Wetlands Health Assessment Toolbox Program

Quality Assurance Project Plan

February 2005

Salem Sound Coastwatch

With:
Massachusetts Office of Coastal Zone Management
The Massachusetts Bays National Estuary Program

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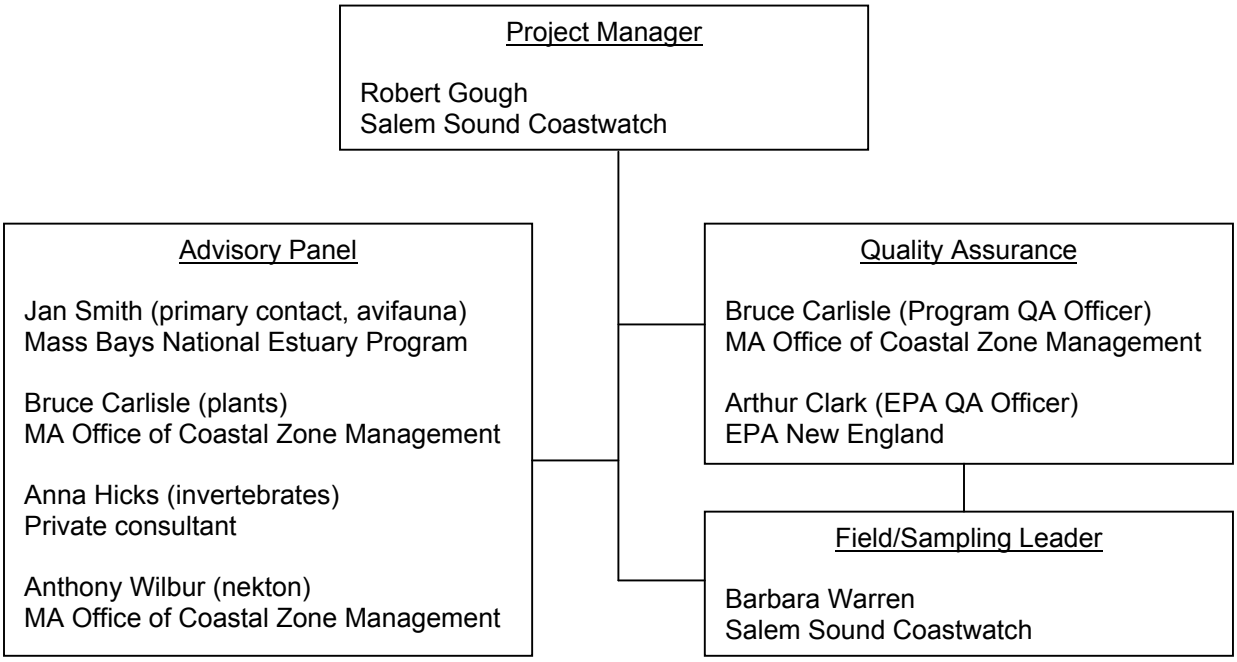

1.0 Problem Definition/Background

1.1 Problem Statement

Salt marshes provide habitat to a vast array of wildlife, serve as nursery grounds for fish, purify water by absorbing potential pollutants, and shelter shorelines from the potentially damaging effects of extreme wave and tidal energy. The value of salt marsh habitat is recognized and its contribution to local ecological health is highly desirable. Therefore, there is great interest in ensuring the condition, or health, of these habitats.

Due to the increased awareness of the importance of these wetlands, local governments and citizens have become more interested in the evaluation of wetland quality and the subsequent restoration of these habitats. Therefore, it has become necessary to establish programs to achieve this goal.

Of primary importance is establishing a baseline assessment of a site's current ecological condition. Wetland assessment may consist of rapid assessment techniques, such as a compilation of impacts (such as tidal crossings including roadways, bike paths, and railroad lines; storm water drainage, and historic mosquito ditching) and more intensive, scientific bio-monitoring of the site. From these assessment activities, findings can be used to support state and regional programs to evaluate wetland restoration potential, actions, and success.

