Quality Assurance Project Plan for Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts

2007-2010

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1.0 Project Management

1.1 Distribution List

MassDEP, Director Wetlands & Waterways Program – Lealdon Langley
MassDEP, Wetland Program Chief – Michael Stroman
MassDEP, Environmental Analyst, MassDEP Project Manager – Lisa Rhodes
MassDEP, Quality Assurance Officer – Richard Chase
MassDEP, Advisor/Field Scientist – James Sprague
MassDEP, Advisor/Field Scientist – Michael McHugh
EPA, -- Mathew Schweisberg
EPA, -- Jeanne Voorhees
EPA, -- Steve DiMattei
UMass CAPS Project Manager - Dr. Kevin McGarigal
UMass CAPS QA Manager – Scott Jackson
UMass CAPS Computer Data QA Manager – Brad Compton
CZM Project Manager – Marc Carullo
CZM QA Manager – Jan Smith
CZM Macroinvertebrate Field/Lab Scientist – Adrianne Pappal
SSCW Macroinvertebrate Field/Lab Scientist – Barbara Warren

1.2 Project/Task Organization

The participating individuals and/or organizations and their roles include:

Jeanne Voorhees – EPA Project Manager – oversee involvement of EPA personnel and project commitments.

Steve DiMattei- EPA QA Officer- participate in the development and implementation of QA/QC procedures for the project.

Lisa Rhodes - MassDEP Project Manager/Field Scientist – oversee the involvement of MassDEP personnel and project commitments.

James Sprague – MassDEP Advisor / Field Scientist – participate in data review and decision-making relative to CAPS and SLAM development; also responsible for field data collection.

Michael McHugh – MassDEP Advisor / Field Scientist – participate in data review and decision-making relative to CAPS and SLAM development; also responsible for field data collection.

Richard Chase – MassDEP QA Officer – participate in the development and implementation of QA/QC procedures for the project.

Lealdon Langley – MassDEP Advisor/Reviewer – participate in data review and decision-making relative to CAPS and SLAM development.

Michael Stroman – MassDEP Advisor/Reviewer – participate in data review and decision-making relative to CAPS and SLAM development.

Marc Carullo – CZM Project Manager / Field Manager - oversee the involvement of CZM personnel and project commitments; also responsible for field data collection, scheduling, training and managing field sampling crew, field quality assurance, data transcription, data analysis, data reporting, database management, computer backup, and software QAQC.

Jan Smith – CZM Quality Assurance Manager / Field Manager – responsible for overall quality assurance; periodically conducts internal audits and coordinates any external audits; also responsible for field data collection, scheduling, training and managing field sampling crew, and field quality assurance.

Barbara Warren – Salem Sound Coast Watch Macroinvertebrate Field/Lab Scientist – responsible for macroinvertebrate field and laboratory data collection including sampling, sorting, and identification.

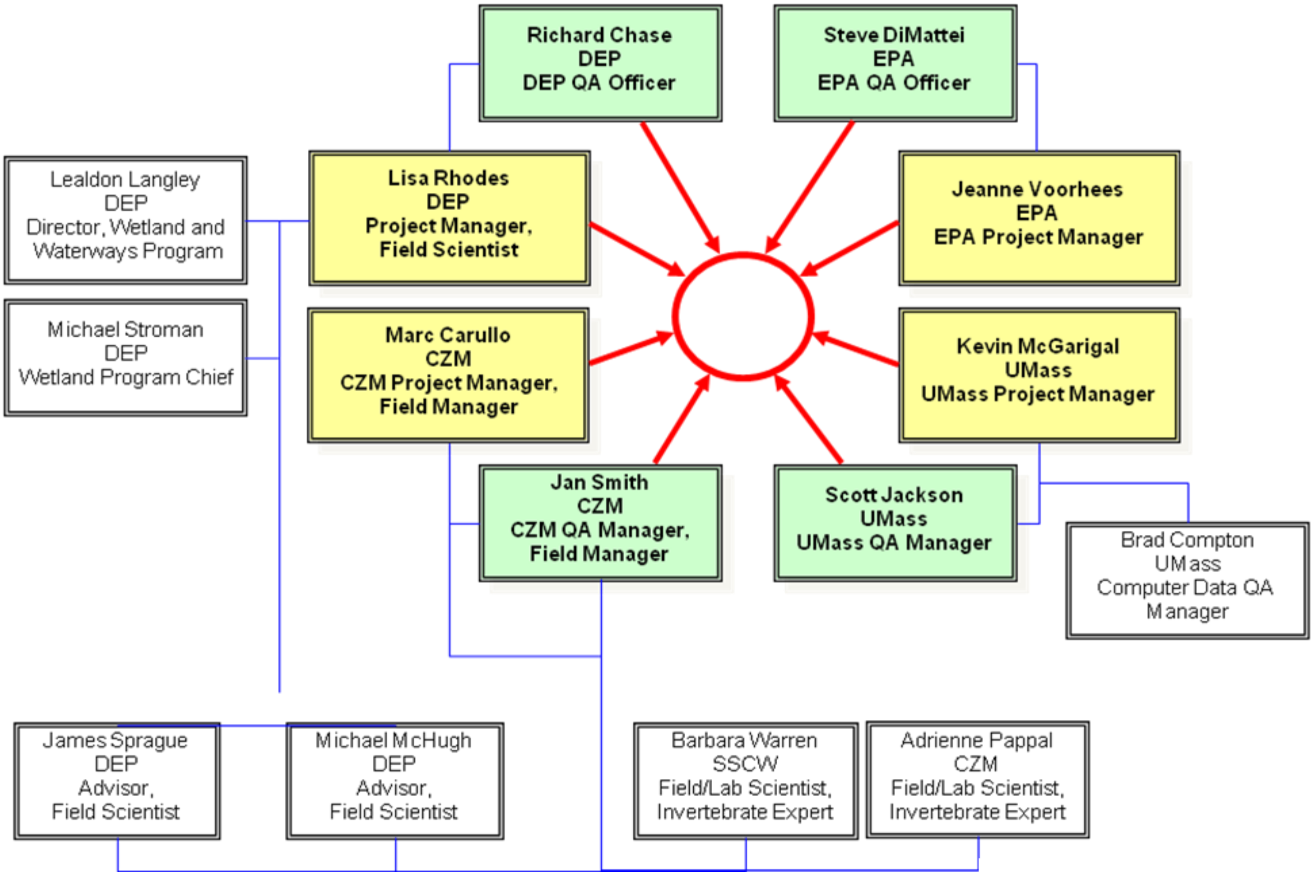
Adrienne Pappal – CZM Macroinvertebrate Field/Lab Scientist – responsible for macroinvertebrate field and laboratory data collection; also responsible for ID validation check of 10% of total macroinvertebrate samples.

