APPENDIX I

Environmental Monitoring Plan

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Peconic Estuary Program

Environmental Monitoring Plan

2001

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Introduction

An effective monitoring program is necessary to assess the status and trends in the Peconic Estuary's water and sediment quality and in the health and abundance of the estuary's habitats and living resources. Assessing status and trends includes both spatial and temporal variations. This information will provide insights into the effectiveness of current management strategies, indicate where goals have been met, if actions should continue, and whether more stringent controls or management is warranted.

Monitoring the changes in a watershed is not a simple task. Watersheds, by their very nature, are dynamic systems where populations of fish, birds, and other organisms fluctuate with natural cycles. Water quality also varies, particularly as seasonal and annual weather patterns change. The task of tracking environmental changes can be difficult, and distinguishing the changes caused by human actions from natural variations can be even more difficult.

This Environmental Monitoring Plan describes the region's existing monitoring efforts as well as recommendations for expanding some existing programs and establishing new monitoring programs. The Plan also describes the environmental changes these data can be used to assess. While agencies or organizations carrying out monitoring programs may extend their efforts beyond the Peconic Estuary Program study area boundaries, the evaluation of the monitoring programs described in this document, whether existing or proposed, applies only to activities within the Peconic Estuary Program study area. By reporting on environmental changes, the Peconic Estuary Program will be able to evaluate whether measurable environmental results have been achieved and whether the goals and objectives of the Comprehensive Conservation and Management Plan (CCMP) are being met. Efforts from Federal, state, county and local government agencies, non-governmental organizations, and private citizens comprise the extant monitoring in the region. Monitoring has been and continues to be performed for water quality, habitats, land uses, and populations. Specific monitoring efforts are described in detail in this document. The Peconic Estuary's study area boundary and waterbodies are shown in Figures 1 and 2.

Monitoring can be divided into output monitoring and outcome monitoring. Output monitoring is programmatic and addresses CCMP implementation issues (resulting in Implementation Reports). Outcome monitoring focuses on changes in ambient conditions, ecological functions, and biological populations and communities (resulting in Environmental Status Reports). This Environmental Monitoring Plan mainly focuses on outcome monitoring.

Monitoring Plan Basis

The pollutants, biological indicators and performance criteria included in this Environmental Monitoring Plan were selected based on the priority management topics in the CCMP and the measurable goals the Program established for each priority management topic. The priority management topics were initially identified in the Peconic Estuary nomination document for inclusion in the National Estuary Program. These topics (and lead agencies) are: Brown Tide (SCDHS), nutrients (SCDHS), habitats and living resources (NYSDEC), pathogens (NYSDEC), and toxics (EPA). In the final CCMP, these topics are joined by critical lands protection, an overarching issue, to form the priority management issues for the Program, along with public education and outreach, financing, and overall implementation. The SCDHS along with The Nature Conservancy, the Suffolk County Department of Planning, and the Citizens Advisory Committee serves as the lead for critical lands protection. These priority issues have been selected, both initially and currently, based on impacts, threats, and importance in meeting the overall goals of the Peconic Estuary Program.

For each priority management topic, the PEP has developed measurable goals. In many cases, these measurable goals are first order estimates based on best available information and on management conference judgment. Each measurable goal in the final CCMP is linked to one or more of the actions in the final CCMP. Each element of the Environmental Monitoring Plan is also linked to one or more of the measurable goals. The relationship between a monitoring program element (and the parameters contained therein) and a CCMP measurable goal is the basis for its inclusion in this Environmental Monitoring Plan.

The Peconic Estuary Program's Environmental Monitoring Program consists of numerous existing monitoring programs, many of which have been expanded due primarily to the existence of the Peconic Estuary Program. The Peconic Estuary Program participants, in preparing this Plan, did not observe any duplication of effort among the agencies or organizations currently conducting monitoring in the estuary and its watershed. Where gaps in and among monitoring programs were identified, recommendations have been made to expand existing monitoring programs or establish entirely new monitoring programs. The Peconic Estuary Program Office in the Office of Ecology of the Suffolk County Department of Health Services serves as the overall coordinator of monitoring efforts in the estuary and watershed. The effectiveness of the Environmental Monitoring Plan will be reviewed as part of the Implementation Report as well as the Environmental Status Report. Recommendations for redirection of efforts will be included in these reports as needed; these proposed changes will be subject to public review.

The Peconic Estuary Program has developed a candidate list of indicators to be used in reporting on environmental outcomes. This list will be refined and finalized in the 2001-02 timeframe. The candidate indicators, related to key measurable goals in the CCMP and elements of the Environmental Monitoring Plan, are as follows:

- Brown Tide Levels
- Dissolved Oxygen Levels
- Nitrogen Levels
- Water Clarity
- Eelgrass and Tidal Wetlands Coverage
- Extent of Shoreline Hardening
- Finfish and Shellfish Landings
- Acres Open to Shellfish Harvesting
- Toxics in the Environment (sediments, biota, and loadings)
- Habitat Restoration (and Land Acquisition/Protection)

Output Monitoring

Programmatic output monitoring will track the products from implementing the CCMP. Monitoring will help keep managers abreast of all implementation programs and the degree to which the programs are or are not achieving their intended outcomes. This type of monitoring holds designated lead organizations accountable for specific actions and steps outlined in the CCMP. Programmatic monitoring can also be used to assess whether an educational outreach program has reached its intended audience.

The Peconic Estuary Program will report on the status of the CCMP actions ("output monitoring") through periodic bulletins and has committed to a full accounting on the status of all CCMP actions every three years, consistent with EPA National Estuary Program Guidance, in the form of an Implementation Report. This reporting commitment is an action in the Post-CCMP Chapter of the final CCMP. The report will evaluate whether the CCMP actions and steps should be modified in order to achieve the CCMP goals and objectives. Where appropriate, resources and efforts may be redirected to attain the desired outcomes of the Program. Recommendations for the redirection of efforts will be subject to public review.

Outcome Monitoring

Outcome monitoring assesses the success in attaining CCMP goals and objectives rather than the implementation of specific actions. For each measurable goal in the CCMP, the associated monitoring parameters provide a measure of success. Characterization reports prepared for the CCMP and summarized in the CCMP, as well as numerous existing monitoring efforts, represent outcome monitoring activities.

The Peconic Estuary Program will provide information on environmental quality ("outcome monitoring") through periodic bulletins and a report every three years on progress in achieving all of the measurable goals described in the CCMP in the form of an Environmental Status Report. This reporting commitment is an action in the Post-CCMP Chapter of the final CCMP. Through the outcome monitoring process, a report on environmental status and trends will be prepared, existing and planned monitoring efforts will be incorporated, critical information gaps will be identified, and standardizing and coordinating future monitoring efforts will be attempted. As with the Implementation Report, the Environmental Status Report will include recommendations for redirection of efforts as needed; these proposed changes will be subject to public review.

Monitoring Plan Elements

Compiling monitoring program information into one document, such as this one, promotes cooperation among agencies and stakeholders, clarifies the need for existing programs as well as for expanded or new programs, and provides an avenue for integrating results from different monitoring programs and projects for scientific, regulatory and general interests. The Peconic Estuary Program has identified thirty-two core monitoring plan elements, which are necessary to determine whether the CCMP measurable goals are being met.

The monitoring plan elements are geared towards the chemical, physical and biological conditions of the estuary. As such, the workplan elements focus on the priority management topics. Other modules such as Public Education and Outreach and Financing will be dealt with in other reports. The Critical Lands Protection Strategy Chapter outlines all the milestones that need to take place in developing a Critical Lands Protection Plan. Actual environmental goals and a monitoring workplan for critical lands protection will be developed as part of the Critical Lands Protection Plan.

The Peconic Estuary Program's technical report *Research, Monitoring & Assessment Priorities for Habitats and Living Resources of the Peconic Estuary* (Peconic Estuary Program, 2000) recommends additional monitoring activities for consideration in the future.

Data Management

The *Peconic Estuary Program Data Management Strategy* (Peconic Estuary Program, 1993) designated the SCDHS Office of Ecology as the repository of water quality data and most Geographical Information System (GIS) data. The Program Office also is the prime repository for natural resource data on a provisional basis. Since that time, the USFWS has worked on several mapping efforts and has provided GIS coverages to the Program Office for storage and distribution. For the foreseeable future, the Program Office in the SCDHS will continue its role as the data repository and data management agency. The Peconic Estuary Program is committed to reviewing the *Peconic Estuary Program Data Management Strategy* as part of the Post-CCMP Implementation Report.

The Peconic Estuary Program intends to develop a real-time, web-based accountability system that will house information related to the CCMP goals and actions. Reports, newspaper articles, photographs and monitoring data will be available through the internet and in hard copy form. Monitoring data will be posted directly via links to a database. The intent of the accountability system is that all PEP-related information will be web-accessible.

