

**Bio-monitoring Proposal:
Mapping and Monitoring of Emergent and Submerged Aquatic Vegetation
in the Reserve System**

1.0 Introduction

Macrophyte communities including emergent tidal wetlands and submersed aquatic vegetation (SAV) beds are important components of estuarine ecosystems. They form buffers between upland systems and the sea and provide complex habitats with irreplaceable value to both coastal systems and their adjacent watersheds. They also serve as important sites for education as well as recreation and are critical components of the National Estuarine Research Reserve System. The presence, growth, and spatial distribution of emergent and submerged vegetation fluctuates over seasonal, annual, and longer time scales in response to natural and anthropogenic causes. Some of these temporal/spatial patterns have been well studied, others are unknown or poorly understood.

Despite their currently recognized values, the distribution, abundance and diversity of these communities have been lost as a direct result of human impact. For example, nearly 50% of the coastal wetlands have been lost in the United States through dredging and filling activities (Dahl 1990). Changes in hydrological regimes through alterations in drainage (Niering and Warren 1980) or tidal flushing patterns (Roman et al. 1984) as well as local subsidence (Davis 1987) have severely impacted many others. In the Chesapeake Bay region beds of submersed aquatic vegetation are currently at their lowest levels of abundance in recorded history (Orth and Moore 1983) and these declines can be directly related to watershed inputs of sediments and nutrients accelerated by human activities (Kemp et al. 1983; Brush 2001).

Natural forces can also have significant influences on these vegetation systems. Storms can be powerful forcing functions modifying these areas over both the short and long term (Davis 1987; Short and Wyllie-Echeverria 1996; Roman et al. 1997). Sea level rise or other changes in water level, as well as global climate change can have a wide range of effects on both submersed and emergent coastal plant communities including: submergence and drowning, changes in salinity, temperature, runoff and water quality, as well as increasing UV radiation (Warren and Niering 1993; Watson et al. 1996; Short and Neckles 1999). Additionally, non-indigenous or invasive plant species can have significant impacts on the structure and function of these habitats (Sandlund 1999).

Evaluating habitat change of vegetation communities can be accomplished at various levels of detail in the landscape. Comprehensive, broad evaluations of habitats typically require the use of airborne or satellite remote sensing tools and imagery. Ground surveys, although not a replacement for remote imagery, provide a level of detail for assessing community composition and change that is complementary to broader scale remote surveys. Additionally, the implementation of statistically rigorous ground surveys can provide a foundation for other monitoring activities related to quantifying the process of change in these communities.

Emergent marshes and submerged aquatic vegetation as defined in this proposal include diverse communities of salt and freshwater tidal marshes, wetlands, floating-leaved plants,

persistent intertidal algae, and SAV (e.g. *Spartina*, *Salicornia*, *Carex*, *Deschampsia*, *Distichlis*, *Phragmites*, *Zostera*, *Ruppia*, *Potamogeton*, *Nelumbo*, *Chara*, *Fucus*, and *Nereocystis*). Although they are important members of estuarine ecological communities, this definition of emergent and submerged vegetation does not include phytoplankton, loosely attached macroalgae, transient mats of macroalgae, nor surface microalgae (i.e. benthic diatoms).

The goal of the NERR System-Wide Monitoring Program (SWMP) is to *"Identify and track short-term variability and long-term changes in the integrity and biodiversity of representative estuarine ecosystems and coastal watersheds for the purpose of contributing to effective national, regional, and site-specific coastal zone management."* Three broad categories have been identified for monitoring: (A) abiotic parameters (i.e. estuarine water quality, nutrients, and local weather), (B) biological monitoring, including communities and habitats, and (C) land-use and land cover in the watershed.

The primary questions addressed by monitoring distribution of submerged and emergent vegetation are broadly applicable within the framework of the NERRS System-wide Monitoring Program: **What are the patterns of inter-annual variability in the area and spatial distribution of emergent and submerged vegetation and what are the patterns of long-term change?** The proposed monitoring of emergent and submerged aquatic vegetation has been divided into two parts: Tier 1 - Monitoring of the overall distribution of emergent marshes and submerged aquatic vegetation within each; and Tier 2 - Monitoring of the vegetative characteristics of selected stands of emergent and submerged aquatic vegetation.

2.0 Tier 1 Mapping and monitoring the overall distribution of emergent and submerged vegetation within reserve boundaries

SAV/Emergent Tier 1 Mapping & Monitoring Workgroup

Doug Bulthuis Chair, Maurice Crawford, Lee Edmiston, Rick Gleeson, Ken Moore, Chuck Nieder, Steve Rumrill, Bob Scarborough, Chris Weidman, Betty Wenner

2.1 Objectives

There are many important questions about emergent and submerged aquatic vegetation communities and habitats that may need to be addressed. Some of these may be addressed with Tier 2 monitoring (Some specific questions that may be addressed with this proposed Tier 1 monitoring are listed in Appendix 2.). In the Tier 1 effort only questions related to changes in areas and spatial distributions of emergent and submerged vegetation within the boundaries of the reserve are addressed. This approach will not deal with all of the important and relevant questions. However, an important principle in monitoring programs is to keep the approach basic and the methods simple so that a reliable program can be implemented and sustained over the long term. Thus, the aim of this Tier 1 approach is to monitor basic area and spatial distribution of vegetative communities at annual and multi-annual time scales. Additionally the approach should follow established protocols as much as possible so that the results will be useful for comparisons with other monitoring efforts and broader questions of change can be addressed.

2.2 Methods

The monitoring of spatial distribution of emergent and submerged vegetation will be addressed by a combination of surveys, remote sensing, ground truth with global positioning system (GPS), georectification and mapping with geographic information system (GIS), and GPS mapping. In general, the protocols adopted for C-CAP (NOAA Coastal Change Analysis Program) and the Chesapeake Bay Program are recommended for use by the reserves (Dobson et al. 1995, NOAA CSC 2001).

The survey methods and remote sensing platforms will necessarily vary among reserves depending on the dominant species present, the areal extent of the species, their depth distribution, water clarity and other factors (Dobson et al. 1995). Ground truth sampling will be required for accurate interpretation of the remotely sensed images. In many of the reserves, color or infrared aerial photography will be the most appropriate platform. In other reserves, satellite imagery may be most appropriate. The diversity of good methods enables individual reserves to use the method appropriate to their vegetation type and size of reserve. Protocols for remote sensing of submerged and emergent vegetation have been developed by several organizations and the protocols used by the reserves will be modified from those protocols, mainly those developed by C-CAP and the Chesapeake Bay Program. Spatial distribution (both total area and location) will be compared among years and among reserves. The most important comparisons will be over time within the same reserve. Thus, the same method or comparable methods should be used within a reserve over time. Comparisons among reserves will be made on the basis of areal coverage of similar species or groups of species and trends in areal coverage over time.

