Preparation	Rinse collection bottles 3x with ambient water before collecting water samples.	Discard sample. Rinse bottle and refill.
Holding time (if necessary)	Complete filtration of chlorophyll-a after all water samples are collected	Qualify samples
Filtration conducted in field (if necessary)	Use Whatman 0.7 µm GF/F filter. Filtration pressure should not exceed 3.4 psig to avoid rupture of fragile algal cells.	Discard and refill
Sample storage	Filters are placed in centrifuge tube wrapped in foil square and stored on dry ice in field. Samples are shipped on wet ice along with water chemistry.	Qualify sample as suspect

5.2.5 Data Review

Checks made of the data in the process of review and verification are summarized in Table 5.9. The Project QA Coordinator is ultimately responsible for ensuring the validity of the data, although performance of the specific checks may be delegated to other staff members. Field QC samples (duplicates and blanks) will be reviewed by the Project QA coordinator using relevant DQO detailed in the MassDEP QAPP for Surface Water Monitoring and Assessment prior to submittal to MassDEP's external data portal, WQX or other relevant data sharing platform (MassDEP 2020).

Table 5.9. Data Validation Quality Control for Water Chemistry Indicators

Activity or Procedures	Requirements and Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Corrective reporting errors
Review holding times	Qualify value for additional review
Review data from QA samples (lab PE samples, and interlaboratory comparison samples)	Determine impact and possible limitations on overall usability of data
Review data from field QC samples (duplicates and blanks)	Determine impact and possible limitations on overall usability of data

5.3 Benthic Invertebrates

5.3.1 Introduction

Benthic invertebrates inhabit the sediment (infauna) or live on the bottom substrates or aquatic vegetation (epifauna) of coastal areas. The response of benthic communities to various stressors can often be used to determine types of stressors and to monitor trends (Klemm et al., 1990). The overall objectives of the benthic invertebrate indicators are to detect stresses on community structure in coastal and estuarine waters and to assess and monitor the relative severity of those stresses. The benthic invertebrate indicator procedures are based on various bioassessment literature (Barbour et al. 1999, Hawkins et al. 2000, Klemm et al. 2003), and on previous coastal surveys (EPA 2014).

The following sections are described in detail in the Marine Benthic Infauna Sorting and Taxonomic Identification QAPP and in the Laboratory Standard Operating Procedures developed by Normandeau Associates (May 2020). These documents are provided in Appendix 6.

5.3.2 Sample Collection Methods

Detailed sample collection and handling procedures are described in the MCCA Field Operations Manual and in Appendix 6 of this document. The samples are collected using a Van Veen grab. The samples are preserved in the field with formalin and delivered or shipped to the laboratory for sorting and taxonomic identification.

5.3.3 Laboratory QA/QC Procedures

The laboratory procedures used for sorting and taxonomic identification of microbenthic organisms are consistent with the laboratory procedures outlined in the National Coastal Condition Assessment (NCCA) 2015 Laboratory Operations Manual (EPA 2014). The methods, including QA/QC, are described in detail in the Appendix A (Laboratory Standard Operating Procedures) to Marine Benthic Infauna Sorting and Taxonomic Identification QAPP developed by Normandeau (Appendix 6).

The specific quality control procedures used by the laboratory are implemented to ensure that:

- Objectives established for various data quality indicators being met.
- Results are consistent and comparable among all participating laboratories.

The laboratories will follow the QA/QC procedures outlined in the laboratory's approved QAPPs. Quality control procedures include: 1) internal QC for sorters (10% of all samples), and 2) internal QC for taxonomists identifying benthic invertebrates (10% of samples per taxonomist).

5.3.3.1 Laboratory Performance Requirements

DQOs are described in Table 5.10. Precision is calculated as percent efficiency, estimated from examination of randomly selected sample residuals by a second analyst and independent identifications of organisms in randomly selected samples.

The DQOs for the analysis of benthic infauna are: 1) all samples will be processed, 2) all animals will be removed for identification and enumeration, 3) all infaunal animals will be counted accurately, 4) the taxonomic identifications will be accurate (correct), and 5) the identifications will correspond to those used throughout the project or the current consensus of the scientific community as documented by the World Register of marine Species (WoRMS) or an equivalent source. At least 95% of all infaunal animals must be removed from a sample to pass the QC evaluation (Appendix 6, Section B3).

Table 5.10. Data Quality Objectives: Benthic Macroinvertebrates

Variable or measurement	Precision	Accuracy
Sort and Pick	95%	95%
Identification	85%	95%

5.3.3.2 Laboratory QC Requirements

Quality Control Requirements for the benthic invertebrate indicator are provided in Table 5.11 and Table 5.12.

Table 5.11 Laboratory Quality Control: Benthic Macroinvertebrates

Check or sample description	Frequency	Acceptance Criteria	Corrective Action
Sample Processing and Sorting			
Sample pickate examined by another sorter	10% of all samples	PSE \geq 95%	If < 95%, examine all residuals of samples by sorter and retrain sorter
Identification			
Duplicate identification by Internal Taxonomy QC Officer	10% samples	PTD \leq 10%	If PTD > 10%, reidentify all samples completed by that taxonomist focusing on taxa of concern
Independent identification	All uncertain taxa	Uncertain identifications to be confirmed by expert in particular taxa	Record both tentative and independent IDs
External QC	10% of all samples completed per laboratory	PDE \leq 5% PTD \leq 15%	If PDE > 5%, or if PTD > 15%, implement recommended corrective actions.
Data validation			
Taxonomic "reasonableness" checks	All data sheets	Taxa known to occur for coastal waters.	Second or third identification by expert