CCMP and NEP Requirements

Consistent with EPA guidance, each of the individual elements of this Environmental Monitoring Plan includes the following:

- Program Objective(s): Program objectives are defined and performance criteria are specified (i.e., parameter needed to guide management decisions).
- Lead Entity: The lead entity is named or proposed.
- Program Status: Program status describes whether the program is existing, existing but there are recommended expansions, or is new.
- Monitoring Extent and Frequency: The geographical extent of the monitoring and sampling frequency is described.
- Monitoring Hypotheses: Testable hypotheses are provided.
- Measurable Goal: The Peconic Estuary Program measurable goal (or goals) related to the monitoring program element is specified.
- Program Description: Summary information addressing the particular monitoring program is included. In many cases, especially where there are existing programs, reference is made to an acceptable sampling and quality assurance/quality control project plan. Those who are interested in the details and specifics of a particular program are encouraged to consult these existing documents. For monitoring programs that do not exist at the current time, but are recommended in this monitoring plan, complete information for all these factors has likely not yet been specified, but will be prior to the initiation of any environmental monitoring effort.
- Costs: Information on costs, including estimates of current efforts and estimates for proposed new or expanded efforts is provided.

The program descriptions and the referenced sampling and quality assurance/quality control project plans together include the following, where this information is available:

- Specification of monitoring variables, including sampling locations and frequency, field sampling locations, field and laboratory analytical procedures, quality assurance and control procedures.
- Specification of the data management system and statistical test that will be used to analyze the monitoring data.
- Description of the expected performance of the initial sampling design (i.e., the minimum difference that can be detected in measured variables over time and between locations).
- Provision of a timetable for analyzing data and assessing program performance.

Finally, information on costs is specified. If the monitoring activity is part of an existing or ongoing base program of an agency or organization, a cost is typically not specified. If it is a recommendation for a new or expansion of an existing monitoring program, to the extent possible, the cost has been estimated for planning purposes. These cost estimates will be the basis for securing additional funds. Potential sources of funding include agency or organization base programs, special funding sources (i.e., the Suffolk County 1/4 percent Sales Tax Program, receipts from selective sales fees, special project grants through governmental and non-governments sources).

Core Monitoring Workplan Elements

Brown Tide Issues
- Brown Tide

Nutrients Issues
- Nutrients
- Dissolved Oxygen
- Light Extinction
- Groundwater
- Point Sources
- Land Use

Habitat and Living Resources Issues
- Eelgrass
- Finfish and Macroinvertebrates
- Wetlands
- Shoreline Hardening
- Piping Plovers, Shorebirds, Raptors, and Other Birds
- Dredging
- Restoration
- Bay Scallops
- Aquaculture and Transplanting Activities

Pathogens Issues
- Coliform Bacteria
- *Pfiesteria* and *Alexandrium*
- Vessel Waste No Discharge Areas

Toxics Issues
- Sediment
- Coastal 2000
- Biota (Fish, Shellfish, and Crustaceans)
- NOAA Mussel Watch Program
- Surface Water
- Groundwater
- Hazardous Waste Sites
- Point Source Discharges
- Federal Toxics Release Inventory
- Pesticide Use
- Two Stroke Marine Engines
- Underground Storage Tanks
- Treated Lumber in the Marine Environment

The technical report *Research, Monitoring & Assessment Priorities for Habitat and Living Resources of the Peconic Estuary* (Peconic Estuary Program, 2000) recommends additional monitoring activities for consideration in the future.

Measurable Goals

For each priority management topic, the PEP has developed measurable goals. In many cases, these measurable goals are first order estimates based on best available information and on management conference judgment. Each measurable goal in the final CCMP is linked to one or more of the actions in the final CCMP. Each element of the Environmental Monitoring Plan is also linked to one or more of the measurable goals. The relationship between a monitoring program element (and the parameters contained therein) and a CCMP measurable goal is the basis for its inclusion in this Environmental Monitoring Plan. However, not all measurable goals are linked to the environmental monitoring plan elements as some measurable goals are related to programmatic concerns.

The PEP's measurable goals with respect to Brown Tide blooms include:

- Continue to better coordinate, focus, and expand Brown Tide research efforts (measured by funding appropriated, frequency of Brown Tide symposiums and frequency of updating the Brown Tide Workplan and coordinations within the Brown Tide Steering Committee).
- Continue the current level of water quality sampling in the Peconic Estuary (measured by the number and frequency of samples taken per year and the number of bays and peripheral embayments sampled). Currently, the Suffolk County Department of Health Services conducts biweekly monitoring at 32 stations in the Peconic Estuary throughout the year, resulting in over 830 samples taken annually.

The PEP's measurable goals with respect to nutrients include:

- Decrease the total nitrogen concentrations in the western estuary to a summer mean of no more than 0.45 mg/l (based on 1994-96 model verification conditions, and measured by surface water nitrogen concentrations as compared to the PEP nitrogen guidelines).
- Improve the dissolved oxygen concentrations in the western estuary to ensure that the New York State dissolved oxygen standard (currently 5.0 mg/l) is not violated (measured by surface and bottom dissolved oxygen levels as compared to the New York State dissolved oxygen standard).
- Ensure that the total nitrogen levels in shallow waters remain at or below 0.4 mg/l to help optimize water clarity, maintaining and potentially improving conditions for eelgrass beds, a critical habitat (based on 1994-96 model verification conditions, and measured by light extinction coefficients as compared to the recommended eelgrass habitat optimization goal of at or below $0.75 \pm 0.05\ m^{-1}$).
- Ensure that the existing total nitrogen and dissolved oxygen levels are maintained or improved in waters east of Flanders Bay (*i.e.*, do not increase TN nor decrease DO) (measured by surface water total nitrogen concentrations as compared to the PEP nitrogen guidelines and surface and bottom dissolved oxygen levels as compared to the New York State dissolved oxygen standard).
- Develop a quantitative total nitrogen load allocation strategy for the entire estuary (measured by development of a strategy and timely endorsement by local and State agencies). Preliminary work group estimates, and work performed by other programs, indicate that a 10-25 percent fertilizer reduction goal is a reasonable first order target for existing residential and agricultural fertilizing programs.
- Implement a quantitative nitrogen load allocation strategy for the entire estuary (measured by attaining the PEP recommendations including the implementation of the recommended Agricultural Environmental Management (AEM) program, as well as other recommendations, which may include fertilizer reduction programs, sanitary system upgrade programs, point source controls, etc., as well as monitoring for the impacts on measurable groundwater quality parameters).

- Ensure that there is no substantial net increase in nitrogen loading to areas east of Flanders Bay and reductions in the Peconic River/Flanders Bay region so that an increase in new development would be offset by reductions in loads from pre-existing uses. The nitrogen work groups will develop means of attaining this goal, which may include groundwater performance standards (*e.g*., nitrogen concentrations in groundwater resulting from post-development discharge/recharge), implementing fertilizer and clearing restrictions, and zoning.
- Continue sponsoring and coordinating research and information gathering (measured by funding appropriated, and research conducted, relative to PEP recommendations).
- Continue and expand open space acquisition programs (measured by funding appropriated and acres acquired in target areas).

The PEP's measurable goals with respect to habitat and living resources include:

- Protect the high quality habitats and concentrations of species in the Critical Natural Resource Areas (measured by acres of open space protected and development of model ordinances).
- Maintain current linear feet of natural shoreline and over the next 15 years reduce shoreline hardening structures by five percent (measured by the percent change of natural vs. hardened shorelines through GIS mapping).
- Maintain current eelgrass acreage (2,100 acres in main stem of the estuary) and increase acreage by ten percent over 10 years (measured by inter-annual aerial surveys with GIS and SCUBA assessments).
- Maintain and increase current tidal and freshwater marsh acreage, and restore areas that have been degraded (*e.g.*, restricted flow, *Phragmites australis* dominated, hardened shoreline) (measured as number of acres of marsh with GIS).
- Maintain a policy of no new mosquito ditches and not re-opening ditches that have filled-in by natural processes; and restore 10-15 percent of mosquito ditched marshes through Open Marsh Water Management (measured by the number of acres of restored tide marsh using Open Marsh Water Management).
- Increase the number of piping plover pairs to 115 with productivity at 1.5 (over a three-year average), distributed across the nesting sites in the Peconic Estuary (measured by annual piping plover surveys).
- Develop recommendations and guidelines to reduce impacts to marine life from dredging-related activities (measured by amount of reduced dredging volumes and protected benthic habitat acreage).
- Foster sustainable recreational and commercial finfish and shellfish uses of the Peconic Estuary that are compatible with biodiversity protection (measured by juvenile finfish trawl surveys, bay scallop landings, and identifying, protecting, and restoring key shellfish and finfish habitat).
- Enhance the shellfish resources available to harvesting through reseeding, creation of spawning sanctuaries and habitat enhancement (measured by scallop and clam abundance/landings).
- Link land usage with habitat quality in tidal creeks (measured by continued funding of benthic and water quality surveys to measure the quality/impacts to the habitats within selected tidal creeks).
- Ensure that the existing and future aquaculture (shellfish and finfish) and transplanting activities are situated in ecologically low-productive areas of the estuary and that they are mutually beneficial to the aquaculture industry, natural resources, and water quality (measured by the extent and location of aquaculture/transplant facilities, water quality measures, and natural resource data).

- Annually initiate five percent of the projects identified in the Habitat Restoration Workgroup Plan for the Peconic Estuary (measured by the number of projects funded and implemented annually).