In general, the methods include acquiring remotely sensed images, georectification of images, collection of ground truth data, interpretation of the images and delineation of vegetative areas, entering the data into a GIS format, verification or accuracy assessment, change detection, and report preparation. Most reserves will need to acquire a spatially accurate base map during the first year to provide a basis for georectification in subsequent years as well as providing a base map for later change detection. Thus, costs during the first year may be much greater than during subsequent years. Each of these methods may be done "in-house" with reserve staff depending on reserve needs and capabilities, or contracted out to university, private consultants, non-profits, or to other agencies. Some additional details regarding these steps are provided in Appendix 2.

2.3 Implementation

We recommend four inter-related tasks be funded during FY04 in order to provide the basics for advancing the mapping and monitoring of emergent and submerged vegetation in the NERRS. A fifth optional task could fund a reserve to develop individual implementation plans for each reserve. These tasks should provide the NERRS with a realistic implementation strategy and cost estimates for system wide implementation. A possible schedule is included in Appendix 3 and illustrates 1) the need for the protocols committee to act quickly starting in October 2003 if this pilot proposal is funded; and 2) the need for pilot reserves to begin work in spring 2004 before any FY04 funds arrive from NOAA.

Task 1. Protocol development for the NERRS

0 - \$5000

Task 2. Pilot implementation at 3 to 5 reserves	\$225,000 - \$300,000
Task 3. Pilot data archive, management, and display	\$20,000
Task 4. Synthesis, coordination, and recommendations	\$8000
Option Task 5. Implementation strategy for each reserve	\$30,000 - \$50,000
FY05 Pilot implementation at 3 to 5 reserves	\$225,000 - \$300,000

2.3.1 Task 1 Protocol development for the NERRS.

Protocols for the NERRS will need to be developed for mapping and monitoring of emergent and submerged vegetation at the level of accuracy to detect long term changes in spatial location as well as area covered. There are several method summaries and guidance documents available. Three that may be particularly helpful for the NERRS are the C-CAP guidance (Dobson et al. 1995), *Submerged Aquatic Vegetation: Data Development and Applied Uses* by NOAA Coastal Services Center, and the methods used in the Chesapeake Bay Program. However, these guidance documents do not provide “cookbook” methods, which can be used at all reserves. There is and will be a need for a trade-off between general protocols for the NERR system and tailoring methods to local vegetation and environmental conditions that the above documents recommend. Protocols for the NERRS need to be outlined before pilot studies can be initiated. The protocols will need to be modified with the results of the pilot studies, and further modified as other reserves implement mapping and monitoring of emergent and submerged vegetation. We recommend a **small** committee of NERR staff be appointed, probably 2 RCs, 1 SC and 1 staff from CSC. If tasks 2 and 3 are recommended at the October 03 meeting, then this committee would begin work in October and help guide the work in Tasks 2 to 4 (or 5). The costs up to \$5000 are for possible travel for the committee and possible consulting costs for CSC staff. (≈ \$5k)

2.3.2 Task 2. Pilot implementation at 3 to 5 reserves.

Pilot studies at 3 to 5 reserves are recommended so that realistic cost estimates and implementation issues can be identified. The reserves should represent both those with experience and without experience in habitat mapping, both those with emergent and submerged vegetation as the main vegetation type, and all pilot reserves should be able to start implementing the pilot study in summer of 2004. (This last requirement is needed to insure some results from pilot sites by 2005 and may limit possible pilot reserves to those that begin their operations grant in June or July.) The \$75,000 cost estimate per reserve is based on a couple of reserves that have conducted some vegetation mapping both in-house and contracting with a partner. Rough cost estimates made by several different reserves varied from \$40k to \$100k per mapping/monitoring cycle. The actual costs can be more accurately estimated after there have been a couple years of experience by a few of the reserves. One important cost variable among reserves will be the total area to be mapped and monitored. It is expected that first year costs will be considerably greater than the following years of monitoring. (Four reserves at up to \$75k each for a total of \$300k.)

2.3.3 Task 3. Pilot data archive, management, and display

The data collected in the mapping and monitoring of emergent and submerged vegetation will be GIS based data and thus fundamentally different from other data collected by the

reserves. Archiving and display of these data for the system as a whole should be planned and developed at the same time as pilot projects at the reserves. In particular, there may be basic decisions about GIS software that may enable later comparisons or display. There are several institutions that may be able to provide this service including CDMO, Coastal Services Center (that hosted the NERRS ESDIM project that included GIS data) and the Virginia Institute of Marine Science that hosts the Chesapeake Bay SAV monitoring program. The costs to help develop the methods and display the pilot sites data are unknown and the \$20,000 figure is "out of the blue" but would mainly cover staff costs and maybe some software and computer operating costs to archive and display results from pilot sites. Whoever is funded for this task would need to work closely with the protocol development committee (Task 1) and the Coordinator (Task 4). ($\approx$ \$20k)

2.3.4 Task 4. Synthesis and coordination for pilot projects and recommendations for future implementation.

One reserve will need to be funded to coordinate and synthesize the results from the pilot sites (Task 2) and work with the protocol committee (Task 1) and the Task 3 institution to draft the recommendations for implementation. This Research Coordinator should probably be one of the pilot reserves although other options are possible. Without this task, the collective experience of the pilot reserves is unlikely to be effectively incorporated into the NERRS and SWMP planning. The task is not trivial and it is not recommended that a task of this magnitude for the system as a whole be carried by one reserve without specific funding. Precedents have been set in earlier pilot studies and have demonstrated that the coordinating and summary roles have been critical. ($\approx$ \$8k)

2.3.5 Task 5. Implementation strategy for each reserve.

It is clear that there are a variety of vegetation types and capabilities among reserves. We recommend that one reserve receive 100% funding to work individually with each reserve, assessing vegetation types and GIS and remote sensing capabilities on and off site and working with Research Coordinators, Stewardship Coordinators, GIS Specialists and other Reserve staff to develop a strategy and cost estimate for implementation at that reserve. Costs may vary by large amounts at individual reserves, particularly for initial set-up, depending on availability of high accuracy shoreline data, orthophotography, detailed bathymetry, etc. The funds would be used to fund a staff person at one reserve to work with staff at all reserves to develop the strategy. A 2-3 page proposal would be developed for each reserve outlining the primary vegetative communities to be monitored, a strategy for implementation at that reserve, and any special issues or problems that would need to be addressed for implementation. If the Strategic Committee gives the go ahead, a more detailed proposal for this task could be developed before the October 2003 meeting. ($\approx$ \$30-50k)

2.3.6 FY05

Results from the first set of pilot studies will not be available at the time that decisions need to be made for FY05. Therefore, it is recommended that 3 to 5 additional reserves be funded as pilot sites for monitoring of emergent and submerged vegetation during FY05.

2.4 System-wide and long-term implementation and cost estimates

System wide and long-term implementation of this aspect of the biological monitoring program would include development of base maps and capability at each reserve using either in-house staff, a partnership with a local institution, or some combination, regular (annual to every five years depending on predominant vegetation and patterns of change) updates. GIS infrastructure at the individual reserves will be built up or enhanced for reserves that use in-house capabilities and staff. Implementation of this monitoring will then build on the investment that has already been made in GIS at the reserves (via PAGIS etc.), and will help build the capacity at the reserves to implement other GIS related tasks (e.g. land use and upland habitat).