Table 5.12. Sample Receipt and Processing Quality Control: Benthic Invertebrate Indicator

QC Activity	Description and Requirements	Corrective Action
Sample Log-in	Upon receipt of a sample shipment, receipt of samples is recorded.	Discrepancies, damaged, or missing samples are reported to Project Co-Leads.
Sample condition upon receipt	Sample issues such as cracked container; missing label; preservation	Qualify samples
Sample storage	Store benthic samples in a cool, dark place.	Qualify samples as suspect
Preservation	Transfer storage to 70% ethanol for long term storage	Qualify samples
Holding time	Preserved samples can be stored indefinitely; periodically check jars and change the ethanol if sample material appears to be degrading.	Qualify samples

5.3.4 Field QA/QC Procedures

Field data quality is addressed, in part, by application and consistent performance of valid procedures documented in the MCCA Field Operations Manual. The Field Crew provides comments on the Sediment Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity. Before leaving the field, the Field Crew will:

- Check the label to ensure that all written information is complete and legible.
- Place a strip of clear packing tape over the label, covering the label completely.
- Record the sample ID number assigned to the benthic invertebrate sample on the Sample Collection Form.
- Provide comments on the Sediment Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity.
- Preserve the sample with buffered formalin.
- Recheck all forms and labels for completeness and legibility

5.3.4.1 Field QC Requirements

Specific quality control measures are listed in Table 5.13 for field quality control requirements.

Table 5.13. Sample Collection and Field Processing QC: Benthic Macroinvertebrates

QC Activity	Description and Requirements	Corrective Action
Check integrity of sample containers and labels	Clear, Intact containers and labels	Obtain replacement supplies
Sample processing (field)	Use 0.5 mm mesh sieve. Preserve with 10% buffered formalin. Fill jars no more than 1/2 full to reduce the chance of organisms being damaged.	Discard and recollect sample
Sample storage (field)	Store benthic samples in a cool, dark place until shipment to analytical lab	Discard and recollect sample
Holding time	Preserved samples can be stored indefinitely; periodically check jars and change the ethanol (change from formalin to ethanol for long term storage).	Change 85% ethanol if sample material appears to be degrading
Preservation	Transfer storage to 85% ethanol for long term storage	Qualify samples

5.3.5 Data Review

Checks made of the data in the process of review and verification is summarized in Table 5.14. The CCA Project QA Coordinator is responsible for ensuring the validity of the data.

Table 5.14. Data Validation Quality Control for Benthic Macroinvertebrates

Activity or Procedure	Requirements and Corrective Action
Review data and reports from labs	Determine impact and possible limitations on overall usability of data
Review data and reports from external QC Coordinators	Determine impact and possible limitations on overall usability of data
Review taxonomic names and spelling	Correct and qualify

5.4 Sediment Contaminants, Total Organic Carbon (TOC), and Grain Size

5.4.1 Introduction

The Field Crew will collect sediment grabs for chemical analyses (organics/metals and TOC), and grain size determination.

5.4.2 Sample Collection Methods

Detailed sample collection and handling procedures are described in the MCCA Field Operations Manual.

5.4.3 Laboratory QA/QC Procedures

Detailed laboratory methods are described in the laboratory QAPPs (Appendix 3).

A single laboratory will analyze the sediment contaminants, TOC and grain size samples. The specific quality control procedures used are implemented to ensure that:

- Objectives established for various data quality indicators being met.
- Results are consistent and comparable among all participating laboratories.

The laboratory will follow the QA/QC procedures outlined in the laboratory's approved QAPP.

5.4.3.1 Laboratory Performance Requirements

The laboratory shall perform analysis of the sediment samples to determine the moisture content, grain size, and concentrations of TOC, metals, pesticides, PAHs, and PCBs.

To demonstrate its competency in analysis of sediment samples, the laboratory shall provide analyte and matrix specific information to MassDEP and MassBays. For example, a demonstration of competency with sediment samples in achieving the method detection limits, accuracy, and precision targets. To demonstrate its competency in QA/QC procedures, the laboratory shall provide Project Co-Leads with copies of approved QAPPs, and applicable SOPs (Appendix 3).

Precision and accuracy objectives are identified in Table 5.15. Table 5.16 identifies the storage requirements. Laboratories will use the analytical methods, which measures the parameters to the levels of the method detection limits identified in Table 5.17.

Table 5.15. DQOs: Sediment Contaminants, Grain size and TOC (Precision and Accuracy)

Parameter/Method	Precision Objective	Accuracy Objective
All contaminants	30% (RPD between MS and MSD)	20% (average %Rs between MS and MSD)
TOC	10% (RPD between duplicates)	10% (CRM)
Grain size	10% (LCS)	Not applicable

* RPD=Relative Percent Difference; %Rs=%Recovery; MS=Matrix Spike; MSD=Matrix Spike Duplicate; CRM=Certified Reference Material; LCS=Lab Control Sample.