The Wetland Health Assessment Toolbox (WHAT) program was established to evaluate wetland health at salt marshes in order to quantify current condition, to determine the need for restoration or mitigation efforts, and to collect data at restoration sites pre- and post-restoration. The use of volunteers to carry out this evaluation is important in developing both a better understanding of the unique importance of coastal wetlands and a sense of stewardship among citizens. The WHAT program has been active on Massachusetts' North Shore since 1999 through the coordination and oversight of Salem Sound Coastwatch. Since its inception, the WHAT program has proven to be highly successful in training volunteers in field techniques and in facilitating environmental stewardship and restoration.

1.2 Intended Usage of Data

The data obtained in this program will be used to assess the condition of salt marshes, to evaluate the need for restoration efforts at salt marshes study sites, and to understand the success of restoration actions. The salt marsh data collected using the WHAT protocol will be shared with scientific research groups working to identify regionally applicable success criteria for restoration projects and to evaluate the effectiveness of tidal marsh restoration on a regional scale. The ultimate long-term goal of the WHAT program is to improve the quality of wetlands in New England through a combination of scientific study and local awareness, and ultimately, to encourage citizens to take an active role in the restoration and preservation of their local wetlands.

2.0 Project/Task Description

2.1 General Overview of Project

The WHAT Program trains volunteers to use an established multi-metric protocol to estimate the overall quality (or condition) of wetland habitat. Staff from the Massachusetts Office of Coastal Zone Management (CZM), the Massachusetts Bays National Estuary Program (Mass Bays), and UMass Extension (UMASS) developed the methods utilized by the WHAT program. Volunteers are instructed in the methods during a combination of both workshop and fieldwork experiences. In 2002, the methods along with supporting material and contextual information were published into a single document – *A Volunteer Handbook for Monitoring New England Salt Marshes* (See Appendix C).

Through volunteer education and participation, this project applies an array of wetland assessment techniques to selected salt marsh sites located on the North Shore region of Massachusetts (including the towns and cities of Salisbury, Newburyport, Newbury, Rowley, Ipswich, Essex, Rockport, Gloucester, Manchester-by-the-Sea, Beverly, Danvers, Peabody, Salem, and Marblehead). The wetland ecological assessment approach used in the WHAT program combines several rapid assessment tools with onsite biological, chemical, and physical investigations.

The rapid assessment tools utilized in the Wetland Health Assessment Toolbox Program include:
• Land Use Index
• Habitat Assessment
The field investigations utilized in the Wetland Health Assessment Toolbox Program include:
• Vegetation survey
• Aquatic macroinvertebrate survey
• Avifauna survey
• Nekton (fish and crustaceans) survey
• Salinity measurements
• Tidal hydrology measurements

Throughout the field season (June – September) volunteers collect the field data. During each of these visits, the Field/Sampling Leader accompanies the volunteers. Parameters are studied at different frequencies throughout the season. During the winter months, the data is analyzed. For the biological investigations, metrics and indices are employed in data analysis and reporting. Limited statistical analysis is employed to examine data patterns, significance, and use for predictive inquiry.

A final report is produced, distributed, and will be distributed to the appropriate boards of the towns where sampling has occurred that year. A copy of this QAPP will accompany the report. The towns and municipalities of the project area include Ipswich, Essex, Rockport, Gloucester, Manchester-by-the-Sea, Beverly, Danvers, Peabody, Salem, Marblehead, Salisbury, Newburyport, Newbury, and Rowley. A copy will also be sent to the distribution list above.

2.2 Project Timetable

ACTIVITY	DATES
Volunteer Recruitment Recruit volunteers through internet sites, local newspapers, local schools, the SSCW newsletter and website, and public gatherings.	April – June
Workshop and Meeting Planning Meet with the project team and scientists to develop a schedule for the summer training sessions and kick-off meeting. Reserve workshop/meeting locations and secure necessary workshop materials.	April-July
Coordinate Volunteer Training Sessions Coordinate with workshop trainers to provide hands-on in-depth training to volunteers in each of the seven parameters (birds, fish, benthic macroinvertebrates, plants, salinity, tidal influence, and land use).	June – August
Coordinate Volunteer Monitoring of Sites Facilitate the formation of volunteer teams to monitor each site and schedule the fieldwork. Accompany volunteers in the field during data collection.	June – September