The costs per reserve will vary significantly depending on the size of the area to be mapped, the accuracy and resolution required, and the infrastructure already present. Rough cost estimates made by several different reserves that have conducted some aspects of the mapping that would be required have varied from about \$40k to \$100k per mapping/monitoring cycle. The actual costs can be more accurately estimated after there have been a couple years of experience by a few of the reserves. One important cost variable among reserves will be the total area to be photographed and monitored. It is anticipated that after the initial base maps and in-house expertise and support are in place, the recurring costs for mapping and monitoring will decrease. If the cost estimates of about \$75k per reserve prove to be what is needed for each mapping cycle, then the NERR System could set up a rolling cycle of six reserves monitoring each year for a total of \$450k per year. Each reserve would monitor emergent or submerged vegetation every third year. If costs per reserve were lower, then perhaps each reserve could monitor every other year. (Large fluctuations in awards for GIS every second or third year could be a major problem for reserves using in-house expertise.)

3.0 Tier 2: Long-term Monitoring of the Vegetative Characteristics of Estuarine Submersed and Emergent Vegetation Communities

SAV Emergent Tier 2 Mapping and Monitoring Workgroup: Ken Moore (chair), Doug Bulthuis, Michelle Dionne, Lee Edmiston, Mike Kennish, Steve Rumrill, Mike Shirley, Betty Wenner, Chuck Nieder, Jean McAvoy, Elizabeth Vernon, Beth Thomas, Bill Roberts, Kim Bothelo, Julie Bortz and Sharon Riggs

3.1 Objectives

Evaluating habitat change of vegetation communities can be accomplished at various levels of detail in the landscape. Comprehensive, broad evaluation of habitats typically requires the use of airborne or satellite remote sensing tools and imagery. Ground surveys, although not a replacement for remote imagery, provide a level of detail for assessing community composition and change that is complementary to broader scale remote surveys. Additionally, the implementation of statistically rigorous ground surveys can provide a foundation for other monitoring activities related to quantifying the process of change in these communities.

The objectives of the Tier 2 monitoring are to implement a monitoring protocol for emergent and submersed vegetation communities that:

1. Are designed to quantify emergent and submerged vegetation patterns in specific areas of interest or concern and their change over space and time;

2. Are consistent with other monitoring protocols used nationally and worldwide;
3. Can be consistently used over a wide range of estuarine sites and habitats, and for a variety of reserve specific purposes;
4. Can be used as a foundation for quantifying relationships among the various edaphic factors and the processes that are regulating the patterns of distribution and abundance in these communities;
5. Provide detailed information that can be used to support comprehensive remotely sensed mapping of vegetation communities and other NERRS System Wide Monitoring Program data collection, as well as NERRS/NOAA education, stewardship and restoration efforts.

3.2 Methods

The approach proposed here consists of fixed transects with permanent sampling stations located along transects that can be stratified, if necessary, within vegetation zones or segments of the marsh or submersed vegetation beds. This approach has been used in a variety of studies for assessments of vegetation communities (Doumlele 1981; Moore et al. 1995; Perry and Atkinson 1997; Perry and Hershner 1999) and has been recently adopted as a monitoring protocol by the National Park Service and others to assess and compare both reference and restoration wetland sites on local and regional scales (Neckles and Dionne 2001; Roman et al. 2001; Neckles et al. 2002). Additionally, similar protocols have been established for quantification of seagrass dynamics in a global seagrass monitoring program (<http://www.SeagrassNet.org>; Short et al. 2002).

3.2.1 Task1: Emergent and SAV Study Sites Selection

Control or reference sites are first identified as areas that have historically not been markedly impacted by natural or anthropogenic factors. The areas should also be representative of natural estuarine vegetation communities in the region. These determinations may have to be made using the best professional judgment of scientists based upon available information for each reserve. The focus of this proposed detailed vegetation monitoring can vary with each reserve's particular circumstances or goals. For example, in the Chesapeake Bay Reserve in Virginia (CBNERRVA), a different emergent marsh community is associated with each of the four reserve sites (<http://www.vims.edu/cbnerr/reservesites/index.htm>). These tidal marsh systems are located along the York River estuary and each encompasses a different salinity regime of the estuary. Each could serve as a reference site. However, since seagrass beds are known to be associated with only the most downriver reserve site, the submersed macrophyte sampling would only be conducted there.

Other sites that represent some potential impacts that are of interest to the reserve could also be established for comparative monitoring. Some potential impacts include:

1. Invasive or non-native species expansions.
2. Rare species declines

3. Changes in hydrology, geomorphic process, sea level rise or salinity intrusions.
4. Catastrophic impacts such as oil spills or storms.
5. Direct or indirect human impacts such as dredging, diking, filling or subsidence due to groundwater withdrawal or other factors.
6. Disease.

Similarly, emergent or submerged areas that currently, historically or will be the focus of restoration efforts, either directly or indirectly through watershed modifications could be chosen for study. Other factors related to education or stewardship goals could also be used in site selection. The objectives of monitoring each specific site should be chosen apriori by each reserve, however, the protocols proposed here can be applied to additional sites chosen in the future. For example, if additional property were acquired as part of a particular reserve and wetlands on that property were the focus of restoration efforts, the habitat change associated with those efforts could be quantitatively monitored over time or could be compared to an existing reference site if appropriate.

3.2.2 Task 2: Emergent and SAV Sites Delineation

The emergent or submersed habitat of interest for study should be delineated and the boundaries defined apriori. A general base map should be developed providing the fundamental features of the site. The degree of detail of this reference map will be dependent on the extent of the geographical detail of the region. Typically, topographic quadrangles, digital orthophoto quarter quadrangles, vertical or oblique photographs could be used.

Stratification of a study area into segments of similar community type based upon the dominant environmental gradient may be necessary if a significant environmental or other gradient exists (Roman et al. 2001). For example an emergent creek marsh system dominated by an upstream-downstream salinity gradient or a restriction in tidal flushing could be stratified into two or more segments (Figure 1). Similarly a submersed aquatic vegetation community affected by a gradient of exposure (fetch), sediment type or some water quality characteristic such as salinity, or tide range could be stratified into several segments.