Table 5.16. DQOs: Sediment Contaminants, Grain Size, and TOC (MDL Targets)

Type	Parameter	Units	MDL Target
	Grain size	% sand and % silt/clay	0.05%
	TOC	mg/kg	0.01%
Metals ¹¹	Aluminum	dry weight µg/g (ppm)	1500
	Arsenic		1.5
	Cadmium		0.05
	Mercury		0.01
	Chromium, Copper		5.0
	Iron		500
	Lead, Manganese, Nickel, Vanadium		1.0
	Selenium, Tin		0.1
	Silver		0.3
	Zinc		2.0
Organics	PCBs	dry weight ng/g (ppb)	1.0
	PEST	dry weight ng/g (ppb)	1.0
	PAHs	dry weight ng/g (ppb)	10

Table 5.17. Analytical Methods: Sediment Contaminants, Grain Size, and TOC

Storage Requirements	Type	Example methods that meet QA/QC
Freeze samples to a temperature ≤ -20°C	Metals (except Mercury)	Extraction: EPA Method 3051A Analysis: EPA Method 6020B
	Mercury	EPA Method 245.7
	PCB, Pesticides	EPA Method 8081B; 8270D-SO</680(M)
	PAHs	EPA Method 8270D
	TOC	Lloyd Kahn Method
Refrigerate at 4°C (do not freeze)	Grain size	D6913/D7928

5.4.4 Field QA/QC Procedures

Field data quality is addressed, in part, by application and consistent performance of valid procedures documented in the MCCA Field Operations Manual. That quality is enhanced by the training and experience of project staff and documentation of sampling activities. The Field Crew will collect a sediment sample for sediment contamination, TOC and grain size analyses. The Field

¹¹ This list may not be completely representative of the list of metals analyzed. Complete list to be provided by Normandeau and Alpha Analytics

Crew will verify that all sample containers are uncontaminated and intact, and that all sample labels are legible and intact.

Before leaving the field, the Field Crew will:

- Check the label to ensure that all written information is complete and legible.
- Place a strip of clear packing tape over the label, covering the label completely.
- Record sample ID number on the Sediment Collection Form.
- Provide comments on the Sediment Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity.
- Store the sediment contaminants and TOC samples on dry ice. Store grain size samples on wet ice.
- Recheck all forms and labels for completeness and legibility.

5.4.4.1 Field Quality Performance Requirements

Any contamination of the samples can produce significant errors in the resulting interpretation. The Field Crew must take care not to contaminate the sediment with the tools used to collect the sample (i.e., the sampler, spoons, mixing bowl or bucket) and not to mix the surface layer with the deeper sediments. Prior to sampling at each site, the Field Crew must clean the sampler and collection tools that will come into contact with the sediment with Alconox and rinse them with ambient water at the site. Field processing quality control requirements can be found in Table 5.18 and Table 5.19.

Table 5.18. Sample Collection and Field Processing QC: Sediment Contaminant Indicator

QC Activity	Description and Requirements	Corrective Action
Check integrity of sample containers and labels	Clean, intact containers and labels.	Obtain replacement supplies
Sample storage (field)	Store sediment samples on ice and in a dark place (cooler).	Discard and recollect sample
Shipping time	Samples kept on ice until delivery	Deliver to lab

Table 5.19. Sample Collection and Field Processing QC: Sediment TOC and Grain Size

QC Activity	Description and Requirements	Corrective Action
Check for homogeneity	Sample must be homogeneous.	Mix sample for a longer period of time
Check integrity of sample containers and labels	Clean, intact containers and labels.	Obtain replacement supplies
Sample storage (field)	Store sediment samples on ice and in a dark place (cooler).	Discard and recollect sample
Shipping time	Samples kept on ice until delivery	Deliver to lab

5.4.5 Data Review

Checks made of the data in the process of review and verification is summarized in Table 5.20. The Project QA Coordinator is ultimately responsible for ensuring the validity of the data, although

performance of the specific checks may be delegated to other staff members. Field QC samples (duplicates and blanks) will be reviewed by the Project QA coordinator using relevant DQO detailed in the MassDEP QAPP for Surface Water Monitoring and Assessment prior to submittal to MassDEP's external data portal, WQX or other relevant data sharing platform (MassDEP 2020).

Table 5.20. Data Validation RC for Sediment Contaminants, TOC and Grain Size Indicators

Activity or Procedure	Requirements and Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box & whisker plots)	Correct reporting errors or qualify as suspect or invalid.
Review holding times	Qualify value for additional review
Review data from QA samples (laboratory PE samples, and interlaboratory comparison samples)	Determine impact and possible limitations on overall usability of data
Review data from field QC samples (duplicates)	Determine impact and possible limitations on overall usability of data

5.5 Sediment Toxicity

5.5.1 Introduction

Toxicity tests will be completed on sediments from marine and estuarine environments. Tests determine toxicity, in terms of survival rate of amphipod crustaceans, in whole sediment samples.

5.5.2 Sample Collection Methods

Detailed sample collection and handling procedures are described in the MCCA Field Operations Manual.

5.5.3 Laboratory QA/QC Procedures

A single laboratory will analyze the sediment toxicity. The specific quality control procedures used are implemented to ensure that objectives established for various data quality indicators are being met. The laboratory will follow the QA/QC procedures outlined in the lab's approved QAPP and the methods outlined in the laboratory's SOPs (Appendix 4 and Appendix 5).

5.5.3.1 Laboratory Performance Requirements

The laboratory may choose to use any analysis method using the organisms *Leptocheirus plumulosus*. Mean survival of the control's treatments must remain greater than or equal to 80% and 90%, respectively. At a minimum, the laboratory must:

- Perform the procedures using the 10-day tests. E.g. Test Method 100.4 in EPA 600/R-94/0257 or ASTM E1367-038
- Test 5 replicates with 20 organisms per replicate (for each sample and control).
- Test no more than 10 samples and one control within each batch.
- Select organisms for each batch of tests that are: a. From the same culture, b. Cultured at the same temperature as will be used for the tests
- Use a water source (for the overlying water) demonstrated to support survival, growth, and reproduction of the test organisms (175 mL of sediment and 800 mL of overlying seawater)

- Use clean sediment for control tests.
- For exposure/feeding, implement: Exposure is static (i.e., water is not renewed), and the animals are not fed over the 10-day exposure period
- Follow the following procedure for homogenization/sieving: Water above the sediment is not discarded but is mixed back into the sediment during homogenization. Sediments should be sieved (following the 10-day method) and the sieve size should be noted).