ACTIVITY	DATES
Compile and Analyze Data Compile all of the data collected during the season on each parameter and analyze the respective indices and overall index of wetland health. Create a concise summary report of data analysis and organize the data for presentation to a wide audience, including volunteers.	September – February
Coordination and Advocacy Work closely with local boards and commissions and organizations working on restoration of wetland sites. Advocate for implementation of wetland restoration projects and provide technical assistance and grant writing support where possible.	Ongoing

3.0 Measurement Quality Objectives

3.1 Data Precision, Accuracy, Measurement Range

Salinity

The frequency and number of samples to be collected in the field is discussed in Section 7.0. The Field/Sampling Leader before each sampling event will calibrate Field instrumentation. Quality assurance/quality control guidelines for parameters are described in Section 10.0.

Macroinvertebrates

Throughout this program, variation in sampling procedures, measurements and habitat descriptors will be minimized. As three random samples are collected at each site, precision will be measured as percent similarity between triplicate samples. Accuracy will be ensured through standard laboratory procedures. Macroinvertebrate field samples will be sorted by volunteers in the laboratory under the supervision of the Field/Sampling Leader who will check the debris from each sorted sample for any remaining organisms. Taxonomic accuracy is achieved through use of standard taxonomic keys for all identifications (Fauchald 1977, Weiss 1995, and Pollock 1998) and presence of an Invertebrate Scientific Advisor. Volunteers will be trained prior to undertaking set tasks, and will be supervised by the Field/Sampling Leader at all times. Accuracy of identification will be evaluated by the Invertebrate Scientific Advisor who will select a minimum of 10% of the original samples for quality control. All samples will be archived by sample ID # to ensure a long-term record.

Vegetation, Avifauna, Nekton

Replicate plots for vegetation, replicate observation stations, and replicate minnow trap stations will be employed to evaluate precision at each study site. Accuracy will be ensured through standardized procedures. Field plot surveys will be laid and supervised by the Field/Sampling Leader. Taxonomic accuracy is achieved through use of standard taxonomic keys for all identifications (Tiner 1987, Tiner 1993, National Geographic Society 1999, Weiss 1995, Robins/Ray/Douglass 1986). Volunteers will be trained prior to undertaking set tasks and will be supervised by the Field/Sampling Leader at all times. Accuracy of identification will be evaluated by the Scientific Advisors who will select a minimum of 10% of the original samples for quality control.

Tidal Hydrology

Measurements for tidal hydrology will be made by volunteers reading from staff gauges above and below the restrictive feature (e.g. under-sized culvert) and tape measures used above and below the restrictive site. The staff gauges are graduated, with accented demarcations every foot and every tenth; the tape measures are marked at every foot and every tenth.

3.2 Data Representativeness and Comparability

Comparability will be ensured for all data sets generated by this project by utilizing standardized protocols for sampling, surveying, and analysis of each chemical, biological, and physical parameter. Representativeness will be ensured by selecting reference sites that are representative of minimally disturbed salt marshes and study sites that characterize impaired (tidally restricted) salt marshes. Study sites have been determined by the direct physical measurement of the degree of tidal hydrological restriction to ensure sites meet this criteria.

3.3 Data Completeness

There are no legal or compliance uses for the data generated by this project. The project data will be deemed complete if 90% of the of the planned data generation, collection, and processing has occurred, unless there are extenuating circumstances like unanticipated weather, natural events, or staff illness.

4.0 Training Requirements and Certification

4.1 Training Logistical Arrangements

Type of Volunteer Training	Frequency of Training
Birds – Identification & Methods	Once per season
Fish – Identification & Methods	Once per season
Macroinvertebrates – Methods	Once per season
Macroinvertebrates – Identification	Once per season
Vegetation – Identification & Methods	Once per season
Salinity – Methods	Once per season
Tidal Hydrology – Methods	Once per season
Land Use – Methods	Once per season

4.2 Description of Training and Trainer Qualifications

Training will occur in conjunction with fieldwork. The sampling day for each parameter will consist of an overview of salt marsh ecology, discussion of the parameter being studied, demonstration of monitoring techniques, and collection of data by volunteers. Thereafter, if a parameter requires more than one sampling during the season, volunteers will continue to receive training and support in the field.