The PEP's measurable goals with respect to pathogens include:

- Maintain current level of lands available to shellfish harvesting, with the ultimate aim of re-opening lands currently closed to harvesting (measured through coliform levels and numbers of acres of shellfish beds available to harvest).
- Maintain and improve water quality of the estuary through a reduction of overall stormwater runoff, particularly key areas identified through the Regional Stormwater Runoff Study (measured through the number of stormwater remediation projects implemented).
- Eliminate all vessel waste discharge to the estuary (measured by the adoption/implementation of a Vessel Waste No Discharge Area in the Peconic Estuary, the number of pump-out facilities and the volume of waste pumped annually).
- Attain a zero discharge of stormwater runoff in new subdivisions (measured by site plans for new developments that achieve this goal and the development of new ordinances and Habitat Protection Overlay Districts).

The PEP's measurable goals with respect to toxics are:

- Improve the quality of the ambient environment (surface waters, groundwaters, sediments and biota) where there is evidence that human inputs impair or threaten these resources (as measured by surface water, groundwater, sediment and biota monitoring programs).
- Comply with schedules for conducting site characterizations, remedial actions and post-remedial monitoring at hazardous waste sites; effectively characterize risks and protect human health and the environment at hazardous waste sites; ensure compliance with permit limits for point source discharges (as measured by compliance with schedules at hazardous waste sites; conducting effective characterizations; and point source monitoring).
- Decrease overall emissions of reportable toxics from the five East End towns (as measured by the Federal Toxics Release Inventory).
- Eliminate holdings of banned, unneeded and unwanted pesticides and hazardous substances by 2005 (as potentially measured by collections during "Clean Sweep" programs, household hazardous waste collection programs and events, or surveys of farmers/commercial landscapers/homeowners).
- Decrease overall agricultural/residential/institutional pesticide applications in the five East End towns (as potentially measured by point-of-sale surveys, surveys of residents, or commercial applicator tallies).
- Eliminate to the maximum extent practicable, pesticide applications on turf grass on all publicly held land by 2003 (as potentially measured by resolutions passed [or equivalent]).
- Eliminate underground storage tanks exempt from current replacement requirements via incentive programs and public education and outreach (as potentially measured following baseline established of number of underground storage tanks [USTs] and monitoring of the number of underground tanks removed, retired, and replaced).
- Decrease the total amount of treated lumber installed in the marine/estuarine environment (as potentially measured by baseline established from shoreline surveys and monitoring of permits issued for bulkheading installations, replacements, and removal).

- Reduce the number of two stroke marine engines in use in the estuary (as potentially measured by harbormaster conducted surveys).

The PEP's measurable goals with respect to education and outreach are:

- Annually, embark on one new, substantial public education effort addressing each of the following areas:
  - Conducting Brown Tide education and outreach;
  - Reducing residential fertilizer use in the Peconic Watershed;
  - Improving, protecting or enhancing habitats and living resources;
  - Reducing pathogen loadings to the estuary; and
  - Reducing the use and loadings of toxics substances to the estuary.

  (as measured by the Peconic Estuary Program Office and the PEP Citizens Advisory committee).
- Annually, conduct one major watershed effort involving students in estuary management (as measured by the Peconic Estuary Program Office and the PEP Citizens Advisory Committee).
- Annually, conduct one major watershed-wide event to educate those who live, work, or recreate in the Peconics (as measured by the Peconic Estuary Program Office and the PEP Citizens Advisory Committee).
- Annually, support the establishment of one new local embayment or tidal creek association (as measured by the Peconic Estuary Program Office and the PEP Citizens Advisory Committee).

The PEP's measurable goals with respect to financing are:

- Effectively use existing funding and secure new or additional governmental funding for CCMP implementation from the following sources:
  - Federal Government, particularly the U.S. Department of Agriculture;
  - State Government, particularly the Clean Water/Clean Air Bond Act and State Revolving Loan Fund;
  - County Government, particularly the Suffolk County ¼% Sales Tax Program;
  - Town Governments; and
  - Village Governments.

  (as measured by the Peconic Estuary Program Office).
- Secure new or additional private sector funding for CCMP implementation, from the following sources:
  - Businesses; and
  - Not for profit organizations.

  (as measured by the Peconic Estuary Program Office).

The Peconic Estuary Program's measurable goals with respect to post-CCMP management and implementation are:

- Implement the Peconic Estuary Program Environmental Monitoring Plan. [See Action M-2]
- Produce annual reports. [See Action M-3]
- Update municipal officials. [See Action M-4]
- Develop sub-watershed implementation plans (as measured by the number of sub-watershed plans initiated). [See Action M-5]

Brown Tide Issues

Brown Tide Monitoring

Program Objective
To track the changes in abundance and distribution of the Brown Tide organism in the estuary and relate the changes to conventional water quality parameters (e.g., dissolved organic and dissolved inorganic nutrients) as well as provide support to Brown Tide researchers. Monitoring coupled with research may further elucidate the processes involved with these phenomena.

Monitoring Hypothesis
Incidences of Brown Tide blooms (duration and extent) are decreasing, most likely in response to changes resulting from some combination of the following factors: the implementation of point and nonpoint source management practices; meteorological conditions; or ecological changes.

CCMP Measurable Goal
Continue the current level of water quality sampling in the Peconic Estuary.

Lead Entity
Suffolk County Department of Health Services; New York Sea Grant is the lead for Brown Tide Research Initiative projects.

Program Status
Brown Tide monitoring is part of an existing program of the Suffolk County Department of Health Services. Existing Brown Tide Research Initiative Projects will be completed in 2002-03.

Monitoring Extent and Frequency
Suffolk County Department of Health Services monitors estuary wide and year round (weekly or biweekly) for Brown Tide cell counts and related water quality parameters. Monitoring under Brown Tide Research Initiative projects is in accordance with approved workplans.

Program Description
Brown tide was first detected in the Peconic Estuary in June of 1985. The Brown Tide organism, *Aureococcus anophagefferens*, is a particularly small phytoplankton species and is only problematic under "bloom" conditions. Brown tide can persist for unusually long periods of time over large areas and has no predictable onset, duration, or cessation. Brown tide has recurred since 1985 and has had a serious impact on natural resources, the local economy, the general aesthetic value of the estuary, and possibly regional tourism. Brown Tide cell counts are included as part of the monitoring programs described below. See Figure 3 for areas of Brown Tide occurrence on Long Island.

SCDHS Surface Water Quality Monitoring: In 1988 the Suffolk County Department of Health Services (SCDHS) Office of Ecology expanded its monitoring operations in an effort to determine the cause of Brown Tide (see Figure 4 for Post-CCMP monitoring stations). While the cause of Brown Tide is still not known, the study's resulting final report, the Brown Tide Comprehensive Assessment and Management Program (BTCAMP) (SCDHS, 1992), served as the initial Brown Tide characterization for the Peconic Estuary Program.

Brown Tide cell counts are now part of the regular SCDHS surface water quality monitoring protocol. Refer to the SCDHS Surface Water Quality Monitoring section in the Nutrient Monitoring Workplan for more information and other parameters sampled by the SCDHS. The *SCDHS Surface Water Quality Monitoring Standard Operating Procedure* (SCDHS, 2000) and the *Quality Assurance Project Plan for the Peconic Estuary Program Surface*

Water Monitoring Program (SCDHS, 1994) describe the standard operating procedures and the QA/QC methods for the entire SCDHS Surface Water Quality Monitoring Program, which includes Brown Tide cell counts..
Brown Tide Research Initiative (BTRI) Committee: The Brown Tide Research Initiative (BTRI) Committee, chaired by the New York Sea Grant, follows the research and monitoring funded primarily through the National Oceanic and Atmospheric Administration's Coastal Ocean Program and Suffolk County. The BTRI program was developed to increase knowledge concerning Brown Tide by identifying the factors and understanding the processes that stimulate and sustain Brown Tide blooms. The Peconic Estuary Program is part of the BTRI Committee. The Initiative is composed of peer-reviewed research projects that were selected from two national calls for projects. Brown tide research and characterizations are systematically updated through New York Sea Grant's Brown Tide Research Initiative Reports.

Brown Tide Steering Committee (BTSC): The Brown Tide Steering Committee (BTSC) was formed to broadly coordinate Brown Tide research efforts both inside and outside New York through the development of a comprehensive Brown Tide research and management plan or Brown Tide Workplan (see Appendix F for the most recent Workplan). The BTSC includes representatives from various agencies and environmental groups as well as elected officials, commercial fisherman, and other interested parties. The Committee is coordinated by Suffolk County.

Costs

Base Programs: Continued research and monitoring depends on continued funding. The SCDHS Surface Water Monitoring Program, along with the SCDHS Routine Point Source Monitoring Program, is funded in part by $20,000 in Post-CCMP EPA funds awarded to SCDHS and by in-kind match from Suffolk County, a minimum grant commitment of $120,000 per year to satisfy the EPA local match requirements. As with prior years, the costs for the monitoring program are likely substantially higher than the EPA grant.