Dr. Kevin McGarigal – UMass Project Manager - participate in data review and decision-making relative to CAPS and SLAM development and modifications, and site selection for field work. Also responsible SLAM data analysis and reporting, and administrative management of TBD field scientists for tidal hydrology component.

Scott Jackson – UMass QA Manager - participate in data review and decision-making relative to CAPS and SLAM development and modifications, and site selection for field work. Also responsible for SLAM data analysis and reporting, and overall quality assurance.

Brad Compton – UMass Computer Data Quality Assurance Manager – responsible for GIS protocol for selecting sampling locations, data transcription processes, data analysis, database management, computer backup and software QAQC.

Project Organization Chart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Field/Lab Scientist, Invertebrate Expert

1.3 Problem Definition/Background

The goal of the Massachusetts Wetlands Monitoring & Assessment Strategy, approved by the US Environmental Protection Agency in 2007, is to develop a plan that validates and/or better directs the state's commitment to protect the physical, chemical and biological integrity of Massachusetts' freshwater and coastal wetlands. Implementation of the monitoring and assessment strategy will increase our understanding of wetland health through the development of criteria to assess designated use impairment, and collection of monitoring data to validate our findings. The strategy will allow us to report on the status and trends of wetlands across the state, while we develop more intense assessment of specific watersheds, chosen for rapid assessment and monitoring.

The strategy is supported by the Massachusetts Wetland Monitoring and Assessment Program, whose specific goal is to develop Site Level Assessment Methodologies (SLAM) to assess freshwater and saltwater wetland condition and to calibrate (and over time validate) the innovative computer program developed by UMass-Amherst (the Conservation Assessment & Prioritization System (CAPS)). CAPS has been adopted by MassDEP to predict ecological integrity on a landscape-scale. (For CAPS information and documentation go to www.masscaps.org). This document serves as a quality assurance project plan (QAPP) for development of a salt marsh wetland SLAM. A separate QAPP has been approved for development of a freshwater wetland SLAM. Development of a separate QAPP for the CAPS computer model is in progress; it will apply to both freshwater wetlands and salt marshes.

1.4 Project/Task Description

Summary of Work

Within the proposed strategy, the DEP-UMass-CZM team intends to develop and deploy a Level 1 (Landscape Assessment), Level 2 (Rapid Assessment, or RAM) and Level 3 (Intensive Site Assessment) *Wetlands Monitoring and Assessment Program* for Massachusetts in four phases (see Table 1.1 below). For a detailed description of the CAPS approach, see the freshwater wetland QAPP entitled *Quality Assurance Project Plan for Development of a Comprehensive State Monitoring and Assessment Program for Wetlands in Massachusetts*, EPA RFA #07271. A QAPP detailing the complex CAPS model is forthcoming.

Under this QAPP we propose to evaluate various taxonomic groups for their potential to yield Indices of Biological Integrity (IBIs) for assessing the condition of salt marshes. These include plants and macroinvertebrates. The IBIs will be used to create a salt marsh SLAM that can be used to understand the relationship between ecological condition and various stressor metrics. Note that SLAMs differ from RAMs in that they may be more intensive than rapid assessments in order to be rigorous enough to test and calibrate landscape-based stressor metrics. Once we have tested and modified (as necessary) the landscape-based assessment methodology (CAPS), we will be positioned to use independent work and the SLAM produced with this project to optionally develop one or more RAMs. RAMs based on condition metrics will then be able to fulfill the original expectations of identifying relationships between landscape-based assessments (CAPS scores) and conditions on the ground (RAM-scores).

The research and development of CAPS entails four basic steps (Table 1.1) as follows:

Table 1.1 CAPS research and development steps.

CAPS R&D Step	Description
1. Conduct preliminary landscape-level assessment	Conduct preliminary landscape-level (level 1) assessment based on CAPS metrics; i.e., derive Index of Ecological Integrity (IEI).
2. Establish stressor-condition relationships	Establish stressor-condition relationships based on intensive empirical field studies for each ecological setting or unique wetland type.
2a. Literature review	Review existing literature to identify potential stressor-condition relationships and useful field methods.
2b. Pilot study	Conduct pilot study to screen potential condition variables and IBI's and develop a draft SLAM. Conduct field study to classify tidal restrictions for CAPS metric.
2c. Operational study	Conduct full-scale operational study to establish stressor-condition relationships. Revise assessment tools (CAPS and SLAM) as necessary to optimize performance.
3. Develop RAM (if appropriate)	Develop RAM from SLAM, if possible.
4. Implement long-term monitoring	Implement long-term monitoring program to validate CAPS prediction and account for time lags.