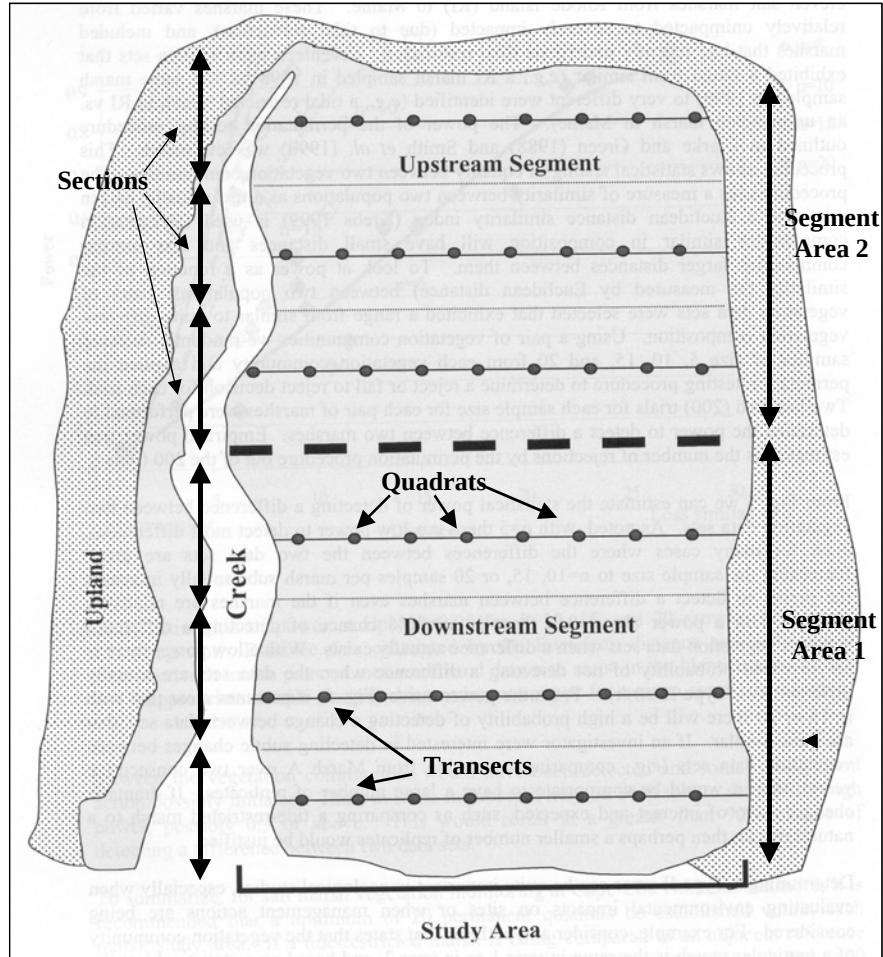


Figure 1. Emergent Marsh Tier 2 Sampling Design
(from Roman et al. 2001)

3.2.3 Task 3: Emergent Vegetation Sampling Setup

Each segment of a study area may then be systematically divided into equal sized sections, if necessary (e.g., for large study systems), to achieve good interspersed samples throughout the area. One or two transects are then randomly located within each section so that a total of three to five transects will be located in a segment for a total of approximately 20 quadrats. Individual transects should be no less than 10m apart to maintain independence and should cover an area that is representative of the segment. Each transect should traverse the elevation gradient from the creek bank to the upland. A detailed description of transect

establishment for an emergent wetland study site using this approach is provided in Roman et al. 2001 (www.nature.nps.gov/im/monitor/protocoldb.cfm).

The first permanent plot on each transect should be randomly located within the marsh zone adjacent to the creek bank or open water. For example, if the creek marsh zone is only 3 m wide then this zone is divided into five 60 cm intervals and the first permanent quadrat is randomly located at the mid-point of one of the five intervals. Similarly, if the creek marsh zone is 30 m wide then the first quadrat is located randomly within the first 10 m of the transect.

The remaining plots are then located at regular intervals along each transect. A total of approximately 20 plots per marsh segment are required for adequate sampling power (Roman et al. 2001), therefore the permanent plot intervals should be adjusted for the overall area of the marsh to achieve this replication. No permanent plots should be less than 10m apart. Scaling of placement of the plots across the landscape will depend on the scale of the study area. For example, a larger marsh could have permanent plots placed at 20m intervals along each transect with individual transects 50m apart. Alternatively, a smaller creek marsh could have permanent plots placed at 10m intervals, with transects 10m apart. Each permanent plots is then permanently marked with labeled stakes driven into the marsh. Sampling plots one meter on a side (Roman et al. 2001) are offset approximately 1 m from the marking stake perpendicular to the transect line and two diagonal corners of each plot are marked with small stakes. A groundwater well is established 1 m from the marking stake at 180° from the sampling plot (Fig. 2). The capped wells will be constructed from schedule 40 PVC extended approximately 50 cm into the marsh surface (after Roman et al. 2001).

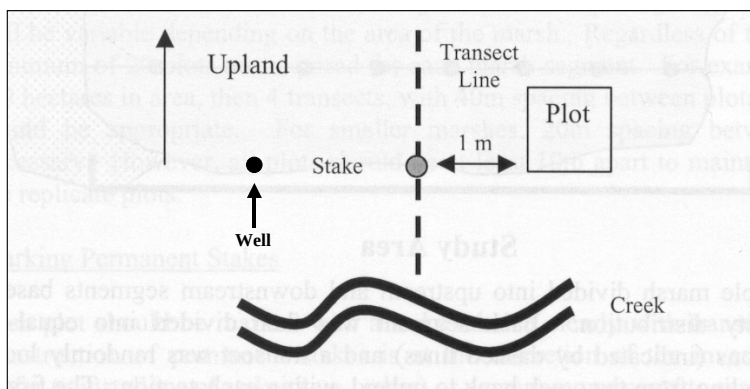


Figure 2. Sampling Plot and Well Orientation
(modified from Roman et al. 2001)

3.2.4 Task 4: Emergent Vegetation Sampling

Each 1m² plot is sampled non-destructively for visual estimates of percent cover for each species or cover category (i.e., wrack, bare ground). A variety of plant cover estimates are available. Here a percent cover estimate with 5% intervals is proposed based on a reference

cover guide that will be established to assist in standardization. This approach is chosen to permit more rigorous statistical analyses than a non-linear approach will allow. In addition to cover estimates, species' shoot or stem densities and each species' maximum canopy height is to be determined within each plot. If the vegetation is very dense then the plot may be sub-sampled. The groundwater well is sampled for salinity/conductivity.

Sampling should be conducted at least during the annual maximum biomass for the marsh plant community in the study area. All sampling should be completed within a two-three week interval, if possible, and should be conducted during low tide to minimize surface water effects. In salt marsh areas this typically period will occur in late summer. In freshwater marshes the plant community may progress through several periods of changing species dominance and sampling may have to be repeated 2-3 times during the growing season (Doumlele 1981; Odum et al. 1984). If the growing season patterns are unknown for the study region, initial monthly sampling should be undertaken during the first year to delineate the seasonal peak(s). Annual sampling should be initially repeated at a 1-2 year intervals and subsequently at 3-5 year intervals depending on the system. If the study area is a restoration or impacted site then the sampling should be repeated annually until the recovery period or rate of change slows.