Brown tide research is currently funded through many specially funded government grants. NOAA, through its Coastal Ocean Program, is providing Brown Tide research funding totaling $3.0 million over six years (funding started in 1997). Between 1997 and 2000, Suffolk County has appropriated $583,000 to support Brown Tide monitoring and investigation efforts. Suffolk County has authorized $150,000 each year for the next three years (2001-2003) from the capital budget for more Brown Tide research and monitoring.

Nutrients Issues

Nutrients Monitoring

Program Objective
To track the long-term trends in nutrient loading and the short-term variations in nutrient concentrations in relation to the PEP nitrogen guidelines (based on 1994-96 conditions) and to refine the guidelines as needed. This will support our review of the effectiveness of the CCMP actions in attaining dissolved oxygen standards.

Monitoring Hypothesis
Nutrient levels (as measured by various forms of nitrogen) are decreasing in areas of the Peconic Estuary, where nutrient guidelines have been exceeded and being maintained where they are currently achieved, in response to the implementation of point and nonpoint source management practices.

CCMP Measurable Goals
Decrease the total nitrogen concentrations in the western estuary to a summer mean of no more than 0.45 mg/l; Ensure that the existing summer mean total nitrogen levels are maintained or improved in waters east of Flanders Bay; Ensure that the summer mean total nitrogen levels in shallow waters remain at or below 0.4 mg/l.

Lead Entity
Suffolk County Department of Health Services.

Program Status
Nutrient monitoring is part of an existing program of the Suffolk County Department of Health Services.

Monitoring Extent and Frequency
Suffolk County Department of Health Services monitors estuary wide (32 stations) and year round (biweekly) for nutrients and related water quality parameters.

Program Description
Nitrogen is the nutrient of primary concern in the Peconic Estuary although the surface water quality conditions with respect to nitrogen levels are generally good. In the summer months, when environmental stresses are at their peak, nitrogen is the "limiting nutrient" for algal growth. Excessive nitrogen inputs stimulate algal growth, which may cause diurnal dissolved oxygen problems. Excessive nitrogen inputs may also harm eelgrass, a critical habitat, due to algal shading, stimulation of epiphytes, and, possibly, direct adverse metabolic impacts. In addition, increased nitrogen levels may affect the duration and/or intensity of a Brown Tide bloom.

SCDHS Surface Water Quality Monitoring: The Suffolk County Department of Health Services (SCDHS) Office of Ecology samples for a suite of nitrogen components (NH3, NOx, NO2, NO3, Urea, TKN, and TDKN) in the Peconic Estuary. Other parameters sampled by the SCDHS include Secchi depth, Temperature, Dissolved Oxygen, Salinity, Total Coliforms, Fecal Coliforms, TPO4, TDPO4, O-PO4, TOC, DOC, SiO3, TSS, Total Chl-a, Fractionated Chl-a, *Aureococcus*, Ambient Irradiance, depth at 20% of Ambient Irradiance, depth at 10% of Ambient Irradiance, and depth at 1% of Ambient Irradiance. While limited sampling began in 1976, the number of stations and samples taken in the Peconics has increased through the years. Currently, the SCDHS conducts biweekly monitoring at 32 stations throughout the year.

The *Post-CCMP Surface Water and Point Source Monitoring Plan* (SCDHS, 1999) further describes the post-CCMP efforts of the SCDHS in the Peconics. As indicated in the *Post-CCMP Surface Water and Point Source Monitoring Plan*, this program continues to adhere to the *Quality Assurance Project Plan for the Peconic Estuary Program Surface Water Monitoring Program* (SCDHS, 1994), on file at SCDHS. The *SCDHS Surface Water*

Quality Monitoring Standard Operating Procedure (SCDHS, 2000) document describes the standard operating procedures for the entire SCDHS Surface Water Quality Monitoring Program.

Costs
Base Programs: Information on costs for the Suffolk County Department of Health Services Surface Water Quality Monitoring Program is included under Brown Tide Issues in this document.

Dissolved Oxygen Monitoring

Program Objective
To track the long-term trends and the short-term variations in dissolved oxygen concentrations in relation to the New York State dissolved oxygen standard.

Monitoring Hypothesis
Dissolved oxygen levels in the Peconic Estuary are improving in response to the implementation of point and nonpoint source nutrient management practices.

CCMP Measurable Goals
Ensure that the New York State dissolved oxygen standard (currently 5.0 mg/l) is not violated in the estuary;
Ensure that the existing dissolved oxygen levels are maintained or improved in waters east of Flanders Bay where dissolved oxygen levels are currently better than standards require.

Lead Entity
Suffolk County Department of Health Services.

Program Status
Dissolved oxygen monitoring is part of an existing program of the Suffolk County Department of Health Services.

Monitoring Extent and Frequency
Suffolk County Department of Health Services monitors estuary wide (32 stations) and year round (biweekly) for dissolved oxygen and related water quality parameters.

Program Description
Dissolved oxygen conditions in the Peconics are generally excellent although diurnal dissolved oxygen variations are a primary water quality management issue. The Peconic Estuary is a relatively shallow, well-mixed estuary and as such is not subject to periods of severe dissolved oxygen depression, as can occur in deeper, more stratified estuaries like the Long Island Sound. Areas with limited flushing and/or highly organic sediments exhibit bottom water, and sometimes surface water values below 5 mg/l (see Figure 5).

SCDHS Surface Water Quality Monitoring: The SCDHS Office of Ecology has been recording dissolved oxygen levels, along with other water parameters, at numerous stations in the Peconic Estuary since 1976. With the help of the Peconic Estuary Program the number of stations and samples taken has increased through the years. Some stations that historically have had low dissolved oxygen measurements are sampled in the morning and afternoon. The Office of Ecology has also done intensive dissolved oxygen surveys (sampling every two hours for 24 hours)

in Flanders Bay, Meetinghouse Creek, and the Peconic River. The *Post-CCMP Surface Water and Point Source Monitoring Plan* (SCDHS, 1999) further describes the efforts of the SCDHS in the Peconics.

Costs

Base Program: Information on costs for the Suffolk County Department of Health Services Surface Water Quality Monitoring Program is included under Brown Tide Issues in this document.

Light Extinction Monitoring

Program Objective

To track the long-term trends and short-term variations in water clarity in relation to the PEP recommended eelgrass habitat optimization goal. By improving water clarity, eelgrass habitat and growth will be optimized (see eelgrass monitoring section).

Monitoring Hypothesis

Water clarity, as measured by light extinction, is improving in the Peconic Estuary, in areas where goals are not being attained and maintained in areas where criteria are being attained, in response to the implementation of point and nonpoint source management practices.

CCMP Measurable Goal

Maintain and potentially improve water clarity conditions for eelgrass beds, a critical habitat in shallow waters. The PEP-recommended eelgrass habitat optimization goal is a light extinction coefficient (Kd) of 0.75 +/- 0.05 m-1.

Lead Entity

Suffolk County Department of Health Services.

Program Status

Light extinction monitoring is part of an existing program of the Suffolk County Department of Health Services.

Monitoring Extent and Frequency

Suffolk County Department of Health Services monitors estuary wide (32 stations) and year round (biweekly) for light extinction and related water quality parameters. Detailed long term investigations are taking place at three eelgrass beds in the estuary.

Program Description

The single most important factor controlling the distribution of submerged aquatic vegetation, light attenuation, is partially linked to the amount of nutrient loading in a waterbody. The average summer light extinction coefficients for the non-Brown tide years 1994and 1996 are shown in Figure 6. High nutrient loading in the shallow waters of the estuary may stimulate algal blooms, decreasing the light penetrating into the water column and consequently hindering eelgrass' ability to photosynthesize. Rooted aquatic plants that are at a species' depth limit for clear water conditions would be expected to decline due to the lack of sufficient light energy in turbid waters.

SCDHS Surface Water Quality Monitoring: The SCDHS Office of Ecology has an extensive monitoring program in the Peconics, measuring light extinction and chlorophyll-a, among other parameters. The *Post-CCMP Surface Water and Point Source Monitoring Plan* (SCDHS, 1999) further describes the efforts of the SCDHS in the Peconics.

Submerged Aquatic Vegetation Long Term Monitoring Program: First initiated in 1997, three existing SAV beds were monitored to determine the annual and long-term variations in eelgrass bed health and the cause of those variations. In 1999, the project was expanded to include three more locations. Monitoring of each site includes the following measures: depth and position of deeper edge of the eelgrass bed, biomass, shoot density, infauna, epifauna, light extinction, chlorophyll-a, total suspended solids, dissolved inorganic nitrogen, and dissolved inorganic phosphorus, among others.

In 2000, the program will include a system-wide survey based on aerial photographs and site visits. These data will be compared against the 1994 Cashin Associates report, *Submerged Aquatic Vegetation Study* to determine trends taking place in the estuary.

Costs

Base Program: Information on costs for the Suffolk County Department of Health Services Surface Water Quality Monitoring Program is included under the Brown Tide Issues in this document.

Information on the Submerged Aquatic Vegetation Long Term Monitoring Project is included in the Eelgrass Monitoring section of this document.

Groundwater Monitoring

Program Objective

To track the long-term trends and short-term variations in groundwater contaminants and better define the zones of groundwater input.

Monitoring Hypothesis

Nutrient levels in the groundwater of the Peconic Estuary Study Area is decreasing to natural background levels in response to the implementation of point and nonpoint source management practices.