This QAPP provides detail for Phase 2b and 2c of this project. General information for Phases 1, 2a, 3 and 4 are provided, but without reference to specific data collection procedures. The QAPP will be amended as needed to accommodate later phases as protocols and procedures for that work are developed. Additional detail on Phase 2b and 2c data collection is contained within the attached Standard Operating Procedures (SOPs).

Phase 1 involves conducting a preliminary landscape-level assessment. This is a critical first step because the landscape-level assessment can serve as a comprehensive (statewide) assessment of ecological integrity until the empirically established stressor-condition models have been developed in Phase 2. In addition, the GIS-derived landscape metrics are prerequisite for sampling in Phase 2 to empirically establish the stressor-condition relationships. Phase 1 does not involve field data collection.

The second phase of work involves establishing specific stressor-condition relationships firmly grounded on empirical observations – this is the most important step of R&D since failure to establish these relationships undermines the scientific credibility of the entire monitoring and assessment program. Phase 2a involves a review of existing literature to identify potential stressor-condition relationships and useful field methods. The purpose of this step is to take full advantage of what others have already done to identify important stressor-condition relationships. Careful attention will be given to the transferability of results from other studies in other geographic areas.

Implementation of Phases 2b (2009-2010) and 2c (2010-2011) is in progress. This work involves the development of preliminary Indices of Biological Integrity (IBI) and a Site-Level Assessment Methodology (SLAM) to provide information about ecological condition for testing and calibrating the CAPS predictions and modifying (as needed) the CAPS models. Field data collection involves sampling of several biotic communities to determine if 1) there is a dose-dependent response in various attributes of the biological community to stressors within the landscape and 2) to validate/calibrate the ecological integrity metrics that are utilized in the CAPS model. Characterization of the wetland and assessment of its biological condition is conducted in the field by assessing macroinvertebrates, vascular plants, and habitat (e.g. habitat patch composition). A tidal restriction assessment was also conducted in 2009. The two main goals for tidal restriction field data collection were: 1) determine the relative magnitude of tidal restriction at select sites, and 2) develop a magnitude of tidal restriction data set that will be used to train a tidal restriction model developed from remotely sensed data interpretation. A tidal restriction metric is being developed from the field data collected under the Tidal Restriction Assessment SOP (Appendix B) and geospatial modeling by the UMass team (for which a separate SOP has been submitted as an appendix of the freshwater QAPP previously mentioned). This is outside the scope of this SOP.

Products

The final products for this project will be:

- Statewide Level 1 assessment of all natural communities (terrestrial, wetland and aquatic) with calibrated/validated data for salt marsh wetlands; results will be made available for each watershed (completed under separate CAPS model QAPP currently in development)
- Indices of Biological Integrity (IBI) for use in Level 3 assessment of salt marsh wetlands throughout Massachusetts
- Site Level Assessment Methodology (Level 3) for salt marsh wetlands
- Reports summarizing assessments conducted in select watersheds

Table 1.2 Anticipated Schedule for Implementation

Project Phase	Date	SLAM	CAPS	General
Phases 1 & 2a	Apr 30, 2009	Establish sampling protocols	Level 1 Assessment completed for entire state—without salt marsh-specific metrics	
	June 15, 2009	Tidal restriction SOP for use in 2009 field season		
	June 30, 2009	Salt marsh SOP for use in 2009 field season		Annual status report
Phase 2b: salt marshes	June 15, 2009	Select sites for tidal restriction study		
	June 30, 2009	Select field plots for salt marsh pilot study		
	June 22-Aug 31, 2009	Tidal restriction data collection		
	July 13-Sept, 2009	Salt marsh data collection		
	July 31, 2010	Draft IBIs and preliminary SLAM for use in operational study		Annual status report
Phase 2c: salt marshes	May 31, 2010	Select field plots for operational study	Results of CAPS calibration process for salt marsh wetlands	
	June-Sept, 2010	Field data collection		
	Aug 31, 2011	Finalize IBIs and SLAM	Level 1 Assessment completed statewide with salt marsh-specific-metrics	
	Sep 31, 2011	Results of salt marsh operational study		Final report on Level 1 (CAPS) and Level 3 (SLAM) assessments for salt marsh wetlands

Geographical Location of Field Tasks

Phase 2b salt marsh sampling (2009) occurred on Massachusetts' North Shore, Boston Harbor, and Cape Cod. These watersheds provided an appropriate mix of urban, suburban, and relatively undeveloped coastal areas. They include salt marshes that are representative of those found throughout Massachusetts. By limiting field work to these select watersheds we were able to sample a greater number of sites towards statistical validation of the CAPS model. Phase 2c sampling (2010) will be open to all of coastal Massachusetts. The following watersheds will be included in the salt marsh site selection process: Buzzards Bay, Cape Cod, Charles, Ipswich, Islands, Merrimack, Mount Hope Bay, Mystic, Narragansett, Neponset, North Coastal, Parker, South Coastal, Taunton, and Weymouth & Weir.