5.5.4 Field QA/QC Procedures

Field data quality is addressed, in part, by application and consistent performance of valid procedures documented in the MCCA Field Operations Manual. The Field Crew will verify that all sample containers are uncontaminated and intact, and that all sample labels are legible and intact. Before leaving the field, the Field Crew will:

- Check the label to ensure that all written information is complete and legible.
- Place a strip of clear packing tape over the label, covering the label completely.
- Record the sample ID assigned to the sediment sample on the Sediment Collection Form.
- Provide comments on the Sediment Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity.
- Store the sample on wet ice.
- Recheck all forms and labels for completeness and legibility.

5.5.4.1 Field Quality Control Requirements

Any contamination of the samples can produce significant errors in the resulting interpretation. The Field Crew must take care not to contaminate the sediment with the tools used to collect the sample (i.e., the sampler, spoons, mixing bucket) and not to mix the surface layer with the deeper sediments. Prior to sampling at each site, Field Crew must clean the sampler and collection tools that will come into contact with the sediment with Alconox and rinse them with ambient water at the site. Field processing quality control requirements are summarized in Table 5.21.

Table 5.21. Sample Collection and Field Processing QC: Sediment Toxicity Indicator

QC Activity	Descriptions and Requirements	Corrective Action
Check integrity of containers/labels	Clean, intact containers and labels.	Obtain replacement supplies
Sample Volume	Preferred maximum volume 2000 mL; minimum volume 900 mL	Qualify samples if less than 900 mL available to submit to lab
Sample Storage (field)	Store sediment samples on wet ice and in a dark place (cooler).	Discard and recollect sample
Holding time	Refrigerated samples delivered on wet ice within 1 week of collection.	Qualify samples

5.5.5 Data Review

Checks made of the data in the process of review, verification, and validation are summarized in Table 5.20. The Project QA Coordinator is responsible for ensuring the validity of the data. Field QC

samples (duplicates) will be reviewed by the Project QA coordinator using relevant DQO based on EPA (EPA 2014) and other sources prior to submittal to WQX and platforms.

Table 5.22. Data Validation Quality Control: Sediment Toxicity

Activity or Procedure	Requirements and Corrective Action
Summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Correct reporting errors or qualify as suspect or invalid.
Review data from reference toxicity samples	Review data from reference toxicity samples
Review data from field QC samples (duplicates)	Determine impact and possible limitations on overall usability of data

6. FIELD AND BIOLOGICAL QUALITY EVALUATION AND ASSISTANCE

MassDEP and MassBays qualified staff will conduct an evaluation and assistance visits with the Field Crew early in the sampling and data collection process, if possible, and corrective actions will be conducted in real time. This visit provides an opportunity to conduct procedural reviews, as required, minimizing data loss due to improper technique or interpretation of field procedures and guidance. The visit also provides the Field Crew with an opportunity to clarify procedures and offer suggestions for future improvements based on their sampling experience preceding the visit. If unforeseen events prevent MassDEP and MassBays from evaluating the Field Crew, the Project QA Coordinator will rely on the data review and validation process to identify unacceptable data that will not be included in the final database. The purpose of this on-site visit will be to identify and correct deficiencies during field sampling operations. The process will involve preparation activities, field day activities and post field day activities as described in the following sections. Additionally, conference calls with Field Crew may be held approximately every two weeks to discuss issues as they come up throughout the sampling season.

One of the important parts of the MCCA project is to make sure that data are collected consistently over the years. The role of the Evaluators is to ensure that the procedures are being performed consistent with the MCCA Field Operations Manual, all data are recorded correctly, and paperwork is properly completed at the site.

MassDEP and MassBays evaluators will schedule the field evaluation visit in consultation with the Normandeau Project Manager and the Field Crew ideally within the first month of sampling. On arrival, the evaluators will review the checklist with the Field Crew during the field sampling day and establish a plan and schedule for their evaluation activities for the day. During the evaluation, the evaluators will observe the performance of the Field Crew through one complete set of sampling activities, take note of errors the Field Crew makes and immediately point these out to correct the mistake, and reviews the results of the evaluation with the Field Crew before leaving the site, noting positive practices, lessons learned, and concerns.

The Evaluators will:

- Observe all pre-sampling activities and verify that equipment is properly calibrated and in good working order, and protocols are followed
- Check the sample containers to verify that they are the correct type and size, and check the labels to be sure they are correctly and completely filled out
- Confirm that the Field Crew has followed MCCA protocols for locating the X-site
- Observe the index site sampling, confirming that all protocols are followed
- Observe the littoral sampling and habitat characterization, confirming that all protocols are followed
- Record responses or concerns, if any, on the Field Evaluation and Assistance Checklist

If the Evaluators observe that the Field Crew is not performing the procedures correctly, safely, or thoroughly, they will work with the Field Crew to ensure that the sampling is conducted properly so that data quality is not adversely affected. If the Field Crew misses or incorrectly performs a procedure, the Evaluators will note this on the checklist and point this out so the mistake can be corrected on the spot.