CCMP Measurable Goals

Ensure that there is no substantial net increase in nitrogen loading to areas east of Flanders Bay and reductions in the Peconic River/Flanders Bay region so that an increase in new development would be offset by reductions in loads from pre-existing uses. The nitrogen work groups will develop means of attaining this goal which may include groundwater performance standards, implementing fertilizer and clearing restrictions, and zoning.

Implement a quantitative nitrogen load allocation strategy for the entire estuary (measured by attaining the PEP recommendations including the implementation of the recommended Agricultural Environmental Management (AEM) program as well as other recommendations which may include fertilizer reduction programs, sanitary system upgrade programs, point source controls, etc., as well as monitoring for the impacts on measurable groundwater quality parameters).

Lead Entity

Suffolk County Department of Health Services.

Program Status

Groundwater nutrient monitoring is part of an existing program of the Suffolk County Department of Health

Services; special projects have been completed in specific areas of concern.

Monitoring Extent and Frequency

Suffolk County maintains a network of wells throughout the study that are sampled year round area to monitor the quality (and quantity) of the groundwater supply, and conduct studies and investigations of the county's hydrology.

Program Description

Groundwater is one of the largest external sources of nitrogen to the estuary, contributing approximately 7,560 pounds per day or about 21% of the total nitrogen load.

The nitrogen in the groundwater originates from fertilizer use, sanitary system waste and other sources. Dominant sources of total nitrogen to the estuary are agriculture (41% of TN loading) and residential development (40% of TN loading) (SCDHS, 1999). Industrial and commercial uses contribute less than 10% of the total nitrogen load to the estuary.

Nitrogen from synthetic fertilizer, applied as nitrate, ammonium salt or urea, may be the most important source of nitrate in the groundwater. Ammonium oxidizes to nitrate in the soil. Nitrate is leached to the groundwater supply through the sandy soils by the recharge of precipitation and by crop irrigation water.

Nitrate contamination in drinking water is a serious concern. The SCDHS tested 45,985 private wells from 1972 to 1994 and 7.4% of the wells exceeded the nitrate Maximum Contaminant Level (MCL) (SCDHS, 1996). The USEPA and New York State drinking water MCL for nitrate is 10.0 mg/l.

The SCDHS Bureau of Groundwater Resources selected ten wells in the county monitoring network to examine the effect of agriculture on groundwater quality from 1975 to 1994 (SCDHS, 1996). For the 20 year period, the average annual nitrate concentration for all ten wells was 11.3 mg/l, with an annual average range of 9.2 mg/l in 1982 to a maximum of 13.7 mg/l in 1988. A monitoring well in Southold contained the highest average nitrate concentration over the 20 year period (15.3 mg/l) and also the highest individual sample concentration detected (33.0 mg/l in 1990). Nitrate concentrations from a more recent study by the SCDHS, *Water Quality Monitoring Program to Detect Pesticide Contamination in Groundwaters of Nassau and Suffolk Counties, NY* (1999) are consistent with these 1996 study figures.

The SCDHS has also monitored groundwater for impacts from pesticide and fertilizer use on golf courses (SCDHS, 1999). A total of 41 samples were collected from 31 wells at 18 separate golf courses. Nitrate concentrations in the Suffolk County golf course wells averaged 4.3 mg/l with a median concentration of 2.6 mg/l. The SCDHS has done a follow-up study this year with an expanded list of analytes and with new monitoring wells at five more courses in the county, including Shinnecock, National, and Maidstone.

The United States Geological Survey (USGS) has delineated the groundwater-contributing areas, as well as preliminary sub-boundaries for the main bays system. The USGS further characterized the Peconic River and Flanders Bay subwatersheds in 1999 by defining the sub-sediment geology through seismic reflections. The Cornell Cooperative Extension together with the SCDHS developed an ultrasonic low flowmeter for use in Flanders Bay and West Neck Bay. The flowmeter data will be used to determine the quality, quantity and location of groundwater discharging into the estuary.

SCDHS Groundwater Monitoring: The SCDHS Bureau of Groundwater Resources maintains a network of wells throughout the county to monitor the quality and quantity of the groundwater supply, and conduct studies and investigations of the county's hydrology. The Bureau will continue to produce groundwater measurement reports. The Peconic Estuary Program will in turn review the trends and modify the CCMP actions and steps accordingly. See Figure 7 for the groundwater quality delineations in the Peconic Estuary study area.

Suffolk County Groundwater Model (Contractor Camp, Dresser, and McKee): A groundwater model is being developed for all of Suffolk County. The model will provide additional information on the groundwater flow paths and travel times in the Peconic watershed.

Costs

Base Program: The NYSDEC has been funding the SCDHS (pesticide) groundwater monitoring program for three years at about $100,000 per year. The NYSDEC recently agreed to a three-year one million-dollar contract with the SCDHS to expand the monitoring program, but funding is based on approval of an annual work plan. This work takes place throughout Suffolk County, not just in the Peconic Region.

Point Source Monitoring

Program Objective

To track the short term and long term variations in point source nutrient loadings into the Peconic Estuary.

Monitoring Hypothesis

Total nutrient loadings to the Peconic Estuary from point sources are at a minimum being maintained, consistent with the PEP "no net increase" policy of surface water point source discharges.

CCMP Measurable Goal

Implement a quantitative nitrogen load allocation strategy for the entire estuary (measured by attaining the PEP recommendations including the implementation of the recommended Agricultural Environmental Management (AEM) program as well as other recommendations which may include fertilizer reduction programs, sanitary system upgrade programs, point source controls, etc., as well as monitoring for the impacts on measurable groundwater quality parameters).

Lead Entity

New York State Department of Environmental Conservation and Suffolk County Department of Health Services

Program Status

Point source discharge monitoring requirements and the Suffolk County Department of Health Services point source monitoring programs are existing program.

Monitoring Extent and Frequency

Point source dischargers are required to monitor effluent quality in their state-issued discharge permit, typically monthly monitoring is required. The Suffolk County Department of Health Services monitors ten routine point source influenced locations in the estuary during the year.

Program Description

Point sources are minor nitrogen sources in the whole estuary, but may still be significant for water quality in specific embayments. There are four major sewage treatment plants (STP) in the Peconic region: Brookhaven National Lab, Riverhead, Sag Harbor, and Shelter Island Heights. The Brookhaven National Laboratory STP is

assumed to be subsumed into the Peconic River baseline flow and loading. Operation of the Riverhead STP "avoids" 43 pounds of residential total nitrogen loading into the estuary each day (i.e., groundwater TN load would have occurred, but for the STP collecting and treating the sanitary waste that would have been generated in the absence of a sewage treatment plant). The remainder of the Riverhead STP loading (roughly 100 lbs/day) is assumed to be "imported" sanitary waste TN loads to surface waters, mainly from commercial and institutional activity served by the facility (SCDHS, 1999). The discharges from the Sag Harbor and Shelter Island Heights STPs are much less than 1% of the total nitrogen loadings in the eastern estuary (SCDHS, 1999).
Major sewage treatment plant upgrades at Riverhead and Sag Harbor are being funded, in large part, by New York State. The upgrades at the Riverhead STP include building a 1.4 million gallons per day advanced wastewater treatment facility utilizing Sequencing Batch Reactor technology, including ultraviolet light disinfection. The Village of Sag Harbor has received NYS Bond Act funding to upgrade their STP to a denitrification system.

SCDHS Routine Point Source Monitoring: The SCDHS Office of Ecology monitors ten routine point source influenced locations including sites in the Peconic River, Meetinghouse Creek, Crescent Duck Farm, Fish Cove and the local sewage treatment plants on a monthly basis. To minimize the effects from the adjacent saltwater portion of Meetinghouse Creek, the two Corwin Duck Farm sites are sampled as close as possible to low tide.

New York State Pollutant Discharge Elimination System (SPDES) Program: The SPDES program is administered by the New York State Department of Environmental Conservation. Permits are written to ensure that point source discharges do not cause or contribute to the violation of ambient water quality standards. There are eight permitted surface water dischargers in the Peconic Estuary System: Brookhaven National Lab, Navy Weapons Industrial Reserve Plant at Calverton, Riverhead Foundation Aquarium, Bayview Ventures, the Plum Island Animal Disease Center and the sewage treatment plants at Riverhead, Sag Harbor, and Shelter Island Heights. Each facility is required to monitor their effluents for a suite of parameters and report to the NYSDEC. The NYSDEC is responsible for reviewing the data and enforcing the permit.

Costs
Base Programs: Funding for the SCDHS Routine Point Source Monitoring Program in the Peconic Estuary was calculated along with the SCDHS Surface Water Quality Monitoring Program. Information on costs for the Suffolk County Department of Health Services Surface Water Quality Monitoring Program is included under Brown Tide Issues in this document.

Land Use Monitoring
Note: This monitoring program element does not include direct environmental measurements.

Program Objective
To track the short-term and long-term trends in land uses in the Peconic watershed.

Monitoring Hypothesis
The total amount of protected open space in the Peconic Estuary Program Study Area is increasing due to acquisition programs and other land protection measures.