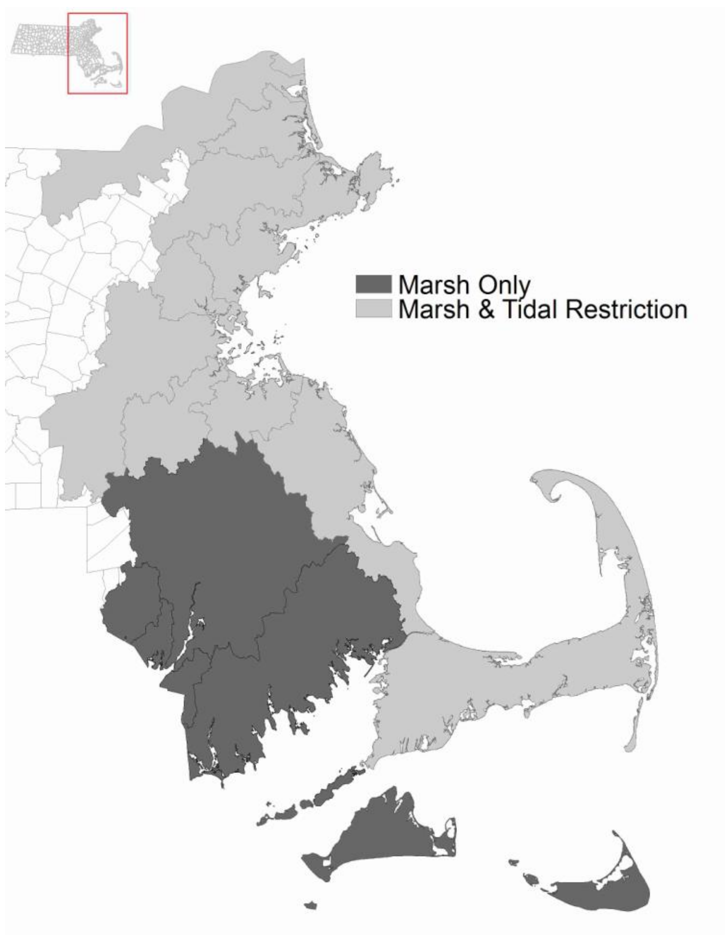

Figure 1.1 Location of watersheds included in the site selection process in support of Phase 2c salt marsh sampling. Note that tidal restriction sampling occurred in 2009 only.

1.5 Quality Objectives and Criteria

QA/QC is laid out in the assessment sampling protocol as a system of audits, standard procedures, and training for each section of the data collection and management plan. These activities and procedures begin with the assessment protocol conceptualizations, where the data requirements are determined, and continue through sampling, measurement of function, and data management to ensure the data quality meets those standards (Clairain et al. 1997) and is overseen by the Quality Assurance Manager and Project Manager.

Along with proper methodologies, confidence in the quality of the data is critical in the subsequent assessment protocol development stages as well as during assessment protocol application. Therefore, quality assurance procedures must be incorporated into the assessment protocol and used in a reliable and consistent manner to provide reproducible data with known statistical properties (Taylor 1985). In addition to the standardized sampling, measurement, and data handling procedures listed above, the assessment protocol includes a statement of data quality standards and methods for: 1) training, 2) internal data audits, and 3) external data audits for which the Project Manager is responsible for coordinating.

Before quality assurance methods to maintain data quality standards can be developed, the quality standards must be determined. Terms used to express data quality standards and examples of the QA/QC used to assure those standards are given below (Sherman et al. 1991):

1) *Precision* - is a measure of mutual agreement among individual measurements of the same variable, usually under prescribed similar conditions. Data precision of the assessment protocol can be checked through the use of replicate field measurements and standard procedures.

2) *Accuracy* - is the degree to which a measurement reflects the true or accepted value of the measured parameter. It is a measure of the bias in a system. Accuracy depends on the technique used to measure a parameter and the care with which it is executed. Standard procedures and QA audits are used to maintain data accuracy.

3) *Completeness* - is a measure of the amount of valid data actually obtained compared with the amount that was expected to be obtained under normal conditions. Ideally, 100% of the data should be collected. Data may be incomplete due to incomplete data collection, lost or damaged data forms, or errors in data transcription.

4) *Representativeness* - expresses the degree to which data accurately and precisely represent a characteristic of the parameter measured. Representativeness is established by proper site selection and appropriate spatial arrangement of sampling areas (i.e. site selection stratified by frequency distribution of selected metrics).

5) *Comparability* - expresses the confidence with which one data set can be compared to another. Collection of data by different investigators is the primary cause of variability in the data. Standardized procedures, internal QA audits, and training minimize variability in the data. Field testing of the assessment models will be used to determine the level of comparability achieved.

Specific details are included in the Standard Operating Procedures (Appendices A and B).

Table 1.3 Data Quality Objectives

Parameter	Units	MDL	RDL	Expected Range	Accuracy (+/-)	Precision
Water salinity (refractometer)	Parts per thousand (ppt)	1	1	5-35 ppt	+/- 1 ppt	Relative Percent Difference (RPD) less than 20% for repeat measurements
Water quality degradation (obvious spills, excessive algae, point source discharge, storm water discharge)	Presence/absence;	NA	NA	Present/absent;	NA	100% agreement on presence/absence among separate observers
Tidal flow restriction	Height of restriction in feet	NA	NA	0-5 ft	NA	Relative Percent Difference (RPD) less than 20% for repeat measurements of upstream and downstream relative tide elevations
Hydrological alteration (culvert, tide gate, dam, weir, stormwater inputs, fill, ditching, channelization)	Presence/absence of water control structures;	NA	NA	Present/absent;	NA	100% agreement among separate observers for presence/absence
Soil alteration (filling, sedimentation)	Presence/absence; Percent of area affected	NA	NA	Present/absent 0-100% (based on five cover classes)	NA	100% agreement on cover class among separate observers for percent of area affected
Habitat complexity (patch composition of open water features, plant communities, and	Transitions per 50 m	NA	NA	0-50 transitions	NA	Within +/- 2 transitions among separate observers