Volunteers will not be officially evaluated since the Field/Sampling Leader will always be present during all sampling events, closely observing, instructing and correcting volunteers as needed to assure correct procedures and quality of monitoring data are taking place. The Field/Sampling Leader will ensure that the recorded data on the field data sheet is accurate.

The Field/Sampling Leader will be trained in all aspects of scientific monitoring by the Scientific Advisors. The Scientific Advisors have extensive knowledge and background in their field of study (See Appendix A for resumes).

5.0 Documentation and Records

All data sheets will be saved, copied, and filed. Computer data will be saved on a hard drive and backed up onto disks and CDs. Data will be shared with Massachusetts Coastal Zone Management, governmental agencies and scientific institutions upon request.

6.0 Sampling Process Design

6.1 Rationale for Selection of Sampling Sites

Salt marsh sampling sites include study sites and reference sites. The study sites are salt marshes that are subject to various types of human-induced degradation, including sites with tidal hydrological restrictions—the reduction in normal tidal range and influence through the physical blocking of the tidal channel—will be examined, salt marsh sites affected by land uses activities, and salt marsh sites

with direct hydrological or fill disturbances. A tidal restriction site has either a roadway, railroad, or bike-path/recreational corridor crossing over the primary creek or channel which links the marsh with the greater estuarine and marine systems. The restrictive features of these crossings include undersized and/or blocked culverts that restrict at least the full passage of spring high tides and in some cases the passage of normal high tides. Biological, chemical, and physical measurements will be made both at the salt marsh affected by the tidal restriction (the restricted study site) and at the salt marsh below the restrictive feature (the reference site). The reference sites or marshes below the tidal restriction receive normal tidal influence and inundation. Reference sites that are representative of regionally pristine or generally unimpaired salt marsh sites are also utilized.

6.2 Sample Design Logistics

	Type of Sample/ Parameter	Number of Samples	Sampling Frequency	Sampling Period
Biological	Fish	3	Monthly	June – August
	Birds	5	Every 3 weeks	June – August
	Macroinvertebrates	1	Once	July – August
	Vegetation	1	Once	August - September
Physical	Tidal Hydrology	1	Once	June – September
	Land Use	1	Once	September
Chemistry	Salinity	3	Monthly	June – August

7.0 Sampling Method Requirements

Volunteers will make every effort to avoid unnecessary disturbance to the sampling sites.
The following describes the sampling procedures for each type of field sampling.

Macroinvertebrates
At each site, a habitat characterization will be completed that summarizes the ambient salt marsh habitat conditions at the sampling site (Appendix B, p. 1). The information collected includes habitat descriptors on hydrology, vegetation, substrate, available food sources for invertebrates, and degree of human impact.

Two sampling devices will be employed in different habitats:
• Intertidal bank zone: plot sampling using wooden frame (18”x18”), and
• Subtidal (permanently flooded) zone: (D-Net and auger).

At each sampling site, three sampling stations will be selected over a 300’ linear distance along the estuarine stream. One station will be located within 0’-20’, another at 140’-160’, and the third within 280’-300’. At each of the three stations, a representative composite sample of macro-invertebrates will be collected as follows:
• Intertidal bank zone at low tide: 1 plot sample,
• Subtidal estuarine zone at low tide: 1 D-Net sample and 1 auger sample.
Each sample will be placed in a zip lock bag that is labeled with site number, site name, date of sampling, sample number, sampling method, name of sampler. The site field record sheets (Appendix B, p. 2-6) also records the relevant sample numbers. Samples will be preserved in 99% ethyl alcohol and placed in a cooler ready to be transported to the laboratory for sorting and identification.
The invertebrate sampling run will occur in August.

The field samples will be sorted by volunteers in the laboratory under the supervision of the Field/Sampling Leader who will check the debris from each sorted sample for any remaining organisms. The contents of each zip lock bag will be sorted separately and the organisms placed in a labeled vial containing 99% ethyl alcohol.

An Identification Workshop will be conducted after all of the macroinvertebrate sampling has occurred. The workshop will be led by an Invertebrate Scientist who will teach volunteers identification techniques. The Field/Sampling Leader and the Invertebrate Scientist will ensure quality of identification and of record keeping.