3.2.5 Task 5: Submerged Aquatic Vegetation Sampling Setup

Beds of SAV are typically found growing along an open shoreline of a bay, lagoon or tidal estuary or river. In most cases the study bed or vegetated area can be considered one segment. Transect placement is similar to the emergent vegetation transect placement, but may not necessarily be a continuation of the emergent vegetation transects if there are no adjacent emergent wetlands. Individual transects are located by first dividing each study area into equal sized sections. One or two transects are randomly located within each section so that a total of four or five transects are established across the study area. Each transect should traverse the elevation gradient from the shoreline bank to the deepest edge of the bed. Transects should be located no less than 10m apart to maintain independence and should cover an area that is representative of the section. The first permanent plot should be located at a random distance off a suitable benchmark on the shoreline (i.e., mean low water-MLW). For example, if the unvegetated, subtidal zone is only 3 m wide then the zone is divided into five 60 cm intervals and the first permanent quadrat is randomly located at one of the five intervals. If the unvegetated, subtidal zone is 30 m wide then the first quadrat is located randomly within the first 10 m of the transect. If the subtidal transect is a continuation of the tidal marsh transect then the first plot location should be located off the initial emergent plot. Differences in scale of the width (shallow to deep, or upland to water edge) of the separate communities may necessitate that the sampling plot intervals be different between the emergent and submersed habitats or portions of the transects. As with the emergent community a total of at least 20 plots per submersed bed study area are required for adequate sampling power, therefore the permanent plot intervals should be adjusted for the area of the bed to achieve this sampling replication. No permanent plots should be less than 10m apart. Because the location and depth of outer edge of a SAV bed can have important implications related to environmental conditions affecting bed dynamics, the location and depth of the outer bed edge should be delineated. As SAV abundance may gradually lessen with depth depending on the depth contour, the outer bed edge may have to be estimated. Typically, it is defined as less than 5% cover.

The permanent transects should be fixed by placing permanent PVC poles and/or stakes at intervals along each transect (Figure 3). A minimum of two to three poles and underwater stakes per transect should be established at appropriate intervals depending on the scale of the study area. If poles are not feasible then at least underwater stakes extending a suitable distance above the sediment surface should be established. In many systems stakes placed 50m to 100m apart and extending 25 cm above the sediment surface are suitable. In large systems the transects may have to be established and marked using GPS, buoys or other appropriate techniques.

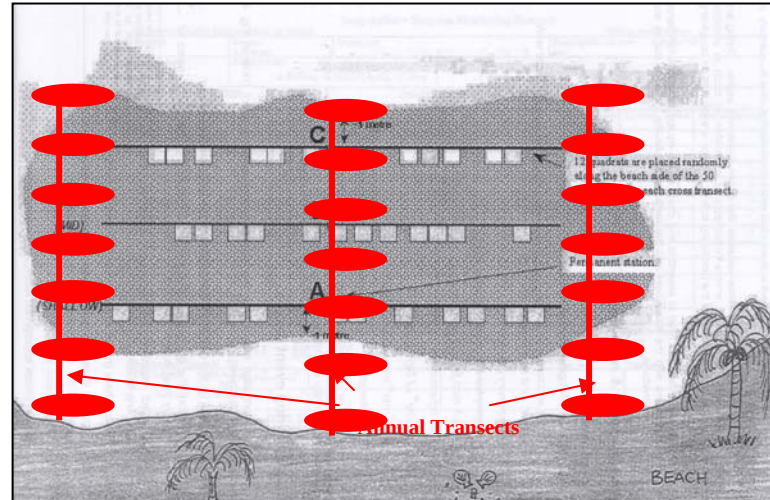


Figure 3. Example of SAV Tier 2 Permanent Transects and SeagrassNet Transects (Modified from Short et al. 2002)

Each sampling plot is offset approximately 1m from each individual plot location along the transect. The sampling plots are located by stretching a 100m or longer plastic or fiberglass measuring tape or non-stretching line between the transect poles. If permanent poles cannot be established then temporary poles of PVC or other locally available material are established for the duration of the sampling.

3.2.6 Task 6: Submerged Aquatic Vegetation Transect Sampling

Each plot is sampled non-destructively for percent cover by each species or cover category (ie. bare ground, detritus) within a 0.25 m² area. (However, SAV clonal patchiness may require a much larger sampling area than 0.25m²). In addition to cover estimates, species shoot or stem density and each species' maximum canopy height should be determined within each plot. If the vegetation is very dense then the plot may be sub-sampled for density, height and leaf or shoot width as appropriate for the community (van Tussenbroek 1996; Short 1983; Phillips 1983). An area reserved for sampling other factors such as sediment nutrients, pore water sulfide, sediment deposition, etc. should be located at a 1m fixed distance from the stake oriented 180° from the sampling plot. Voucher specimens including flowers, fruits and belowground material of each species and their various morphological variants should be sampled and appropriately preserved by each reserve.

Sampling should be conducted during the annual maximum biomass for the SAV species in the study area. All sampling should be completed within a two-three week interval if possible. In many seagrass areas this typically will occur from early to mid summer. In freshwater SAV areas this period may occur in late summer or early fall (Moore et al. 2000). In mixed species SAV communities such as those in the lower Chesapeake Bay (Orth and Moore 1986) there may be seasonal dominance of one species (*Z. marina*) in early summer and another (*R. maritima*) in the late summer and two samplings may be required. If the growing season patterns are unknown for the region, initial monthly sampling may be required to delineate the season peak(s). Since SAV can be subject to significant year-to-year variability in abundance, annual sampling should be conducted. If the study area is found to be consistently stable then monitoring intervals can be extended to 2-3 years or more.

3.2.6 Task 7: SAV SeagrassNet-Based Sampling

SeagrassNet is a global monitoring program developed to investigate and document the status of seagrass and SAV resources worldwide. Here we are proposing to adopt this protocol (Short et al. 2002) as an optional component of the NERRS submersed vegetation monitoring. For reserves selecting this approach it will provide detailed, complementary information relative to the structure of the vegetation communities. In addition, it will permit detailed comparisons of the status and trends of submersed vegetation communities in the NERRS reserves with seagrass and other SAV communities worldwide. The SeagrassNet program started with a pilot study in seven countries of the Western Pacific in 2001 and is now expanding to other countries. Its purpose is to develop a network of intensive monitoring sites linked via the World Wide Web by an interactive database (www.seagrassnet.org). The monitoring component consists of a science oriented monitoring program that is based on specific standardized monitoring protocols (Short et al. 2002). The general approach of this detailed monitoring protocol is to establish three, permanent, 50-m wide, cross-transects that are oriented parallel to the shoreline near the inner edge, middle and outer edge of the SAV bed. The center of the transects would be located along a perpendicular transect located as above (Figure 3).

The sampling is repeated quarterly (every three months). Two weeks prior to each sampling a Hobo® (Model 8-004-02; MicroDAQ.com, Ltd) light logger is deployed at the midpoint of each of the three cross-transects, and an additional logger is placed on shore above the high tide elevation. Six quadrates are located randomly along the 25 m cross-transects to the left and right of the centerline. Sampling of each 0.25m² quadrat consists of: vertical photographs using disposable cameras; visual % cover; water depth and local time; canopy height for dominant species; evidence of grazing recorded; flower and fruit counts. A biomass core is sampled 0.5m adjacent to the quadrat. The vegetation is separated into leaves, sheaths and stems, and belowground material. The shoots are counted by species. Dry weights are then determined on all components. Triplicate, small (20 cc syringe) sediment cores are sampled from the mid-point of each cross-transect for organic content and grain size (Short and Coles 2001). The distance to channelward seagrass edge (continuous meadow) and distance to last shoot (most offshore) and distance from the shore to the shallowest edge is measured to evaluate any bed migration. Voucher specimens of each species identified including shoots, flowers and fruits (if available) and belowground material should be collected and appropriately stored by each

reserve. Duplicate specimens would be sent to SeagrassNet where they are currently housed in a special collection at the Smithsonian Institution.