Parameter	Units	MDL	RDL	Expected Range	Accuracy (+/-)	Precision
marsh zones)						
Vascular plants	Species presence (or genus if species ID is not possible); Relative abundance	NA	NA	1-50 0-100%;	100% accuracy of identification at either species or genus level;	Percent cover within 5% among separate observers
Invasive plants	Species presence (or genus if species ID is not possible); Relative abundance	NA	NA	0-5; 0-100 %	100% accuracy of identification based on spot checks by trained project staff and/or experts (as applicable)	Percent cover within 5% among separate observers
Wetland site stressors (boating, trails & roads, trash/litter, dumping, mowing)	Presence/absence;	NA	NA	Present/absent;	NA	100% agreement on presence/absence among separate observers
Buffer zone stressors (vegetation management, litter, dumping, point source discharges, erosion/ sedimentation, structures)	Percent of buffer zone affected; Number of point-source discharges; Number of structures	NA	NA	0-100% (based on five cover classes); 0-5 discharges; 0-50 structures	NA	100% agreement on cover class among separate observers for percent of area affected
HGM classification (wetland)	Class & subclass	NA	NA	NA	100% accuracy of classification based on spot checks by trained project staff and/or experts (as applicable)	100% agreement among separate observers
Cowardin et al. classification (wetland)	System, subsystem, class, water regime,	NA	NA	NA	100% accuracy of classification based	100% agreement among separate

Parameter	Units	MDL	RDL	Expected Range	Accuracy (+/-)	Precision
	modifiers				on spot checks by trained project staff and/or experts (as applicable)	observers
Location by coordinates (GPS)	Degrees and decimal minutes	NA	NA	NA	0 – 10 m Dependent upon a variety of environmental factors	Repeated readings to verify coordinates essentially the same
Macroinvertebrates	Taxonomic richness (to family-level); Relative abundance	NA	NA	0-50; 0-90%	90% accuracy of identification (to target taxon; for most taxa, this will be family)	90% of confirmation samples positively confirmed by expert(s)

MDL = Method Detection Limit
RDL = Reporting Detection Limit

1.6 Special Training/Certification

Field crew members will have sufficient previous training and experience to reliably conduct field data collection or they will receive training from the CZM QA Manager, CZM Project Manager, and/or other project scientists with relevant expertise. All Field Scientists will receive training from the QA Manager on appropriate QA/QC procedures. The CZM QA Manager will keep a list of those trained along with the dates that the training occurred (i.e. documentation to show who was trained and when). Additional detail is included in the Standard Operating Procedures (Appendices A and B).

1.7 Documents and Records

The most current approved version of the QA Project Plan will be provided to the appropriate personnel by the CZM Project Manager. All data collected will be maintained in raw form (field data forms) and electronic form (database and image library) for at least five years in the CZM project manager's office at 251 Causeway Street, Suite 800, Boston, MA. The QAPP and SOPs will be dated to distinguish among different versions in case there are revisions made over the course of the project. The Project Manager will include all reports of the project status on the annual report, including any problems and the proposed recommended solutions. Annual status reports and final reports will be provided in electronic form to everyone on the distribution list. Hard and soft copies of reports, as well as all electronic data records, will be maintained at CZM for at least five years. Electronic data records, including results of the assessments and analyses, as well as GIS data generated over the course of the project, will also be maintained at CZM for at least five years. These include a report of macroinvertebrate samples confirmed by a second expert; see Section 4.2, Verification and Validation Methods, for additional information. All records will be shared among CZM, DEP, UMass, and EPA.

2.0 Data Generation and Acquisition

2.1 Sampling Process Design

Phase 2c

Phase 2c of the salt marsh wetland stressor-condition study involves a full scale operational study based on the 2009 pilot study to firmly establish stressor-condition relationships. The steps involved are essentially identical to those described above for the pilot study, except that 1) the geographic scope will expand, 2) the number of sites sampled will increase, and 3) in addition to inner marsh sampling, marsh border will be sampled for vascular plants based on a separate design.

Sample locations for marsh border will be placed at edges of salt marshes, stratified across quartiles of the habitat loss metric (≈ development intensity). One hundred and fifty points will be selected, with a goal of visiting 50 points. Points will be separated by at least 500 meters and will be rejected if physical and/or legal barriers prohibit access. Rejected points will be replaced with alternative points within the same stratification parameters.

Sample locations for inner marsh are selected via a stratified random process to represent a broad range of geographic and ecological conditions. Inner marsh sites will be selected randomly within salt marshes (as depicted in MassDEP Wetlands mapping data; 1:12,000 based on photography from 1993-1999), and stratified into 100 bins (deciles of the first principal component of CAPS metrics crossed with deciles of the second principal component; CAPS metrics included in the principal components analysis include habitat loss, watershed habitat loss, wetland buffer insults, traffic intensity, sediment intensity, toxic pollution, edge predators, imperviousness, connectedness, and similarity; all of which are further defined in the forthcoming CAPS model QAPP). Points will be separated by at least 500 meters from each other and from points sampled in 2009. Although the goal is to sample 70 points during the 2010 field season, approximately 350 points will be selected to allow for rejected points. Points will be rejected if the following criteria are not met:

- The point is not within 200 meters of a salt marsh creek, bay, or salt pond;
- The creek, bay or salt pond are not suitable for auger and D-Net macroinvertebrate sampling (e.g. channel width is less than 2m, bank height is less than 1m);
- The point is not accessible due to physical barriers;
- The point is not accessible due to legal barriers (i.e. permission to access private property cannot be obtained).

Each sampling point will be moved not more than 200 m to the nearest permanent tidal creek; points will be deleted if this is not possible. Sampling sites that have been rejected for safety or accessibility reasons, or for not having met certain habitat criteria, will be replaced with alternative sites within the same stratification parameters. All records, including those for the rejected sites, will be retained.

All records, including those for rejected sites, will be retained. Inner salt marsh and border salt marsh sampling designs are further explained in the Salt Marsh Assessment SOP (Appendix A).