When the sampling operation has been completed, the Evaluators will review the results of the evaluation with the Field Crew before leaving the site (if practicable), noting positive practices and problems (i.e., weaknesses [might affect data quality]; deficiencies [would adversely affect data quality]). The Evaluators will review the list and record responses or concerns from the Field Crew, if any; on the checklist. The Field Crew Leader will sign the checklist after this review.

7. DATA ANALYSIS PLAN

7.1 Introduction

The goal of the MCCA is to address two key questions about the quality of the Massachusetts coastal waters:

- What percent of coastal waters are in a good condition to support aquatic life use?
- What is the relative importance of key stressors in impairing aquatic life use in coastal waters?

The Data Analysis Plan describes the approach used to process the data generated during the field survey to answer these questions. Results from the analysis will be included in a final report and used in future analysis.

The intent of data analyses is to describe the occurrence and distribution of selected indicators throughout the estuaries and coastal waters in Massachusetts. The analyses will identify the condition of coastal waters. Statistical analysis techniques appropriate for using data collected using probabilistic survey designs will be used for interpreting survey results. However, other data

analyses may be used for further assessments according to the respective needs of MassDEP and MassBays.

Sampling locations for the MCCA survey were selected using a probability-based design associated with rules for selection to meet certain distribution criteria. It was important to ensure that the design yields a set of coastal areas that would provide for statistically valid conclusions about the condition of coastal areas across the state.

7.2 Datasets

The datasets used for the final MCCA report evaluating the coastal condition of Massachusetts will consist of data collected during the MCCA project (2020 – 2023). Subsets of the overall MCCA dataset may be used by MassDEP or MassBays to assess individual assessment units or areas. Other data (e.g. tides) may be used as appropriate.

7.3 Indicators for the Coastal Assessment

7.3.1 Water Chemistry and Chlorophyll

A wide array of water chemistry parameters will be measured. Water chemistry analysis is critical for interpreting the biological indicators. Chlorophyll-a, Secchi depth, light attenuation and nutrient measurements will be analyzed and evaluated using the relevant Massachusetts surface water quality criteria and assessment guidance (MassDEP 2018).

7.3.2 Benthic Invertebrates

To distinguish degraded benthic habitats from undegraded benthic habitats, regional benthic indices and thresholds of environmental condition have been developed by EPA for the NCCA 2010. Benthic invertebrate from the MCCA project will analyzed and evaluated using the appropriate regional indices and thresholds reliable sources including NCCA technical documents (EPA 2016; Hale and Heltshe, 2008; Paul et al., 2001).

7.3.3. Sediment Chemistry/Characteristics

The MCCA survey is collecting sediment samples, measuring the concentrations of chemical constituents and percent TOC in the sediments, and evaluating sediment toxicity as described in the QAPP and Field Operations Manual. The results of these measurements and evaluations will be analyzed and evaluated using appropriate Massachusetts surface water quality criteria and assessment guidance (MassDEP 2018). The results of these evaluations will be used to identify the percent of coastal waters with sediment contamination. The sediment quality index is based on measurements of three component indicators of sediment condition: sediment toxicity, sediment contaminants, and sediment TOC (EPA 2016). This information will also be used in identifying stressors to ecological/biological condition.

7.3.4 Submerged Aquatic Vegetation Eelgrass

The presence/absence and percent cover of eelgrass will be measured. The measurement will be used to evaluate the percent of coastal waters with eelgrass and its relative cover. Habitat suitability will be explored to determine if an estimate of eelgrass absence when suitable habitat exists can be determined for Massachusetts coastal waters.

8. RELATED DOCUMENTS

MassDEP (2020) Site Evaluation Guidelines for MAP2, Coastal Waters (CN527.00)

MassBays & MassDEP (April 2020) MCCA Field Operations Manual (CN528.00)

REFERENCES

Hale, S.S., and J.F. Heltshe. 2008. *Signals from the benthos: Development and evaluation of a benthic index for the nearshore Gulf of Maine*. Ecological Indicators 8:338–350.

MassDEP. 2005a. *CN 0.44 Lab Data Elements*. November 2005. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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MassDEP. 2018. *CN 455.0 - Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual for the 2018 Reporting Cycle*. May 2018. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

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USEPA. 2002. *Guidance for Quality Assurance Plans EPA240/R-02/009*. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

USEPA. 2014. *National Coastal Condition Assessment Quality Assurance Project Plan*. United States Environmental Protection Agency, Office of Water, Office of Wetlands, Oceans and Watersheds. Washington, D.C. EPA 841-R-14-005.

USEPA. 2016. *NCCA 2010 Technical Report National Coastal Condition Assessment*. January 2016. Environmental Protection Agency. Washington, DC.

Appendix 1. MCCA Survey Design

**Massachusetts Department of Environmental Protection
Massachusetts Bays National Estuary Program
Massachusetts Coastal Condition Assessment (MCCA)
Survey Design 2020 – 2023**

Target Population

The target population for this survey is a combination of all coastal waters within:

- 1) Massachusetts Department of Environmental Protection (MassDEP) estuarine assessment units
- 2) Massachusetts Bays National Estuary Program (MassBays) estuarine assessment units
- 3) A near-shore seaward boundary defined by a maximum distance from Massachusetts shoreline of 3 miles and a maximum depth of 10 meters

Excluded from the target population are any tidal rivers or streams that are only represented in GIS by polylines versus polygons (i.e. small tidal streams and ditches) and any areas classified as intertidal estuarine or marine wetland in the National Wetland Inventory (NWI). The term “coastal waters” in the remainder of this document refers to all waters within the target population.