Vegetation

At each site, the salt marsh wetland vegetation will be surveyed according to the following protocol. Six transects will be established based on a stratified random sampling approach. The evaluation unit will be segmented into three sub-units along equal sections of the 300 linear feet creek channel. The area between the 0' and the 100' points will be sub-unit #1; the area between the 100' and the 200' points will be sub-unit #2; and the area between the 200' and the 300' points will be sub-unit #3. In each of the sub-units, two randomly selected transects will be laid. The transect locations will be determined by a computer random numbers algorithm producing a random integer between 0 and 100. The random integer will be the distance in feet from the start point (0') of each sub-unit.

The transects will run roughly perpendicular from the channel to the upland edge, paralleling the evaluation area boundaries. At each site, transects will be laid according to a consistent compass bearing (for example, all six transects will be laid on a bearing of 150° from channel bank to upland edge). Along each transect, $1m^2$ quadrats will be located every 60 feet (quadrats will be located every 30 feet if the transect is less than 120ft long), starting at/near the creek edge progressing along the entire length of the transect until the upland edge. The last quadrat will be located in the salt marsh fringe community, well within the wetland and not in the upland.

Using a standard data sheet (Appendix B, p. 7-10), in each quadrat along each transect, every plant occurring within that quadrat will be identified by genus and species. For each unique species within the quadrat, the abundance of that species will be determined using visual estimates of the percentage of the quadrat occupied by that species. This method is adapted from protocols developed by Tiner (1996), Jackson (1995), Daubenmire (1959) and Braun-Blanquet (1932). Investigators will also define the community type that the quadrat falls in: low marsh, high marsh, or fringe. Coverage values will be revised if necessary. To be as accurate as possible, coverage estimates include duff, leaves, bare ground, and open water, collectively designated as *other*. Coverage estimates will be adjusted during the analysis stage to account for the coverage of this *other* category.

Vegetation surveys will be conducted once at each site during the peak growing period from mid August to mid September.

Avifauna

Point counts will be utilized as the primary sampling method, using visual and auditory cues. Volunteers will be accompanied by at least one expert observer and will sit quietly in a vantage point where all of the evaluation area can be viewed. Using a standard data sheet (Appendix B, p. 11-12), all species and individuals will be counted and recorded by the observers, as they are heard or seen demonstrating any activity in the evaluation area or in a 100-foot buffer area surrounding the evaluation area. Observers will note on the data sheets whether the individual(s) are sitting or flying and if the individual(s) occurs in the wetland or the buffer area. Counts will be conducted for a period of 20 minutes. All individuals will be counted, with a concerted effort not to duplicate individuals. Sites will be surveyed in the early morning in order to capture peak activity. Sites will be surveyed June - September to capture migrating shorebird usage, since salt marsh habitats are known to have comparatively fewer breeding species but offer important foraging grounds.

Nekton (Fish and Crustaceans)

Nekton is studied in order to establish a list of fish species using the salt marshes creeks. Data is collected throughout the summer months. Salt marshes are sampled three times throughout the season with the reference and study sites sampled at the same time.

A total of six minnow traps (1/8" fine mesh) are used for each sampling date — three for the study site and three for the reference site. The traps are equally spaced along the study and reference gradient; that is, for a 300 foot stretch, traps will be located at 0ft, 150ft, and 300ft. Traps are positioned at the edge of the tidal creek. Minnow traps are deployed for approximately 2 hours. Samples are processed, water quality readings taken at deployment and retrieval (i.e., water temperature and salinity), and all information recorded.

All fishes and crabs are identified to species and the numbers of each species counted. Standard length of fish and carapace length of crabs are measured to nearest millimeter. Each species is weighed to the nearest gram. Any external abnormalities, such as skin lesions or parasites, are noted.

In the case that an unidentifiable species is encountered, it will be placed in a vial with preserve (99% ethyl alcohol), clearly labeled with date, site, sample number, station, and subunit #, and returned to the lab for identification.

All data is recorded on a standardized field sheet (Appendix B, p.13). Additional information recorded includes names of samplers, date, time, station, temperature, and salinity.

Salinity

The salinity component of the project seeks to obtain an understanding or accurate estimation of the salinity of the marsh in order to aid in the interpretation of biological data collected for multi-metric indices. In particular, salinity, both in the shallow groundwater (within the plant root zone) and the surface water within the creek channel, is of interest to aid in the examination of both plant and invertebrate communities.