Sampling sites for the 2009 tidal restriction field assessment were identified using various GIS data representing road and rail centerlines, linear hydrological features, and existing tidal restriction atlas data developed for the Massachusetts Wetlands Restoration Program. CZM and DEP staff remotely assessed each site on a set of criteria using local knowledge and GIS resources, including but not limited to aerial photography (oblique and orthophotography), DEP Wetlands, and MassGIS Open Space data. Sites were assessed for sampling based on the following criteria:

- Physical access (including safety considerations)
- Legal access
- Potential for restriction
- Lack of control structures (e.g. flapper, electric sluice, or self-regulating tide gates)

Sites that met these criteria were prioritized for sampling based on the total acreage of salt marsh upstream (as depicted in MassDEP Wetlands mapping data; 1:12,000 based on photography from 1990-1993), with emphasis placed on those with greater acreage. The goal was to sample 50 potential tidal restrictions. By prioritizing sites by the area of salt marsh they potentially impact, we provided more accurate data inputs to the tidal restriction model. Tidal restrictions are not being assessed in the field during 2010 sampling.

Field data collection will be conducted using the SOPs developed in Phases 2a and 2b. Salt marsh field data collection will involve sampling of several biotic communities to determine if 1) there is a dose-dependent response in various attributes of the biological community to stressors within the landscape and 2) to validate/calibrate the ecological integrity metrics that are utilized in the CAPS model.

Characterization of the wetland and assessment of its biological condition will be conducted in the field for macroinvertebrates, vascular plants, and habitat (e.g., tidal hydrology, water geochemistry, marsh zonation, and open water patch composition). Phase 2c field data collection will include:

- Location (GPS) and site description
- Water geochemistry (salinity)
- Habitat complexity (marsh zone and open water patch transitions per 50 m)
- Vascular plants (species, relative abundance)
- Macroinvertebrates (taxonomic richness, relative abundance)
- Water quality degradation (obvious spills, excessive algae, point source discharge, non-point source discharge)
- Hydrological alteration (culvert, tide gate, dam, weir, storm water input, fill, ditching, channelization)
- Soil disturbance (filling, sedimentation, haying, vehicle use)
- Wetland site stressors (boating, trails & roads, trash/litter, dumping)
- Buffer zone stressors (vegetation management, litter, dumping, point source discharges, erosion/sedimentation, structures)

Results from the Phase 2b salt marsh pilot study and 2c operational study will be used to calibrate the CAPS metrics.

Future Phases

Planning has not yet been completed for future phases of the work beyond implementation of Phases 1 and 2a-c. Options for future work include:

- Implementing Phase 2a-c for another coastal wetland type (e.g. intertidal rocky shore, submerged aquatic vegetation bed, saline/brackish flats)
- Adaptation of the Rapid Assessment Method for New England Salt Marshes (NERAM)
- Initiating a long-term monitoring program for salt marshes

The measurement procedures specified in the next section of the sampling protocol and attached SOPs describe how conditions for individual sites are measured. The sampling and measurement procedure sections include documentation and QA/QC procedures to ensure that the data are collected correctly and are reproducible. The data management procedures are the final section of the sampling protocol. These procedures set how the data will be formatted for analyses and archived. Data management includes ensuring that the data are complete and correct. The following sections and attached SOPs describe these sections of the sampling protocol in more detail.

2.2 Sampling Methods

Phase 2c survey work related to SLAM development and the development of IBIs will involve a mixture of 1) field estimation of environmental parameters, 2) detail measurements in the field and 3) sample collection for laboratory analysis or identification. Use of transects and time-constrained sampling is typically used to standardize effort. Two field crews will deploy with no less than one field leader and one field scientist for vascular plant sampling, and one field leader and two field scientists for macroinvertebrate sampling. Salt marsh field personnel will consist of DEP and CZM staff, with the exception of an outside invertebrate expert to lead all macroinvertebrate field sampling and lab processing. DEP, CZM, and UMass interns may occasionally accompany field crews. Details on survey and sampling procedures are detailed in the Salt Marsh Assessment SOP (Appendix A).
Phase 2c tidal restriction work will involve a mixture of 1) field estimation of environmental and physical parameters, and 2) detailed measurements in the field. Use of time-constrained sampling is used to standardize effort. One field crew consisting of two UMass/CZM interns will conduct the sampling. Interns will receive extensive training on the sampling protocol and instrumentation prior to the sampling period, and thereafter as needed. They will be joined by the CZM QA Manager at least once every spring tide sampling cycle (i.e. once a month) for review.

The data gathered in the field will be entered onto field data forms and entered later into one or more Access databases. Data are cross-checked for errors by the Field Manager and double-checked for completeness by the CZM Project Manager and UMass Computer Data QA Manager.

Table 2.1 Phase 2c Data Collection

Parameter	Method	Units	Sample Holding Container	Method Sample Preservative	Maximum Holding Time
Water salinity	Refractometer measurements at 20 m and 80 m along Transect A (location of macroinvertebrate D-Net sampling)	Parts per thousand (ppt)	NA	NA	NA
Water quality degradation (obvious spills, excessive algae, point source discharge, storm water discharge)	Observation along transects	Presence/absence; Percent of area affected	NA	NA	NA
Tidal flow restriction	Tide gauge measurement upstream and downstream of restricting structure	Feet	NA	NA	NA
Hydrological alteration (culvert, tide gate, dam, weir, storm water inputs, fill, ditching, channelization)	Observation along transects and proximal to assessment area	Presence/absence of water control structures; Net effect of hydrological alteration; Percent of area affected	NA	NA	NA
Soil alteration (filling, sedimentation, haying, vehicle use)	Observation along transects and proximal to assessment area	Presence/absence of soil alteration parameters; Percent of area affected	NA	NA	NA
Habitat complexity	Assessed along transects	Transitions per 50 m transects	NA	NA	NA
Vascular plants	Relative abundance will be measured using the point-intercept method along three 50 m transects	Species presence; Relative abundance by species (or genus if species ID is not possible)	Plastic bag	Refrigerated	48 hours