CCMP Measurable Goals
Continue and expand open space acquisition programs; Ensure that there is no substantial net increase in nitrogen loading to areas east of Flanders Bay and reductions in the Peconic River/Flanders Bay region so that an increase in new development would be offset by reductions in loads from pre-existing uses. The nitrogen work groups will develop means of attaining this goal which may include groundwater performance standards, implementing fertilizer and clearing restrictions, and zoning.

Lead Entity
Suffolk County Department of Planning.

Program Status
Land use monitoring for the study areas is part of an existing program of the Suffolk County Department of Planning that was initiated with the Peconic Estuary Program.

Monitoring Extent and Frequency
Land uses (and other related information such as zoning and ownership) at a tax map scale have been determined for the entire Peconic Estuary Program Study, including both upland areas and underwater lands. The SCPD will be developing a strategy for updating the GIS land use and zoning databases.

Program Description
Land protection programs and other regulatory and non-regulatory land planning efforts are critical to nitrogen management. Forty percent of the Peconic watershed was available for development in 1995 (SCPD, 1997). If open space programs were not implemented and all 40% were developed at low density residential land uses, the current nitrogen loads to the western estuary, South Fork, and Shelter Island would more than double, as compared with existing conditions (SCDHS, 1999).

Suffolk County Planning Department (SCPD) Land Use Monitoring: The SCPD established an accurate Geographic Information System (GIS) database for existing land uses at a tax map scale for the Towns of Riverhead, Southold, Shelter Island, Southampton, East Hampton, and the Peconic River corridor in the Town of Brookhaven (SCPD, 1997). The SCPD also has a verified GIS database for existing zoning in this same region. With these databases, the Department is able to quantify the land use acreage by general categories, by jurisdiction and by watershed zone. The thirteen general categories of land use include low density residential, medium density residential, high density residential, commercial, industrial, recreation and open space, and vacant, among others. As a follow-up to the report *Peconic Estuary Program Existing Land Use Inventory* (SCPD, 1997) detailing the existing land uses in eastern Suffolk County in 1995, the SCPD is in the final stages of preparing the report *1999 Existing Land Use Inventory - Eastern Suffolk County*.

The SCPD will develop a strategy for updating the GIS land use and zoning databases, to be included in the first post-CCMP report. The update and maintenance of the GIS databases will require coordination of activities among the Suffolk County Planning Department, Suffolk County Real Property Tax Service Agency (SCRPTSA), town tax assessors and town planners. Current land uses will be compared to the PEP Existing Land Use Inventory (SCPD, 1997) to determine the rate of converting vacant or agriculture land to developed uses. Methods may include tax assessor codes, aerial photographs, building permits, and site inspections.

Other Programs: Several other programs will be addressed in the annual post-CCMP report including open space and farmland preservation, Harbor Protection Overlay Districts (HPODs)/local ordinances, and clearing restrictions.

Costs
Base Programs: Land use monitoring will be funded through base programs.

Habitat and Living Resource Issues

Eelgrass Monitoring

Program Objective
To monitor the abundance and quality of eelgrass beds in the estuary.

Monitoring Hypothesis
Eelgrass bed abundance (and aerial coverage) is increasing and health (as measured by density, growth, epiphyte coverage, and other ecological measurements) is improving in the Peconic Estuary due to the implementation of point and nonpoint source controls and management practices.

CCMP Measurable Goals
Maintain current eelgrass acreage (2,100 acres in main stem of the estuary); Increase eelgrass acreage by 10% over 10 years.

Lead Entity
Cornell Cooperative Extension of Suffolk County

Program Status
The Submerged Aquatic Vegetation Long Term Monitoring Project is an existing program. Aerial photo analyses of eelgrass coverage estuary-wide was performed in 2000. It is recommended that aerial photo analyses of eelgrass coverage be repeated periodically, at an interval to be determined

Monitoring Extent and Frequency
The Submerged Aquatic Vegetation Long Term Monitoring Project involves intensive investigations at a limited number of sites (presently six) in the estuary. Aerial photo analyses of eelgrass coverage estuary-wide was performed in 2000. It is recommended that aerial photo analyses of eelgrass coverage be repeated periodically, at an interval to be determined (perhaps every three years).

Program Description
Submerged Aquatic Vegetation Long Term Monitoring Project: In 1997, Cornell Cooperative Extension's Marine Program began SAV monitoring at three sites in the Peconic Estuary: Orient Harbor, Town of Southold; Northwest Harbor, Town of East Hampton; and Bullhead Bay, Town of Southampton. A minimum of three stations was sampled per site for SAV, sediment analysis, and water quality analysis. SAV measurements include: species composition, dry weight biomass of algae and eelgrass, depth and position of deep edge of eelgrass bed, shoot density, presence and dry weight biomass of epiphytes, and presence of wasting disease. Each site was sampled twice a year. Cornell Cooperative Extension uses water quality data from the SCDHS surface water quality monitoring program. These data consist of the following parameters: chlorophyll-a, total suspended solids, dissolved inorganic nitrogen, dissolved inorganic phosphorus, and light attenuation (for further information see: Nutrients monitoring section). In addition, water temperature, salinity, and light measurements at the surface and at one meter increments are taken at the time of SAV sampling. Sediment measurements include grain size and percent organic matter.

In response to external scientific peer-review, the monitoring program was revised (1998 sampling) as follows: SAV sampling was performed annually during the summer, the number of samples collected per site was increased to 12, and sediment sampling will be repeated every five years for each site. In 1999, Cornell Cooperative Extension expanded its monitoring program to include three additional sites in Gardiners Bay, Town of Shelter Island; Three Mile Harbor, Town of East Hampton; and Southold Bay, Town of Southold. Furthermore, underwater video of each site was also taken in 1998 and 1999. In 2000, the sampling plan was further refined to

improve statistical replication and reduce any potential impacts of the sampling methods to the extant eelgrass beds. Within each of the six monitoring sites, six stations were sampled. At each station, eelgrass stem density counts were performed for six quadrats. Plants sampled from an additional four quadrats were cut to determine eelgrass shoot and algal biomass, epiphytes, wasting disease, and stem density. This sampling protocol results in a total of 60 samples of eelgrass stem density, and 24 samples of shoot and algal biomass per monitoring site. Furthermore, the eelgrass roots are left intact to allow for regrowth. Aerial photo analyses of the eelgrass coverage estuary-wide are being performed in 2000 in cooperation with the US Fish and Wildlife Service. Aerial photos will provide a more extensive view of existing eelgrass beds and provide estimates of percent cover.

See Dumais and Smith (1997) for further details on the data analysis and quality control and quality assurance of this project.

Costs

Base Program: The Submerged Aquatic Vegetation Long Term Monitoring Project is funded at approximately $71,000 per year. Approximately $50,000 was provided from EPA Post-CCMP funds awarded to SCDHS. The remainder is provided by in-kind matching funds from Cornell Cooperative Extension.
New Costs: External funding for future annual sampling has been estimated at approximately $30,000. A source of funding to carry out this work has not yet been identified.

Finfish and Macroinvertebrate Monitoring

Program Objective

To determine the temporal and spatial distribution, abundance, and different life stage habitat requirements of finfish and macroinvertebrate species throughout the Peconic Estuary.

Monitoring Hypothesis

Finfish and macroinvertebrate abundance, diversity, distribution and health are improving due to the implementation of harvesting regulations and habitat protection.

CCMP Measurable Goals

Identify the important and sensitive recruitment and spawning areas of targeted finfish and macroinvertebrates; Increase the abundance of finfish species through protection of their habitats, food sources and restoration of degraded spawning and recruitment areas.

Lead Entity

New York State Department of Environmental Conservation

Program Status

Existing Program west of Shelter Island; recommended expansion of program to areas east of Shelter Island.

Monitoring Extent and Frequency

NYSDEC has run an annual monitoring survey of juvenile finfish west of Shelter Island since 1987. Sampling is performed on a block grid design superimposed over the Peconic Estuary (77 sampling blocks). Sixteen stations are randomly selected each week and sampled with an otter trawl during daylight hours.

Program Description

The CCMP recommends monitoring of finfish and macroinvertebrate species through: (1) habitat utilization mapping (subtidal habitats including SAV beds), (2) seine surveys, and (3) trawl surveys to develop a species occurrence list throughout their life cycle and identify sensitive recruitment and spawning areas.

NYSDEC Juvenile Finfish Survey: While there are currently no monitoring efforts in the Peconics for the adult finfish, the NYSDEC runs an annual monitoring survey of juvenile finfish west of Shelter Island since 1987. Sampling is performed on a block grid design superimposed over the Peconic Estuary (77 sampling blocks). Sixteen stations are randomly selected each week and sampled with an otter trawl during daylight hours. The original intent of the surveys was to develop an annual index of recruitment of juvenile weakfish and examine the relationship between parental stock size and environmental factors (water temperature, salinity, dissolved oxygen and secchi disc) on year class strength for weakfish (*Cynoscion regalis*). Data collection was later expanded to derive similar information on several other finfish species including winter flounder (*Pleuronectes americanus*), scup (*Stenotomus chrysops*), bluefish (*Pomatomus saltatrix*), tautog (*Tautoga onitis*), butterfish (*Peprilus triacanthus*), and northern puffer (*Sphoeroides maculatus)*. The surveys also provide important data on more than 70 other species of finfish and crustacea. In the 1998 report, "Species Composition, Seasonal Occurrence and Relative Abundance of Finfish and Macroinvertebrates Taken by Small-Mesh Otter Trawl in Peconic Bay, New York" (Weber *et al.*), nine years of data are compiled and evaluated.