Sample Frame

The sample frame was derived from GIS coverages of the 2016 MassDEP estuarine assessment units, 2017 MassBays estuarine assessment units, 1999 MassGIS Bathymetry of the Gulf of Maine, MassGIS Massachusetts shoreline, and a 3-mile buffer of the shoreline. The bathymetric map and 3-mile buffer coverages were used to identify areas seaward of the shoreline that are less than 10 meters in depth and less than 3 miles from shore. Any polygons not contiguous with the shoreline (i.e. isolated shallow locations within the 3-mile buffer) were eliminated from the sample frame. The sample frame contains some areas (approx. 130 sq. km) classified as intertidal estuarine or marine wetland in the National Wetland Inventory (NWI) that were not removed due to uncertainty regarding the delineated boundaries. Target population determinations for sites selected in these areas will be determined on a case-by-case during site evaluations.

Survey Design

A Generalized Random Tessellation Stratified (GRTS) survey design for an area resource is used with regional stratification and unequal probability of selection based on polygon classification. The details are given below.

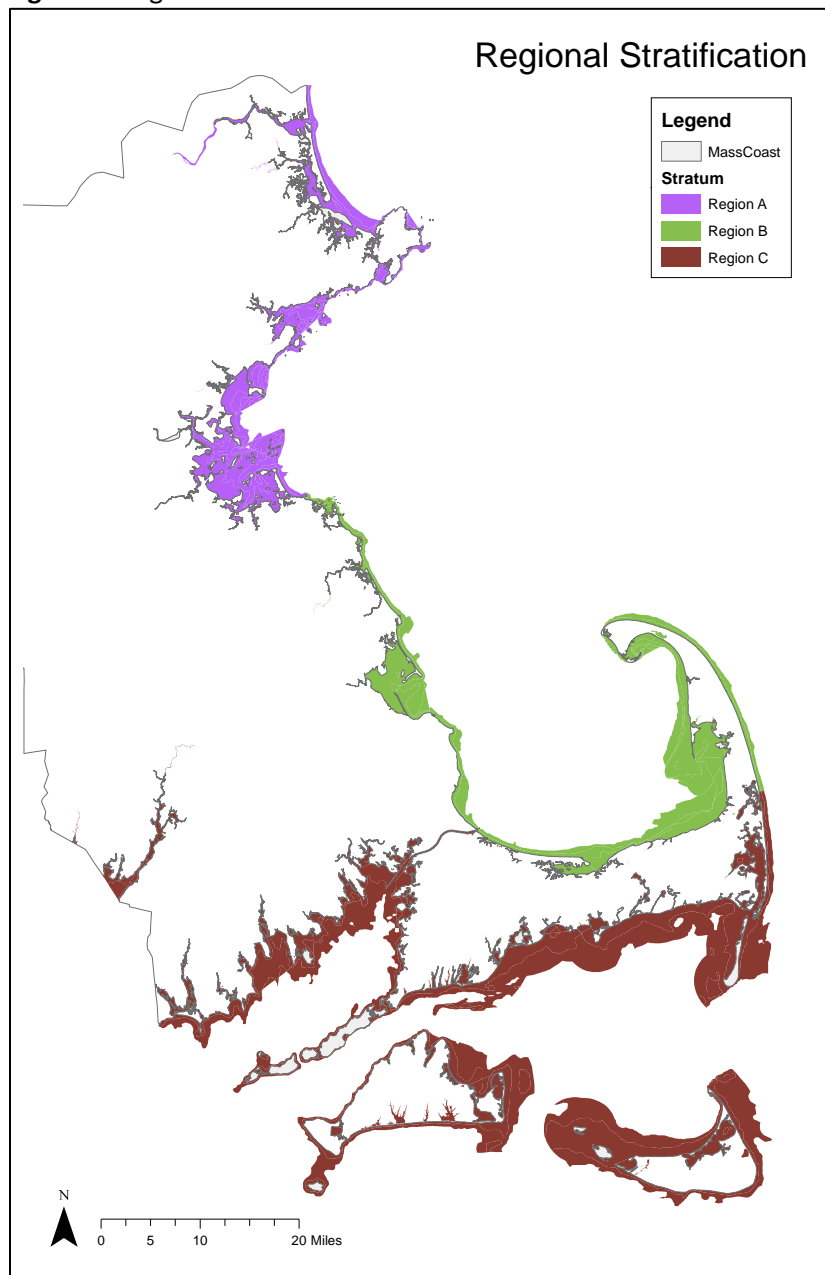
Stratification

The survey design is stratified by three geographic regions within Massachusetts to improve sampling logistics (Figure 1). One region will be targeted and sampled each year from 2021 to 2023, starting with the Region A in 2021 and concluding with Region C in 2023. A pilot project will be conducted in 2020 in multiple strata using a small subset of the selected primary sites to test sampling methodology.