Parameter	Method	Units	Sample Holding Container	Method Sample Preservative	Maximum Holding Time
Invasive plants	Relative abundance will be measured using the point-intercept method along three 50 m transects	Species presence; Relative abundance by species	Plastic bag	Refrigerated	48 hours
Wetland site stressors (trails & roads, trash/litter, dumping)	Observation along transects and proximal to assessment area	Presence/absence of wetland site stressors; Linear meters (trails & roads); Percent of area affected	NA	NA	NA
Buffer zone stressors (vegetation management, litter, dumping, point and nonpoint source discharges, erosion/sedimentation, structures)	Observation along wetland-buffer boundary	Percent of buffer zone affected; Number of point and nonpoint source discharges; Number of structures	NA	NA	NA
HGM Classification (wetland)	Observation from plot point	Class & subclass	NA	NA	NA
Cowardin et al. classification (wetland)	Observation from plot point	System, subsystem, class, water regime, modifiers	NA	NA	NA
Location by coordinates (GPS)	Trimble GPS Unit from plot center (record unit accuracy estimate for each reading; e.g., PDOP = 6)	Degrees and decimal minutes	NA	NA	NA
Macroinvertebrates	Measured at specified points along baseline transect using auger, D-Net, and quadrat techniques	Taxonomic richness; Relative abundance (% of sample)	Plastic bag post-collection; Plastic or glass jar post-sorting	90% ethyl alcohol and kept cool	Two weeks before sorting; One year before identification

2.3 Sample Handling and Custody

Native vascular plant collections will be limited to species that cannot be identified in the field. For species that cannot be positively identified in the field samples will be collected for lab identification and photographed for digital preservation. Taxonomic identification at the species level (preferred) or genus level (if species identification is not possible) will be achieved in the laboratory through the use of field guides, technical keys, and reference to regional herbaria housed at research universities such as UMass. Samples will be labeled in the field with the plant ID (e.g. “unknown sedge #1”) site location, date, and person who collected the sample, and assigned a code in the laboratory for use in digital preservation. Invasive plants will not be removed. They will be identified in the field through the use of field guides and technical keys. In the event that they cannot be identified in the field they will be properly described and photographed for digital preservation.

Figure 2.1 Vegetation Sample Label

Vegetation Sample	
Date:	Site ID:
Sample ID:	Collector ID:
Comments:	

Figure 2.2 Chain of Custody Log for Vegetative Samples

Salt Marsh SLAM Development
Vegetation Sample Log

Site location	Date	Plant ID	Collector

Relinquished by: ______________________________ Date _______________

Received by: _________________________________ Date _______________

Macroinvertebrates will be collected into 90% ethyl alcohol and kept cool until transfer to laboratory for storage. Samples will be sorted within two weeks of collecting. They will be labeled in the field with the site ID, sample ID, date, person who collected the sample, sampling method, and preservative used. Macroinvertebrates will be identified to the family-level. Identifications for at least 10% of the organisms will be separately confirmed by a second macroinvertebrate expert (CZM Macroinvertebrate Field/Lab Scientist). This is further described in the Salt Marsh Assessment SOP (Appendix A).

Figure 2.3 Macroinvertebrate Sample Label

Macroinvertebrate Sample	
Date:	Site ID:
Sample ID:	Collector ID:
Sampling Method:	
Preservative Used:	
Comments:	

2.4 Analytical Methods

Laboratory analysis will be limited to some biological sample processing (macroinvertebrates and vascular plants) and microscopic examination for purposes of taxonomic identification. Macroinvertebrate taxonomic identification protocols are outlined in the Salt Marsh Assessment SOP (Appendix A). All field analytical methods are outlined in the Salt Marsh Assessment SOP (Appendix A) and the Tidal Restriction Assessment SOP (Appendix B).

2.5 Quality Control

Quality Control will be maintained throughout the project through the following measures.

- Thorough review of comparable methodologies from other states and development of comprehensive field data collection methodologies (completeness, comparability)
- Computer aided use of stratified random sampling procedures for site selection (accuracy, representativeness)
- Use of standardized sampling procedures such as transect and time-constrained sampling (precision, accuracy, representativeness)
- Prompt review and documentation of any changes to the SOPs (precision, accuracy, comparability)
- Use of highly qualified field scientists (precision, accuracy, comparability)
- Rigorous training and mentoring of less experienced technicians in both structured and informal settings, the latter on an as needed basis (precision, accuracy, comparability)
- External validation of taxonomic identification for taxa with which the field crew

has had limited prior experience (100% of samples); minimum of 10% of total samples (precision, accuracy)

- Daily checks to ensure that data forms are completely filled out (completeness)

It is important to maintain consistency in data collection and handling methods throughout the effort. It is not uncommon for methods to change as new situations arise and must be incorporated into the data set. The Quality Assurance Manager is responsible for periodically inspecting the methods used and inconsistencies will be documented and if possible, corrected. Any significant changes will be made in coordination with MassDEP and EPA. If corrections are not possible, documentation will be included with the reference data for interpretation during subsequent analyses and model variable calibration. Documentation adds credence and provides defensibility to technically sound measurements (Taylor 1985).

2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Field equipment will be inspected by the CZM Project Manager or CZM QA Manager each day before going out to collect field data. At the field site equipment will be tested prior to data collection to ensure that it is working properly. Equipment will be subject to regular maintenance as needed and as recommended by the manufacturer.

Table 2.2 Instrument/Equipment Calibration, Inspection, Testing and Maintenance.