In order to obtain an estimate of the salinity levels within the evaluation unit of each study site, samples will be taken from the creek surface water and from a series of ground water wells. Three stations will be established along two transects which bisect the wetland. Transect location will be determined by measuring 150 and 300 feet from the tidal restriction along the salt marsh creek. At these locations, transects will be laid perpendicular from the creek channel to the upland edge of the salt marsh. Two shallow ground water wells will be installed along each transect, one closer to the bank and the second near the upland edge. A third sampling station at which surface water samples will be collected will be located where the transect meets the creek channel. The shallow ground water wells will be constructed of plastic PVC pipes and perforated geotextile fabric.

Samples will be collected during low, late ebbing, or early flowing tides as long as there is no surface water on the marsh. Standing water will be pumped out of the shallow ground water wells before salinity samples are taken using a hand-held pump. This is to ensure that the water sample consists of recharge water and not rain or surface waters. Once a sufficient amount of groundwater has recharged the well, the water will be extracted from the well using a PVC bailer. Water samples will be collected from the creek channel using the same bailer. A salinity measurement will be taken from the sample using a refractometer.

Each site will be sampled monthly from June/July to August/September. All salinity measurements will be recorded onto the Salinity Field Data Sheet. Data sheets will include names of volunteers, site name/location, station, date, time of sampling, times of low and high tides, approximate tide at sampling, additional observations (including weather), and other relevant information. (Appendix B, p. 14)

Field data sheets are maintained by the Field/Sampling Leader to document each sampling event.

Tidal Hydrology

The goal of the tidal hydrology investigation is to accurately measure the tidal height and duration at each study site. Through this protocol, the amount of hydraulic restriction will be documented for sites subjected to tidal regime alterations through the engineered diking and/or inadequate channelization/culvert-sizing. This information will provide a quantitative measure of each sites' tidal regime, and for sites that are adversely affected by tidal restrictive features, the data will provide hydraulic engineers with the information used to model the proper sizing of new culverts for coordinated efforts to restore degraded salt marsh sites.

At each site, a permanent benchmark will be selected, and its elevation will serve as the reference datum. This datum can be converted to a standardized coordinate datum set, such as the National Geodetic Vertical Datum (NGVD 1929) if local NGDV benchmarks can be located and surveyed.

Staff gauges will be installed in the salt marsh creek channel at locations just up and down from the engineered tidal restrictive feature (e.g. culvert or bridge).

Trained volunteers will take observed readings of the water level at the staff gauge stations, reading the gauge to the nearest tenth of a foot every 15 minutes over the course of a tidal cycle. Observed levels will be recorded on a standard field data sheet (Appendix B, p. 15).

Land Use

The goal of the land use investigation is to document how the land around the salt marsh site is used. Land use is determined partially by consulting color orthophotographs obtained from MassGIS and using GIS technology. The land uses are determined within buffers of 30 meters, 100 meters and 1 kilometer around the wetland. A site visit is also employed as a method to determine land uses that may not be visible from overhead photographs (Appendix B, p. 16-17).

8.0 Sample Handling and Custody Procedures

Macroinvertebrates

On return from the field—where the samples have been preserved in 99% ethyl alcohol and placed in a cooler—the samples will be stored in a refrigerator for no longer than 2 weeks before the invertebrates have been sorted from the debris, and placed in glass vials, preserved in alcohol, and sealed with screw tops. Each vial will be labeled with its sample number and site details. Once the invertebrates have been identified, counted and recorded, they will once again be placed in the original glass vials, preserved in alcohol, and sealed with screw tops. The samples will be kept in an archival location for a period of two years to provide an opportunity to take contents to genus and species level, if required, or to perform a QAQC audit.

The sample custody sheet (Appendix B, p. 18) records all samples, their numbers, the site from which they were collected, when they were collected and preserved, their arrival at the laboratory, when they were sorted and preserved in vials, and by whom; when they were identified and counted, and by whom, and where they are archived. At each stage of sample handling the appropriate person completes the appropriate record on the custody sheet. The sheets are kept with the Field/Sampling Leader, who is also responsible for sample archives.