Currently individual SeagrassNet participants send all voucher specimens, field photographs and field data to the Jackson Estuarine Lab for data summarization; further sample processing, QA/QC and archiving. Field data are entered directly into the web. All other processing is done locally. For NERRS, one reserve could serve the archival function as well as serving as the focus of the interactive database. Data QA/QC would be done locally and then sent directly to CDMO for archiving and in a manner similar to the current nutrient monitoring data.

3.2.7 Task 8: Data Analyses

Analysis of long-term trends would be undertaken by each reserve to answer their specific questions relative to their SAV and emergent Tier 2-based, transect sampling. Non-parametric statistical tests of emergent and submerged, transect-based sampling can be used to evaluate similarities of vegetation communities between sites or over time (Roman et al. 2001). Ordination techniques and similarity indices as well as regression techniques can also be used to develop hypotheses relative to community structure or relationships between vegetation and other environmental factors. Data files would be archived at CDMO in a form similar to the ongoing station-based nutrient sampling.

3.3 Implementation and Cost Estimates

It is proposed that approximately 3-4 reserves serve as sites for the initial implementation of the Tier 2 emergent sampling and a similar number for the Tier 2 SAV sampling during 2004. During this first year monthly transect sampling has been proposed to quantify the annual peak(s) in abundance. After the first year only sampling at the annual peaks in biomass sampling is proposed. In some reserves there will be multiple peaks in biomass so several samplings per year may be required. Approximately one-person month of effort is proposed for Tasks 1 and 2. Approximately one person-month (two individuals for two weeks) would be required for setting up the transects for each study area (Tasks 3 or 5). After that, approximately ½ a person-month for each sampling (Tasks 4 or 6). Data reduction and analysis would require another ½ person month per sampling (Task 8). Overall, during Year 1 approximately 1 person-year of effort would be required. Salary cost per reserve would be approximately \$56,000 (including fringe) with approximately (\$2,000 initially and \$1,000 subsequently in supplies and equipment plus indirect costs. The total would be approximately \$58,000 each, for the emergent and the SAV. After the initial year, sampling costs would be reduced proportionally. Assuming four samplings per year the costs are estimated at approximately \$16,000 per year per study area.

SeagrassNet based sampling (Task 7) is conducted quarterly requiring approximately ½ person month per sampling per site. Total costs are estimated at approximately \$10,000 per year. During the first year additional costs would be incurred for training and other one-time expenses for an additional \$5,000. Currently, the SeagrassNet data is managed at the University of New Hampshire, however it is proposed that NERRS manage its own data. Ultimately tabular data would be archived and made available through CDMO, however, because of the SAV related technical data that would be generated it is proposed that one reserve with SAV technical

expertise be the clearing house and web-based server for the information. Additional cost for this effort are estimated at approximately \$25,000 per year.

Tier 2 Cost Summary (Yearly Per Reserve for Emergent or SAV, no indirect)

Tasks 1, 2	Study site selection and delineation (one time expense)	\$4,000
Tasks 3 or 5	Transects Setup (one time expense)	\$4,000
Tasks 4 or 6	Vegetation Sampling (initial 12 per year)	\$26,000
	Vegetation Sampling (subsequent 4 per year)	\$9,000
Task 7	SeagrassNet Sampling (initial year)	\$15,000
	SeagrassNet Sampling (subsequent years)	\$10,000
	Technical Data Management (one reserve)	\$25,000
Task 8	Transect Data Reduction and Analysis (initial 12 per year)	\$24,000
	Transect Data Reduction and Analysis (subsequent 4 per year)	\$8,000

3.4 Science Implications

This proposed sampling design is based upon established, peer reviewed and published protocols and is consistent with other ongoing emergent and submersed monitoring programs. The spatial design and sampling intensity is appropriate for long term monitoring where the objective is to compare specific study areas over time. Some specific questions that can be tested may be related to: What is the change in non-impacted habitat, degraded or recovering habitat over time? How do specific impacted and un-impacted emergent and submersed vegetation in a reserve compare? What is the effect of invasive species on the plant community? What factors are related to observed vegetation changes? How is global climate change and relative sea level rise affecting representative vegetation areas in the reserves? Are any changes in vegetation communities among the reserves consistent?

3.5 Management Implications

Quantification of habitat changes both within and among the reserves in the reserve system is an important NERRS goal. In addition, the developing strategy and framework for NERRS restoration efforts requires consistent, “Scientifically-based” monitoring studies that can be applied similarly to natural, impacted and restored sites, so that the effectiveness of habitat restoration and well as quantification of cause and effect relationships can be measured. Additionally, accurate evaluation of change in coastal vegetation systems at the national and international level requires that consistent methodologies be applied so that any broad trends can be more clearly determined. Evaluating patterns of non-native and invasive species expansion across broad regions also requires a consistency of approach. The emergent and submersed vegetation monitoring approach proposed here will address these and other management objectives.

4.0 Literature Cited

Brush, G.S. 2001. natural and anthropogenic changes in Chesapeake Bay during the last 1000 years. Hum. Ecol. Risk Assess. 7: 1283-1296

Dahl, T.E. 1990. Wetland losses in the United States, 1780s to 1980s. United States Department of the Interior, Fish. and Wildlife Service, Washington, DC. 21 pp.

Davis, R.A. and M. Andronaco. 1987. Impact of hurricanes on Pinellas county, Florida, 1985. Sea Grant Report, University of south florida. Gainesville, Fl. 53 pp.

Dobson, J.E., E.A. Bright, R.L. Ferguson, D.W. Field, L.L. Wood, K.D. Haddad, H. Iredale III, J.R. Jensen, V.V. Klemas, R.J. Orth and J.P. Thomas. 1995. *NOAA coastal change analysis program (C-CAP): guidance for regional implementation*. 92 pp. [Prepared for CoastWatch Change Analysis Project, Coastal Ocean Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce]. U.S. Department of Commerce, NOAA, National Marine Fisheries Service: NOAA Technical Report NMFS 123.

Doumlele, D.G. 1981. Primary production and seasonal aspects of emergent plants in a tidal freshwater marsh. *Estuaries* 4: 139-142.

Kemp, W.M., R.R. Twilley, J.C. Stevenson, W.R. Boynton, and J.C. Means. 1983. The decline of submerged vascular plants in upper Chesapeake Bay: Summary of results concerning possible causes. *Mar. Technol. Soc. J.* 17: 78-89.

Moore, K.A., J.L. Goodman, J.C. Stevenson, L. Murray and K. Sundberg. 1995. Chesapeake Bay nutrients, light and SAV: relations between variable water quality and SAV in field and mesocosm studies. Final Report. CB003909-02. EPA Chesapeake Bay Program, Annapolis, MD. 106pp.