While the NYSDEC's survey is extensive, it should be expanded to the east of Shelter Island. This information is essential to better understand the significance of the Peconics to important finfish and invertebrate species. Additional efforts should focus on resident species such as winter flounder, tautog, as well as transient species such as alewife (*Alosa pseudoharengus*), weakfish, scup, windowpane flounder (*Scopthalmus aquosus*), summer flounder (*Paralichthys dentatus*), northern puffer, butterfish, etc. Data on invertebrate species vulnerable to these gear types such as squid, horseshoe crabs, lady, blue, and green crabs, mantis shrimp, whelk, etc. should also be reported. For information on the trend analyses and QA/QC, see Weber et al. (1998). Ideally, trawl data should be entered into a geographic information system (GIS) to analyze spatial aspects of the data and to enable comparisons with habitat maps. Multivariate statistical analyses linking water quality and finfish data should also be performed.

Benthic Macroinvertabrate Survey: A program should be established to regularly conduct surveys of benthic macroinvertebrates (abundance, distribution, and diversity) in the Peconic Estuary.

Costs

Base Program: The NYSDEC Peconic Bay Trawl Survey is annually funded by the Wallop-Breaux Sport Fish Restoration Program.
New Costs: Analysis and GIS mapping of the Peconic Bay Trawl Survey data would require an additional $45,000 annually. Expansion of the trawl survey East of Shelter Island has been estimated at approximately $500,000 and an additional $100,000 would be needed annually for staff. Costs for annual benthic macroinvertebrate sampling have not been determined.

Wetlands Monitoring

Program Objective

To monitor the abundance, distribution, diversity and quality of fresh and salt water wetlands in the Peconic Estuary.

Monitoring Hypothesis

Wetlands in the Peconic Estuary are increasing in abundance and distribution in response to the implementation of management and restoration programs.

CCMP Measurable Goals

Maintain and increase current tidal and freshwater marsh acreage; Restore degraded tidal and freshwater wetlands (e.g. restricted flow, *Phragmites australis* dominated, shoreline-hardened); particularly those identified in the Habitat Restoration Workgroup Plan over 10 years; Restore 10-15% of the mosquito-ditched saltwater marshes through Open Marsh Water Management (OMWM) over the next 10 years, and maintain a policy of no new ditching.

Lead Entity

New York State Department of Environmental Conservation, with the U.S. Fish and Wildlife Service.

Program Status

NYSDEC and USFWS mapping efforts (described below) were completed as part of existing program. An expansion of the existing program is necessary for additional work to be completed (also described below). Future surveys and trend analysis is recommended.

Monitoring Extent and Frequency

The NYSDEC has performed GIS mapping of saltwater wetlands in the Peconic Estuary east of Shelter Island only (includes spatial distribution, acreage, and marsh types). Funding is needed to complete the survey west of Shelter Island and routinely track the trends of wetland coverage approximately every 5 years. The U.S. Fish and Wildlife Service surveyed wetlands in the entire Peconic Estuary watershed as part of the National Wetlands Inventory in 1997.

Program Description

USFWS National Wetlands Inventory: In 1997, the United States Fish and Wildlife Service surveyed wetlands in the Peconic Estuary watershed as part of the National Wetlands Inventory. The data were GIS mapped and are useful for tracking wetland trends over time. See the USFWS (1998) report by Tiner for details on trend analyses and data QA/QC.

NYSDEC Wetlands Inventory: The NYSDEC has also performed GIS mapping of saltwater wetlands in the Peconic Estuary East of Shelter Island only (includes spatial distribution, acreage, and marsh types). The NYSDEC performs such GIS mapping through a combination of aerial photo surveys and ground truthing. Funding is needed to complete the survey west of Shelter Island and routinely track the trends of wetland coverage approximately every 5 years. This is particularly important in light of the increasing rate of developmental pressure and sea-level rise. A program to assess wetland quality and map sensitive areas at risk should be established.

Costs

New Costs: At this time, no new or additional funding has been identified to finalize the NYSDEC mapping of saltwater wetlands west of Shelter Island. Finer-scale survey saltwater wetland analysis and mapping west of Shelter Island is estimated at $500,000. Routine trend analysis would require an additional $50,000 annually. Marsh restorations have been funded through a variety of funding sources including: NYS Bond Act, USFWS, Towns and the private sector. Costs of establishing a program to assess wetland quality and mapping sensitive areas at risk have not been developed.

Shoreline Hardening Monitoring

Program Objective
To quantify estuarine-wide shoreline hardening, characterize changes to the coastlines (erosion, deposition), assess impacts to habitat and living resources, and develop "environmentally friendly" systems to assist in implementing a CCMP priority of "no net increase" in shoreline hardening throughout the estuary.

Monitoring Hypothesis
The rate of loss of natural shoreline in the Peconic Estuary is slowing in response to the implementation of PEP policies and education and outreach efforts.

CCMP Measurable Goals
Maintain current linear feet of natural shoreline and over the next 15 years reduce shoreline hardening structures by 5%; Maintain and increase current tidal and freshwater marsh acreage, and promote new growth through the removal of existing shoreline hardening structures.

Lead Entity
New York State Department of Environmental Conservation, in concert with the Peconic BayKeeper, the U.S. Fish and Wildlife Service and Cornell Cooperative Extension of Suffolk County.

Program Status
A one time monitoring survey of shoreline hardening structures (including aerial and ground truthing surveys) was completed in 2000 through the Peconic Estuary Program. Future surveys and trend analysis of shoreline hardening structures is recommended

Monitoring Extent and Frequency
The entire Peconic Estuary Shoreline was monitored in this one time survey in 2000.

Program Description
Quantitative mapping is an important first step and will be carried out through aerial photo interpretation by the US Fish and Wildlife Service under contract to the PEP during the year 2000. The Peconic BayKeeper, Cornell Cooperative Extension and the NYSDEC PEP Program Coordinator will assist in ground truthing. Once the baseline information is established (e.g. percent coverage of hardened shoreline, types of structures, etc.), trend analysis of percent shoreline hardened will be tracked by future aerial and ground truthing surveys through GIS mapping and analysis. An assessment of detrimental effects of hardened shoreline and docks on the estuary is also needed to fully understand impacts on habitat and natural resources. The analysis will also include a characterization of all shoreline hardening found in the Peconics and an investigation of "environmentally friendly" systems. Future funding for additional surveys and trend analysis of shoreline hardening structures is recommended, but not yet appropriated.

Costs
Base Program: This monitoring is funded in part by the PEP Natural Resources Subcommittee funds at $19,000 and Suffolk County Capital Budget Funds ($49,000). New Costs: Biennial trend analysis using GIS mapping is estimated at $70,000.

Piping Plovers, Shorebirds, Raptors and Other Birds

Program Objective
To determine piping plover habitat use, availability, and prey abundance in the Peconic Estuary and to assess affects of habitat changes to make recommendations to enhance plover breeding and productivity. To ensure that shorebirds, raptors and other birds and their habitats are monitored for productivity.

Monitoring Hypothesis
The abundance and distribution of shorebirds, raptors, waterfowl and other birds in the estuary is increasing due to improvements in habitat quantity and quality, food abundance, and controls on predators.

CCMP Measurable Goals
Increase the number of piping plover pairs to 115 with productivity at 1.5 (over a 3-year average), distributed across the nesting sites in the Peconic Estuary; Maintain current linear feet of natural shoreline and over the next 15 years reduce shoreline hardening structures by 5% to increase habitats for shorebirds.

Lead Entity
The NYSDEC in cooperation with The Nature Conservancy, and the U.S. Fish and Wildlife Service.

Program Status
Existing program for monitoring piping plovers and least terns in the Peconic Estuary Program Study Area. Recommended expansion of existing program for other birds and for enhancing habitat to improve shorebird productivity.

Monitoring Extent and Frequency
Piping plover and osprey surveys in the Peconic Estuary Program Study Area are funded annually by NYSDEC and The Nature Conservancy. Waterfowl surveys in the Peconic Estuary Program Study Area are also conducted by U.S. Fish and Wildlife Service

Program Description
Endangered Species Program: The NYSDEC in cooperation with the The Nature Conservancy monitor for piping plovers and least terns in the Peconic Estuary through the Endangered Species Program. Initial review of piping plover productivity data indicates that populations are down at a number of Peconic Estuary sites. The reasons are unclear, as there are multiple factors that can play a role in breeding success and overall productivity. Throughout Long Island, there is an interest in "enhancing" habitat to improve shorebird productivity. Therefore, baseline data on prey abundance and shorebirds' microhabitat (i.e., intertidal zone -- sand and cobble patches, wrack, areas where there is sparse vegetation, beach berm, and moist swales) preferences is important information, particularly in the Peconic Estuary, which consists of habitats that do not readily fit typical habitat descriptions found in the literature.