Vegetation, Avifauna, Nekton and Salinity

No samples are taken from the field, as these investigation components are conducted in-situ.
If a particular species of vegetation or fish cannot be identified by the volunteers or Field/Sampling Leader, a representative specimen may be removed for laboratory identification. In this case, the sample will be preserved, labeled (with station name, site ID, date, and time) and transported by the Field/Sampling Leader.

Tidal Hydrology
No samples are taken from the field. Data sheets are transferred to the Field/Sampling Leader following a survey run.

Land Use
No samples are taken from the field. Data sheets are transferred to the Field/Sampling Leader following a survey.

9.0 Analytical Methods Requirements

Macroinvertebrates
Once in the lab, the samples will be sorted, and the macroinvertebrates will be identified and preserved according to the following protocol.
Depending on the sample size, a portion of the sample—approximately 100 to 200 ml—will be carefully placed in a #30 sieve. The sample will be carefully rinsed and then backwashed onto a white, enamel sorting tray. The sample will be spread over the tray with a small volume of water, and care will be taken to remove any clinging organisms from the sieve. The tray will be placed on a desk or work bench, under strong light, and with the hand lens and forceps, the invertebrates will be removed from the vegetation and detritus and placed into a vial two thirds filled with alcohol or other preservative. The sample will be sorted by trained team members in the laboratory under the supervision of the principal investigator. The principal investigator will check the debris from each sorted sample for any remaining organisms. Organisms from the same sample will be placed in preserved (alcohol-filled) vials, and the above process will be repeated for the entire sample. Each sorted and preserved sample vial will be logged with information detailing who sorted and when the sorting was done.

For the identification, the contents of each sample vial will be examined and recorded individually to be able to make comparisons between sampling methods and habitats. The contents of each vial will be emptied into a petri dish, ensuring no organisms are left on the sides of the emptied vial. The petri dish will be placed under the dissecting scope starting at 10X, and if necessary increasing the magnification to verify identification, in a deliberate, systematic manner, scanned back and forth. Using standard taxonomic keys for all identifications (Fauchald 1977, Weiss 1995, and Pollock 1998), the invertebrates will be identified to family level only. The results will be recorded and enumerated for each taxon (Appendix B, p.19-21). As each individual organism is identified and registered, it will be removed with forceps and returned to a labeled storage vial, two thirds full of 99% ethyl alcohol. If, at some future date, it is thought to be necessary to identify the collection for the project to a lower level of taxonomy, it will be possible. If the total number of organisms for each composite sample exceeds 100, then the 100-organism sub-sample procedure (from Barbour et al., 1999) may be adopted. This prescribed method of sub-sampling provides a representative estimate of the marine fauna as well as a consistent unit of effort. It is appropriate for rapid assessment protocols with limited time and financial resources.

Vegetation, Avifauna, Nekton, Tidal Hydrology and Land Use
There is no calibration for these surveys. Taxonomic identification and abundance reporting are completed in the field on standard field sheets (see Section 7.0).

Salinity
Instrumentation (refractometer) is calibrated before each sampling event.

10. Quality Control Requirements

10.1 Field QC Checks

The Field/Sampling Leader will be present during all sampling events, closely observing, instructing and correcting volunteers as needed to assure correct procedures and quality of monitoring data are taking place. The Field/Sampling Leader will be trained in all aspects of scientific monitoring by the Scientific Advisors. The Scientific Advisors have extensive knowledge and background in their field of study. Scientific Advisors will also accompany the Field/Sampling Leader and volunteers one to three times throughout each sampling season. Accuracy of identification and assessment of protocols will be evaluated by the Scientific Advisors who will report any issues of concern to the Program QA Officer and the Field/Sampling Leader. The Program QA Officer will evaluate the issues of concern and will identify corrective actions if necessary with the input of the Scientific Advisors. The deviations and corrective actions will be reported to the Field/Sampling Leader, the Program Manager, and the EPA QA Officer. Corrective action will be implemented if needed, which may include specimen identification confirmation (for samples retained from the sampling event), rejection of the data, and resampling. The cause of failure will be evaluated to prevent reoccurrence.

10.2 Data Analysis QC Checks

Erroneous values and outliers or any suspect data will be reviewed by the Program QA Officer. The Program QA Officer will evaluate the suspect data and will identify corrective actions if necessary with the input of the Scientific Advisors. The corrective actions will be reported to the Field/Sampling Leader.