Moore, K.A., D.L. Wilcox, and R.J. Orth. 2000. Analysis of abundance of submersed aquatic vegetation communities in the Chesapeake Bay. *Estuaries* 23: 115-127.

Neckles, H.A. and M. Dionne (eds.) 2001. Regional standards to identify and evaluate tidal wetland restoration in the Gulf of maine. Wells National Estuarine Research Reserve Technical Report, Wells, Maine. 21pp.

Neckles, H.A., M. Dionne, D.M. Burdick, C.T. Roman, R. Buchsbaum and E. Hutchins. 2002. A monitoring protocol to assess tidal restoration of salt marshes on local and regional scales. *Res. Ecology* 10: 556-563.

Niering, W.S. and R.S. Warren. 1980. Vegetation patterns and processes in New England salt marshes. *BioScience* 30: 301-307.

NOAA/NOS. 1999. national Ocean Service Strategic Plan, 1999-2004. NOAA/National Ocean Service. Silver spring, MD.

NOAA Coastal Services Center. 2001. Submerged Aquatic Vegetation: Data Development and Applied Uses CD-ROM. U.S. Department of Commerce, NOAA, Coastal Services Center: NOAA/CSC/20116-CD.

Odum, W.E., T.J. Smith, J.K. Hoover and C.C. McIvor. 1984. Ecology of tidal freshwater marshes of the United States east coast: A community profile. Biol Serv. Program, Fish. Wildl. Serv. 190 pp.

Orth, R.J. and K. A. Moore. 1983. Chesapeake Bay: an unprecedented decline in submerged aquatic vegetation. Science 22: 51-52.

Orth, R.J. and K.A. Moore. 1986. Seasonal and year-to-year variations in the growth of of Zostera marina L. (eelgrass) in the lower Chesapeake Bay. Aquat. Bot., 24:335-341.

Orth, R. J., D. J. Wilcox, L. S. Nagey, J. R. Whiting, and J. R. Fishman. 2001. 2000 Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay and Coastal Bays. VIMS Special Scientific Report Number 142. Final report to U.S. EPA, Chesapeake Bay Program, Annapolis, MD. Grant No. CB993777-02-0, <http://www.vims.edu/bio/sav/sav00>

Perry, J.E. and R.B. Atkinson. 1997. Plant diversity along a salinity gradient of four marshes on the York and Pamunkey Rivers in Virginia. Castanea 62: 112-118.

Perry, J.E. and C.H. Hershner 1999. Temporal changes in the vegetation pattern in a tidal freshwater marsh. Wetlands 19: 90-99.

Phillips, R.C. and R.L. Lewis III. 1983. Evidence of environmental gradients on variations in leaf widths and transplant success in North American seagrasses. Mar. Technol. Soc. J. 17: 59-68.

Sandlund, O.T., P.J. Schei and A. Viken (eds.) 1999. Invasive species and biodiversity management. Kluwer Academic, Boston, MA. 431 pp.

Short, F.T. 1983. The seagrass, *Zostera marina* L.: Plant morphology and bed structure in relation to sediment ammonium in Izembek lagoon, Alaska. Aquat. Bot. 16: 149-161.

Short, F.T. and R.G. Coles (eds.) 2001. global Seagrass Research Methods. Elsevier Science B.V., Amsterdam, 473 pp.

Short, F.T., L.J. McKenzie, R.G. Coles and K.P. Vidler. 2002. SeagrassNet Manual for Scientific Monitoring of Seagrass Habitat. University of New Hampshire. 55 pp

Short, F.T. and S. Wyllie-Echeverria. 1996. natural and human-induced disturbance of seagrasses. Environ. Cons. 23: 17-27.

Short, F.T. and H.A. Neckles. 1999. The effects of global climate change on seagrasses. Aquat. Bot. 63: 169-196.

Roman, C.T., W.A. Niering, R.S. Warren. 1984. Salt marsh vegetation change in response to tidal restriction. Environ. Management 8: 141-150.

Roman, C.T., J.A. Peck, J.R. Allen, J.W. King, P.G. Appleby. 1997. Accretion of a New England (USA) salt marsh in response to inlet migration, storms, and sea-level rise. *Est. Coast. And Shelf Sci.* 45: 717-727.

Roman, C.T., M.J. Janes-Piri and J.F. Heltshe. 2001. Monitoring salt marsh vegetation. Long-term Coastal Ecosystem Monitoring Program, Cape Cod national Seashore, Wellfleet, MA. 47 pp.

van Tussenbroek, B.I. 1996. Leaf dimensions of transplants of *Thalassia testudinum* in a Mexican Caribbean reef lagoon. *Aquat. Bot.* 55: 133-138.

Warren, R.S. and W.A. Niering. 1993. Vegetation change on a northeast tidal marsh: interaction of sea-level rise and marsh accretion. *Ecology* 74: 96-103.

Watson, R.T., M.C. Zinyowera, R.H. Moss. 1996. Climate change 1995 – Impacts, adaptations, and mitigation of climate change: Scientific-technical analysis. Contribution of working group II to the Second Assessment Report of the Intergovernmental panel on climate Change. Cambridge University Press, NY. 878 pp.

5.0 Appendices

Appendix 1. Questions addressed by Tier 1 monitoring of the distribution of emergent and submerged vegetation in the NERRS

Appendix 2. Some steps in the Tier 1 mapping and monitoring of emergent and submerged vegetation in the NERRS

Appendix 3. Possible schedule for Tier 1 pilot reserves and protocols committee

Appendix 4. Possible Tier 2 schedule for pilot reserves and proposal committee

5.1 Appendix 1. Questions addressed by Tier 1 monitoring of the distribution of emergent and submerged vegetation in the NERRS

The primary questions addressed by monitoring distribution of submerged and emergent vegetation are broadly applicable within the framework of the NERRS System-wide Monitoring Program: **What are the patterns of inter-annual variability in the area and spatial distribution of emergent and submerged vegetation and what are the patterns of long-term change?**

[There are many important questions about emergent and submerged aquatic vegetation communities and habitats that may need to be addressed. Some of these may be addressed with Tier 2 or Tier 3 monitoring. This Tier 1 proposal addresses only the question of changes in area and spatial distribution of emergent and submerged vegetation within the boundaries of the reserve. This approach will not address all of the important and relevant questions. However, an important principle in monitoring programs is to keep the approach basic and the methods simple so that a reliable program can be implemented and sustained over the long term. Thus, the aim of this proposal is to monitor basic area and spatial distribution of vegetative communities at annual and multi-annual time scales.]

The following questions are some of the questions that may be addressed at the reserve level with this proposed monitoring. Comparing or aggregating the data from reserves will address regional and system wide questions:

- * What species of emergent and submerged vegetation occur in the estuarine habitats of the reserve?
- * How much area does each vegetation type cover?
- * Where are the main vegetation groups located within the estuarine habitats that occur in the reserve?
- * What proportion of the area of emergent and submerged aquatic vegetative communities are non-indigenous species?
- * Does the total area for each vegetative type change from year to year?
- * Are there long term (multi-year) trends in the area covered by each vegetation type?
- * Is the location of vegetation types changing (even if area may remain similar) year to year?
- * How do any spatial or temporal changes compare with abiotic environmental factors or with other biotic factors?