Table 1. Regional strata descriptions

Stratum	Major Basin Description
Region A	Merrimack, Parker, Ipswich, North Coastal, Boston Harbor
Region B	South Coastal, North Cape Cod (Cape Cod Bay)
Region C	South Cape Cod (Nantucket Sound), Islands, Buzzards Bay, Narragansett Bay, Mount Hope Bay

Figure 1. Regional strata



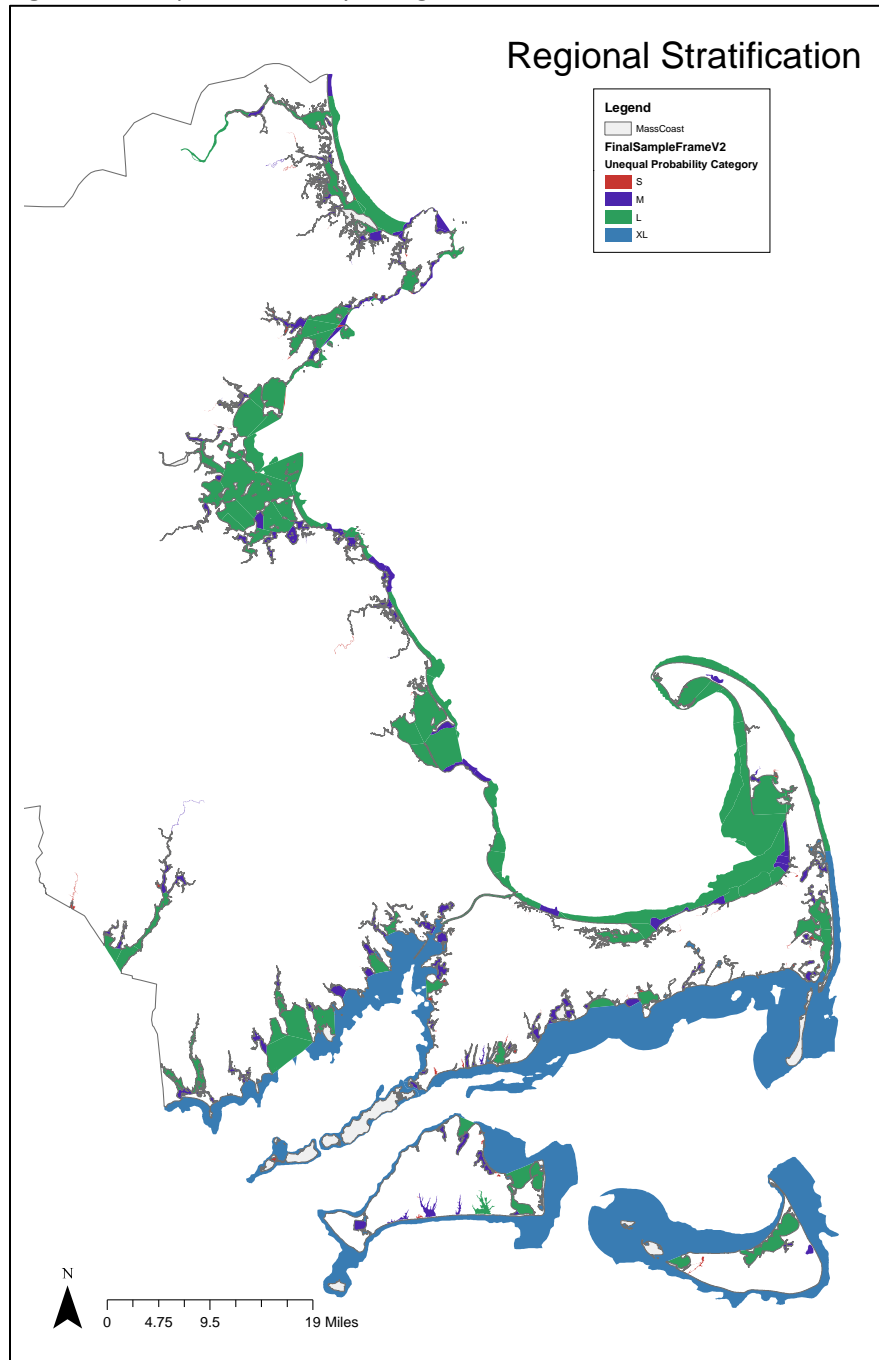
Unequal Probability Categories

The MAP2 estuaries design is an unequal probability design within each regional stratum. Unequal probability categories were created based on the area of each polygon/estuary segment to ensure the selection of sites in smaller polygon/estuary segments. Region B and C were divided into 4 size categories while Region A was divided into just 3 size categories (Figure 2). Unequal probability category targets categories were set to allow sufficient sites for analysis with and without the XL size category.

Panels

This survey design has a single panel.

Figure 2. Unequal Probability Categories



Expected Sample Size

The designed sample size is a total of 90 sites for the state with 30 sites in each stratum. In addition, 60 oversample sites were selected in each stratum. It is expected that 10-15 of the sites (approx. 3-5 in each strata) will be sampled during the pilot project in 2020. The remaining 75 – 80 sites will be sampled from 2021 – 2023 (approx. 25 sites per year), starting with the Region A in 2021 and concluding with Region C in 2023.

Site Use and Replacement

Each site selected to be sampled is given unique site identification (siteID). Site numbers consist of the project abbreviation (MAP2E) and a number between 001 and 270. Within each regional stratum, the total list of sites evaluated for potential sampling must have all site IDs from the largest to the lowest number evaluated (i.e. none can be skipped). For example, if MAP2E-178 is the largest site ID evaluated within the Region C stratum, then all site IDs that are lower than 178 within the Region C stratum must be evaluated. Even more critical is that if MAP2E-178 is the largest site ID that is actually sampled in the field, then all lower site IDs within the Region C stratum that are evaluated to be within the target population and are accessible must also be sampled in the field.