11.0 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Once a year, before that year's active field season, the Field/Sampling Leader will inventory, inspect, and test all field equipment. Broken or defective items will be repaired or replaced.

12.0 Instrument Calibration and Frequency

Equipment Type	Calibration Frequency	Standard or Calibration Instrument Used
Refractometer	Each time used, within 2-3 hours of use	Fresh water, salinity 0 ppt
YSI Salinity Meter	Each time used, within 2-3 hours of use	Standard solutions
YSI DO Meter	Each time used, within 2-3 hours of use	Standard solutions

13.0 Inspection/Acceptance Requirements

Equipment is visually inspected and/or tested before each sampling use. Broken equipment is repaired or replaced.

14.0 Data Acquisition Requirements

The most recent MassGIS color orthophotographs and GIS technology are used to obtain information concerning land usage and acreage of study areas.

15.0 Data Management

The Field/Sampling Leader will inspect field sheets at the end of each sampling day. Within 72 hours, the Field/Sampling Leader will contact any samplers whose field sheets contain noticeable errors or omissions. Corrective action may be implemented, which may include rejection of the data and resampling. The Field/Sampling Leader will make a duplicate copy of the field sheet to keep as back-up.

All data will be entered into a computerized spreadsheet/database program designed for this project and which is compatible with hardware and software used by state agency. As a QC check, the Program QA Officer will review finalized data.

16.0 Assessment and Response Actions

Review of WHAT monitoring and data management activities is the responsibility of the Field/Sampling Leader and the Program QA Officer. Scientific Advisors will accompany volunteers one to three times throughout each sampling season. Accuracy of identification and assessment of protocols will be evaluated by the Scientific Advisors who will report any deviations or issues of concern to the Program QA Officer and the Field/Sampling Leader. The Program QA Officer will evaluate the deviations and concerns and will identify corrective actions if necessary with the input of the Scientific Advisors. The deviations and corrective actions will be reported to the Field/Sampling Leader, the Program Manager, and the EPA QA Officer.

Volunteers in need of performance improvement will be retrained on-site during the evaluation.

17.0 Reports

WHAT final reports will be produced and distributed by March of the following year. These reports will consist of data results, interpretation of data (if possible), information on project status, volunteer highlights, results of QC audits and internal assessments. Summaries of all reports, highlighting the assessment results, project status and volunteer achievements, will be made available to all volunteers.

18.0 Data Review, Validation and Verification Requirements

All WHAT field and laboratory data are reviewed by the Scientific Advisors and the Field/Sampling Leader to determine if the data meet QAPP objectives. Decisions to reject or qualify data are made by the Scientific Advisors and the Program QA Officer.

19.0 Validation and Verification Methods

As part of the WHAT protocol, any sample readings out of the expected range are reported to the Field/Sampling Leader. A second sample is taken by the Field/Sampling Leader as soon as possible to verify the condition. In the case of misidentification of organisms, the volunteers will be retrained in identification techniques.

Once the data has been entered into the WHAT database, the Field/Sampling Leader will print out the data and proofread it against the original data sheets. Errors in data entry will be corrected. Outliers and inconsistencies will be flagged for further review, or discarded. Problems with data quality will be discussed in the final report to data users.

20.0 Reconciliation with Data Quality Objectives

As soon as possible after each sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and resampling may occur. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration/maintenance techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained. Any limitations on data use will be detailed in the final report, and other documentation as needed (see Section 16.0).

21.0 References

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22.0 Appendices

Appendix A:
Resumes

Resume: Bruce Carlisle
Resume: Robert Gough
Resume: Anna Hicks
Resume: Barbara Warren
Resume: Jan Smith
Resume: Anthony Wilbur

Appendix B:
Data Sheets

Habitat Assessment Score Sheet
Salt Marsh Invertebrate Field Sheet
Plant Survey Field Data Sheet
Avifauna Survey Field Form
Nekton Survey Field Form
Salinity Field Data Sheet
Tidal Influence Field Sheet
Invertebrate Samples Record Check
Invertebrate Data Form

Appendix C:
A Volunteer's Handbook for Monitoring New England Salt Marshes