5.2 Appendix 2. Some steps in the Tier 1 mapping and monitoring of emergent and submerged vegetation in the NERRS

The methods to be used for mapping and monitoring the area and spatial distribution of emergent and submerged vegetation will probably be based on C-CAP protocols and modifications required for the reserves. The following paragraphs outline some of the steps that likely will be included or need to be addressed.

Acquisition of imagery. Because of the size of most reserves and the size of the vegetative communities to be mapped, aerial photography will usually be the preferred platform. Aerial photography will usually need to be specifically acquired for the project. Sources of aerial photography include private firms, state agencies, and some federal agencies. A close working relationship is usually required with the contractor to insure photography is obtained under appropriate tidal height, weather conditions and water clarity conditions.

Ground truth data. Ground truth data will need to be collected for the mapping and monitoring. These should include GPS and percent cover for each of the dominant vegetative types/species. Data for reference and control points may be collected along with the ground truth data for vegetation. Ideas for collecting this ground truth data include using reserve staff, temporary staff, summer students hired for this mapping/monitoring project, or volunteers. The percent cover may be done in a few categories of percent cover, by point grid, or estimated by the observer and may require some training of the observer.

Georectification. The images need to be georectified. We can do this by having the photos orthorectified commercially (or in-house if the software is available) or go rectifying with ArcView and extensions to a base map or images. Most reserves will need to acquire a spatially accurate base map for the first year

Interpretation of the images. Imagery may be interpreted and vegetative boundaries delineated or classification techniques may be used. In either case, the ground truth data will be required for the photo interpretation. There are considerable advantages for the collection of ground truth data and photo interpretation to be done by the same person or under her/his direction, and for the photo interpretation to be done by reserve staff.

Entering the data as GIS format. This step will vary among reserves depending on the method used for photo interpretation. Some photo interpretation and delineation is being done on screen. There is a useful "habitat digitizer" tool for ArcView for which CSC offers training. If the delineation is done on screen in ArcView, then the delineation and entering into GIS format become one step. Some mapping and monitoring projects first delineate, for example, on mylar over aerial photos. These mylar sheets are then scanned and the polygons attributed on the computer to various species and percent cover. The Chesapeake Bay Program has been using such a process for many years with a high degree of effectiveness of being able to document changes in cover of submerged aquatic vegetation from year to year.

Verification or accuracy assessment. It is recommended that accuracy assessment be conducted with each year's mapping of vegetation. The ground work of accuracy assessment can be conducted at the same time as ground truth data collection. Accuracy assessment can also be conducted after delineation of vegetative cover, but the whole process needs to be on a fast track or seasonal changes in vegetative cover will be recorded as erroneous classification. Some form of accuracy assessment is recommended so that there is an objective quantification of the error associated with the mapping and monitoring.

Report preparation. Each (annual, biennial, every five years) mapping and monitoring should include preparation and production of a report documenting the results, the area of each vegetative classification, maps showing locations of emergent and submerged vegetation, comparisons with previous years both of aerial coverage and locations, the methods used, and the accuracy assessment. In addition, the GIS data files should have Federal Geographic Data Committee (FGDC) compliant metadata and the shapefiles with metadata posted to a web site. The Coastal Services Center has already set up such a site for the reserves that were involved in the ESDIM project <<http://www.csc.noaa.gov/pagis/html/esdimindex.htm>>.

The frequency of monitoring will vary depending on the rate of inter-annual change in the dominant vegetation or the vegetation of interest. For many reserves, annual mapping may be most appropriate (as, for example, in the Chesapeake Bay Program for submerged aquatic vegetation). Initially, some reserves may require a two-year granting/funding cycle to map the vegetation for one year. This two-year time frame is an attempt to be realistic about the time required for an initial mapping project to be completed. However, for many reserves an 18-month cycle will be appropriate for the initial mapping of emergent/submerged vegetation.

5.3 Appendix 3. Possible Tier 1 schedule for pilot reserves and protocols committee

The timeline for monitoring of estuarine vegetation will vary among reserves and may conflict with the funding cycle. A possible (and optimistic for many reserves) timeline that illustrates this might be:

Oct 03	Decisions whether to fund for FY04
Oct 03 - Feb 04	Protocol committee meets and decides on overall GIS standards for pilot sites, solicits nominations for pilot sites, preliminary selection of pilot sites, requests budget proposals from prospective pilot sites.
Feb 04	Winter meetings for confirmation and feedback. Operations award guidance includes pilot sites based on proposals, synthesis and Coordination RC, pilot archive institution, and possibly implementation strategy reserve.
Feb - Mar 04	Pilot sites plan area, species, and vegetation types to be monitored
Apr - May 04	Pilot sites request proposals and set up contract and conditions for aerial photography, set out ground control markers. Advertise and hire for ground truthing, GIS, and photointerpretation.
Jun - Jul 04	Acquisition of aerial photographs
Jul 04	FY04 funds arrive from NOAA
Jun - Aug 04	Acquisition of ground truth data and accuracy assessment data and ground control data
Sep - Nov 04	Scanning and georectification of aerial photos or orthorectification of photos
Oct 04	Pilot reserves for FY05 selected and confirmed at annual meeting
Oct - Dec 04	Delineation of vegetation and cover classes
Nov 04 - Jan 05	Entering into GIS format and attributing vegetation classes
Jan - Feb 05	Analysis of change from historic distribution and accuracy assessment
Feb - Jun 05	Report preparation, develop ArcView shapefiles, write FDGC compliant metadata, revise and complete report, post data to website.

This "timeline" is hypothetical, but it does illustrate some of the needed considerations and some of the timing conflicts that may arise. The appropriate time (months, weeks) for acquisition of aerial photography will vary widely among reserves, may vary for submerged vegetation and tide marshes within the same reserve, and may be dependent on weather and other haphazard constraints. However, that timing (months) will determine the timeline for the rest of the project and it may not align well with the budget cycle of ERD or the state agency. These issues will vary from one reserve to another and will need to be addressed up front.

5.4 Appendix 4. Possible Tier 2 schedule for pilot reserves and protocols committee

Oct 03	Discussion of peer-reviewed proposal for funding FY04
Oct 03 - Feb 04	Protocol committee meets and decides on overall GIS standards for pilot sites, solicits nominations for pilot sites, preliminary selection of pilot sites, requests budget proposals from prospective pilot sites.
Feb 04	Winter meetings for confirmation and feedback. Operations award guidance includes pilot sites based on proposals, synthesis and

	Coordination RC, pilot archive institution, and possibly implementation strategy reserve.
Feb - Mar 04	Pilot sites plan study areas for monitoring. Undertake sampling training at Technician Workshop
Apr 04 - Mar 05	Undertake seasonal or monthly monitoring.
Jun - Jul 04	Coordinate data submission and protocols with CDMO and/or SeagrassNet