Sample Frame Summary

	Categories (sq. km)				
Stratum	Small (0-0.4 km ²)	Medium (0.4-2.9 km ²)	Large (2.9-100 km ²)	X – Large (>100 km ²)	Total
Region A	5	55	294	0	354
Region B	4	40	278	101	423
Region C	12	74	180	998	1264
Total	5	55	294	0	354

Site Selection Summary

		Categories				
	Stratum	Small (0-0.4 km ²)	Medium (0.4-2.9 km ²)	Large (2.9-100 km ²)	X – Large (>100 km ²)	Total
Primary	Region A	5	10	15	NA	30
	Region B	4	16	8	2	30
	Region C	5	8	9	8	30
	Total	14	34	32	10	90
Oversample	Region A	10	25	25	NA	60
	Region B	11	22	22	5	60
	Region C	13	21	18	8	60
	Total	34	68	65	13	180

Description of Sample Design Output

Variable Name	Description
siteID	Unique identification label for each site in the sample
Longitude	Site location longitude in decimal degrees coordinates (see projection below for datum).
Latitude	Site location latitude in decimal degrees coordinates (see projection information below).
xcoord	X-coordinate of the site (see projection information below)
ycoord	Y-coordinate of the site (see Albers projection information below)
mdcaty	Multi-density categories used for unequal probability selection
weight	Weight, inverse of inclusion probability, to be used in statistical analyses
stratum	Strata used in the survey design
panel	Identifies and Oversample
EvalStatus	Site evaluation decision for site: TS: target and sampled, LD: landowner denied access, etc. (see below)
EvalReason	Site evaluation text comment
auxiliary variables	Remaining columns are from the sample frame provided

Appendix 2. EDD Template and Data Elements

The following is an example list of **COMMON PROBLEMS** with EDDs:

- Significant figures have been and continue to be a problem – When discussing reporting with any laboratory, it should be emphasized that Significant figures should be addressed in any report they send us. Common problems include shaving off trailing zeros (0.10 turns into 0.1) or adding or keeping digits beyond appropriate (0.102 when the MDL is given as 0.02)
- Values for MDL and RDL should be reported with ALL results to the correct # of sig figs – Not just results for which they are encountered (Exception might be for bacteria results?). Also, a lab should have a standardized way of reporting MDL and RDL and should define them with respect to the results (i.e. How they determine MDL and RDL and if they interpolate results down to the MDL or if they extrapolate down to the MDL)

LAB DATA ELEMENTS

Lab Code: (Required)

Available choices include:

- DWM-CERO
- DWM-WERO
- DWM-SERO
- DWM-NERO
- OTHER (as approp.)

Lab Sample Number: (Required)

Sample ID assigned to sample by the lab.

Field Sample Number: (Required)

Field sample number assigned to sample in the field by the field crew and provided to the lab on laboratory paperwork (i.e. Chain of Custody Sheets)

Analyte/Characteristic: (Required)

Analyte/compound for which result is to be reported.

Sample Fraction: (Required)

Fraction of sample being analyzed (i.e. Total, dissolved)

Result: (Required) report *as text field*

Result or outcome of analysis of sample reported to the correct number of significant digits. The following is a list of desired entries in this field:

[Result]	A numeric result (in text format), reported to correct number of significant figures
<MDL	Result is less than the Method Detection Limit

<RDL	Result is less than Reporting Detection Limit
>UQL	Result is greater than Upper Quantification Limit
**	Missing result for administrative reason – i.e. broken bottle
##	Result censored following laboratory QAQC criteria

Lab Qualifier: (Conditional)

Laboratory specific flag indicating qualification of a result. Required if a result is reported as “##” (Censored)

Result Comments: (Conditional)

Laboratory comment related to a specific result - required if result is to be reported as “**” (Missing) or “##” (Censored)

Include sample/analytical information, such as dilutions, unusual observations, above average sample color/turbidity/sediments, etc.

Units: (Required)

Reporting units for result or outcome (i.e. mg/L, ug/L, CFU/100ml)

MDL: (Required) report *as text field*

Method Detection Limit, reported to correct number of significant figures
The following is a list of desired entries in this field:

[MDL Value]	A numeric result, reported to correct number of significant figures
**	Missing result for administrative reason
##	MDL value censored following laboratory QAQC criteria

RDL: (Required) report *as text field*

Reporting Detection Limit, reported to correct number of significant figures
The following is a list of desired entries in this field:

[RDL Value]	A numeric result, reported to correct number of significant figures
**	Missing result for administrative reason
##	RDL value censored following laboratory QAQC criteria

UQL: (Conditional) report *as text field*

Upper quantification limit – required if a result is to be reported as “>UQL” (Result is greater than Upper Quantification Limit) reported to correct number of significant figures (i.e. Too Numerous to Count – TNTC- should be reported “>UQL” in the Result column while indicating in the UQL field the value above which it cannot be counted)

Analytical Method: (Required)

Analytical method of results to be reported.

Analysis Date: (Required)

Date that sample was analyzed (Use an analysis date consistent with determining holding times)

Analysis Time: (Required)

Time that sample was analyzed in 24hr format (Use an analysis time consistent with determining holding times)

Site Locator: (Optional)

Site or Station location information provided by field sampling crew

Collection Date: (Optional)

Date that sample was collected by field crew

Collection Time: (Optional)

Time that sample was collected by field crew

Appendix 3. Alpha Analytical, Inc. Quality Systems Manual

Appendix 4. Enthalpy Analytical Toxicological Evaluation of Sediments for the NCCA

Appendix 5. EnviroSystems (Enthalpy Analytical) Laboratory Quality Assurance Manual

Appendix 6. Normandeau Associates, Inc. Marine Benthic Infauna Sorting and Taxonomic Identification: Quality Assurance Project Plan