Equipment	Calibration	Inspection/testing	Maintenance
Optical level	All calibration will be done according to manufacturer's recommendations (see attached manual, Appendix E)	Daily inspection for damage or other problems; instrument will be tested each day to ensure that it is working properly	The optical level will be maintained according to manufacturer's recommendations (see attached manual, Appendix E)
Refractometer	All calibration will be done according to manufacturer's recommendations (see attached manual, Appendix F)	Daily inspection for damage or other problems; instrument will be tested each day to ensure that it is working properly A check standard with mid-range values will be used at the end of each field day to test for instrument drift	The refractometer will be maintained according to manufacturer's recommendations (see attached manual, Appendix F)
Trimble GeoExplorer GPS unit	NA	Units will be inspected daily for damage or other problems; units will be tested monthly using known locations	Keep batteries charged and in good condition; clean as needed
Various microscopes	NA	Daily inspection for damage or other problems	Clean, replace light source as needed
Various digital cameras	NA	Daily inspection for damage or other problems	Recharge, replace, and clean batteries as needed

2.7 Instrument/Equipment Calibration and Frequency

Instruments will be calibrated on a regular basis as recommended by the manufacturer (see Table 2.2).

2.8 Inspection/Acceptance of Supplies and Consumables

All laboratory and field supplies will be inspected and either accepted or rejected for use by the CZM Project Manager or CZM QA Manager. See specific SOPs for a list of supplies and consumables.

2.9 Non-Direct Measurements

Peer-reviewed literature and final agency reports will be used as supporting documentation in this study. Sampling site selection will make use of MassDEP mapped wetlands data (1:12,000 based on photography from 1990 to 1993) and land cover maps compiled by UMass as part of Level 1 assessment of Massachusetts.

2.10 Data Management

Data will be collected in the field and entered onto field data sheets. Field data sheets are inspected and signed by the sampling team Field Manager before leaving the site. S/he will review field sheets at the end of each sampling day. In the event that significant errors or omissions were missed during on-site inspection, the Field Manager will contact samplers to rectify the situation within 72 hours. Data sheets will be returned to the laboratory and stored for data entry by the CZM Project Manager at a later date. Data entry screens will be formatted to resemble the field data form and drop-down menus used to reduce data entry errors. All data will be reviewed for data entry errors and corrected by the CZM Project Manager and the CZM QA Manager. The database (MS Access) will be stored in a private directory on a secured network server and will be backed-up hourly. Only the CZM Project Manager will have access to the master database. The CZM QA Manager will maintain a database copy in a separate private directory on the same secured network for purposes of review only. Once review is complete, the CZM QA Manager will delete his copy of the database. All supporting documents and ancillary data (e.g., photos, maps, etc.) will be stored in a private directory owned by the CZM Project Manager on the previously mentioned, secured network server.

3.0 Assessment and Oversight

3.1 Assessments and Response Actions

Quality assessment techniques include internal and external audits (Sherman et al. 1991). These serve to ensure that the QC procedures are being followed and are effective in maintaining data quality.

1) Internal checks - Internal checks will be incorporated into all phases of data collection and management. Equipment condition will be checked at each site prior to sampling and entries on field data sheets will be reviewed by the Field Manager for completeness

before leaving each site.

2) External audit - External validation of species identification for taxa with which the field crew has had limited prior experience (100%). In addition, a minimum of 10% of the overall samples will be identified by a second expert for validation.

Deficiencies and other non-conforming conditions will be addressed by the CZM Project Manager. Corrective actions will be verified and documented by the CZM Quality Assurance Manager.

3.2 Reports to Management

The Project Manager will include all reports of the project status on the annual report, including any problems and the proposed recommended solutions. Any deviations to the QAPP will be reported.

4.0 Data Validation and Usability

4.1 Data Review, Verification, and Validation

All field and laboratory data are reviewed by the CZM Project Manager and CZM QA Manager to determine if the data meet QAPP objectives. They will make the ultimate decisions to reject or qualify data. A peer-review workshop of scientists experienced in wetland assessment will be held to review data and data analysis.

4.2 Verification and Validation Methods

Assessment depends on the complete and accurate transference of the field data from the data sheets to the laboratory or office network computers and spreadsheets (Clairain et al. 1997). Validation and verification methods for field sampling will occur as prescribed in the salt marsh and tidal restriction SOPs. All raw data will be submitted to the CZM Project Manager for quality assurance review and data entry. The CZM QA Manager will also participate in quality assurance review, and the Macroinvertebrate Field/Lab Manager will participate in review of the macroinvertebrate data. Also see Section 2.10, Data Management for data management and verification.

Sample readings out of the expected range will immediately be reported to a Field Manager, upon which s/he will take a second sample to verify the condition. For macroinvertebrate sampling, a minimum of 10% of organisms will be identified by a second expert for 100% confirmation. If an error greater than 1% is found, all samples from that sampling period will be re-identified. All validation records will be retained.

With the exception of data entry for macroinvertebrate samples, only one person (the CZM Project Manager) will manage the data sets. Comparison of the raw data with data in the database will be conducted to confirm proper transfer of data as well as any qualification or censoring of data. Once the sampling period has closed, the UMass Computer Data QA Manager and CZM Project Manager will analyze the data to look for outliers and anomalous data using frequency plots and statistical analyses in preparation of metric parameterization (further described in a separate CAPS model QAPP currently under development)..

4.3 Reconciliation with User Requirements

It is not uncommon for methods to change as new situations arise and must be incorporated into the data set. The data and methods will be periodically inspected for inconsistencies or user conflicts and will be documented and if possible, corrected. If corrections are not possible, documentation will be included for interpretation during subsequent analyses.

If the data collected in Phase 2b allows for this project to proceed to the data collection procedures for Phases 2c & 3, then the project goals for Phase 2a & b will have been met. If this is not the case, then the project team will meet to decide what additional steps, if any, will be taken to complete Phases 2a and 2b.

The final SLAM will be based on an evaluation of the usefulness and user-friendliness of field variables and methods. CAPS validation and modification will ensure credible and accurate landscape level assessments leading to more cost effective methods for assessing and evaluating wetlands statewide.

5.0 References

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