Furthermore, it is recommended that a comprehensive monitoring plan be developed for the Peconic Estuary that ties together other monitoring programs (e.g. ospreys, terns waterfowl) and recommendations for improved comprehensive monitoring in this region be developed.

Costs
Base Program: Piping plover and osprey surveys are funded annually by NYSDEC and The Nature Conservancy. Waterfowl surveys are also conducted by USFWS.

New Costs: Costs for developing and implementing the comprehensive monitoring plan for ospreys, terns and waterfowl have not yet been developed.

Dredging

Note: This monitoring program element does not include direct environmental measurements.

Program Objective

To track the volumes and locations of dredging in the Peconics and reduce impacts to critical marine habitats.

Monitoring Hypothesis

The total amount of dredging for navigational purposes in the Peconic Estuary is decreasing due to the implementation of sediment control practices and stormwater management.

CCMP Measurable Goal

Develop recommendations and guidelines to reduce impacts to marine life from dredging-related activities.

Lead Entity

(proposed) New York State Department of Environmental Conservation, in coordination with the PEP Program Office and the Suffolk County Department of Public Works.

Program Status

Proposed new program.

Monitoring Extent and Frequency

Proposal is to develop a tracking system of all dredge-related activities (public and private) that occur annually within the Peconic Estuary Program Study Area.

Program Description

While there are no tracking programs yet established to evaluate the locations and volumes of annual dredging within the Peconic Estuary (i.e., public and private), the NYSDEC maintains a permitting system that records all dredging activities in NY marine waters. Coordination between the PEP and NYSDEC Environmental Permitting should be established so as to. Additionally, Suffolk County Department of Public Works maintains records of navigational maintenance dredging that they perform in the estuary and therefore, should also be included in the coordination efforts.

Costs

New Costs: A funding source for this monitoring has not been identified yet. Initial project cost is estimated at $30,000 (contractor fee) with a biennial maintenance cost estimated at $15,000.

Restoration Monitoring

Note: Portions of this monitoring program element does not include direct environmental measurements.

Program Objective

To track and assess the success of habitat restoration projects in the Peconic Estuary.

Monitoring Hypotheses

The extent and distribution of habitat restoration sites in the Peconic Estuary study area is increasing due to the implementation of the Peconic Estuary Program's "Habitat Restoration Plan for the Peconic Estuary" (Dec. 2000) and the availability/allocation of funding to carry out specific projects.

Habitat restoration efforts in the Peconic Estuary study area are successful, as measured by success criteria and monitoring protocols. The ecological function of restored habitats are equivalent to similar natural areas or reference sites, specific to a habitat type.

CCMP Measurable Goals

Annually initiate 5% of the projects identified in the Habitat Restoration Workgroup Plan for the Peconic Estuary and identify reference wetlands for comparative purposes such as functionality; Restore degraded tidal and freshwater wetlands (e.g., restricted flow, *Phragmites australis* dominated, shoreline-hardened); particularly those identified in the Habitat Restoration Workgroup Plan over 10 years; Restore 10-20% mosquito-ditched saltwater marshes through Open Marsh Water Management (OMWM) over the next 10 years, and maintain a policy of no new ditching.

Lead Entity

(proposed) Peconic Estuary Program Habitat Restoration Workgroup, in concert with the New York State Department of State and Cornell Cooperative Extension of Suffolk County, sponsors of individual habitat restoration projects.

Program Status

Proposed new program(s).

Monitoring Extent and Frequency

Proposal is to develop a tracking system of all habitat restoration activities (public and private) that occur annually within the Peconic Estuary Program Study Area, including both short and long-term monitoring evaluations, and monitoring before, during, and after restoration as needed to evaluate success of restoration efforts. Individual restoration projects would also be assessed according to success criteria and monitoring protocols.

Program Description

The CCMP recommends evaluating the success of restoration efforts. While restoration efforts can be successful in reaching their goals, there have also been examples in the Peconics of restoration efforts that have not resulted in actual long-term recovery of the targeted habitat. Therefore, it is essential to quantitatively assess and monitor restoration projects in order to take steps, if necessary, to correct any problems. A number of restoration projects are now underway as a result of available funding from the NYS Clean Air Clean Water Bond Act. More restoration projects are expected to be funded in the future. It is critical for restoration projects to build in the capacity to monitor sites upon completion of restoration. Restoration assessment needs to be linked to the reference sites in order to make quantitative comparisons of functionality. As part of assessment, monitoring before, during, and after restoration is also needed to evaluate success of restoration efforts. It is strongly recommended that the Habitat Restoration Workgroup's Plan for the different types of restoration projects in the Peconic Estuary be followed as an initial guideline. The development of a tracking database for each restoration project should also be developed for both short and long-term monitoring evaluations.

Costs
New Costs: A funding source for this monitoring has not been identified yet. An estimated cost of $35,000 is required to initiate such monitoring and an additional $15,000 is necessary for database maintenance on an annual basis. Appropriate monitoring associated with individual restoration projects should be included in the cost of the effort; costs will vary according to habitat type, scale, and location of the project.

Bay Scallops

Program Objective
To monitor the quantity and quality of bay scallops in the estuary and evaluate the success of enhancement efforts. To perform a distribution-focused study of the survival dynamics of juvenile bay scallops including and examination of settlement, recruitment, and size frequency and year class-abundance of bay scallops located inside and outside of eelgrass beds.

Monitoring Hypothesis
Bay scallop abundance and distributions are related to water quality, predator abundance and habitat quantity and quality in the estuary, as well as to commercial and recreational harvests.

CCMP Measurable Goal
Enhance the shellfish resources available to harvesting through reseeding, creation of spawning sanctuaries and habitat enhancements.

Lead Entity
(proposed) New York State Department of Environmental Conservation, in coordination with the PEP Program Office, the National Marine Fisheries Service and Cornell Cooperative Extension of Suffolk County.

Program Status
Proposed new program.

Monitoring Extent and Frequency
Proposal is to annually monitor the quality and quantity of bay scallops an evaluate the success of enhancement efforts in the Peconic Estuary Program.

Program Description
A program should be established that tracks the annual recruitment success and survival dynamics of bay scallops. Anecdotal information indicates that adult bay scallops were once abundant enough that they were found outside of eelgrass beds in deeper waters where they were harvested by dredging. Today, bay scallops are harvested almost entirely in eelgrass beds because they are not as abundant and are no longer found in deeper waters. Given the huge fluctuations that have occurred in bay scallop populations as a result of Brown Tide, it is important to perform a distribution-focused study of the survival dynamics of bay scallops and to monitor for changes in abundance and distribution and evaluate the effectiveness of reseeding efforts.

NMFS Commercial Landings Program: The National Marine Fisheries Service (NMFS) is in charge of coordinating the yearly landings and economic data on bay scallops caught in the Peconic Estuary and they have well established QA/QC and statistical procedures.

Costs
Base Program: NMFS provides funding for landings and economic data annually.

New Costs: A funding source for the recruitment and survival monitoring has not been identified yet. It is estimated that a full evaluation and tracking of the parameters of interest would cost $200,000 over three years.

Aquaculture and Transplanting Activities

Program Objective
To monitor the locations and extent of aquaculture and transplanting activities in the Peconic Estuary to minimize potential impacts to critical habitats and conflicts with other uses.

Monitoring Hypotheses
Aquaculture activities have no short or long-term impacts on the water quality in the Peconic Estuary.

Transport activities have no impact on natural populations of shellfish species in non-bed areas.

CCMP Measurable Goal
Ensure that the existing and future aquaculture (shellfish & finfish) and transplanting activities are situated in ecologically low-productive areas of the estuary, and that they are mutually beneficial to the aquaculture industry, natural resources and water quality.

Lead Entity
(proposed) New York State Department of Environmental Conservation, in coordination with the PEP Program Office, the Suffolk County Department of Planning and Cornell Cooperative Extension of Suffolk County.

Program Status
Proposed new program.

Monitoring Extent and Frequency
Proposal is to annually monitor the locations and extent of aquaculture and transplanting activities in the Peconic Estuary.

Program Description
There are no coordinated monitoring programs for either aquaculture (shellfish/finfish) or transplanting activities in the Peconics. The NYSDEC issues permits for aquaculture and transplanting activities and therefore, can better monitor the types, scale and locations of these activities in the estuary annually through GIS mapping. Long-term monitoring should be established to best situate culturing and transplanting activities that are mutually beneficial to the estuary and the aquaculturists. This coordination should also include the Suffolk County Planning Department, as Suffolk County is ultimately responsible for the development of an aquaculture plan for the Peconic Estuary.

Costs
Base Program: The NYSDEC annually funds the permitting of aquaculture and transplanting activities.
New Costs: The initial cost to develop a GIS map is estimated at $10,000. Annual maintenance cost of the GIS map is estimated at $5,000. Mapping and ground-truthing of the entire estuary bottom is estimated to cost $700,000.

Pathogen Issues

Coliforms Monitoring

Program Objective
To monitor and evaluate water quality in designated New York State Shellfish Growing Areas throughout the Peconic Estuary. Monitoring is necessary to properly classify growing areas for the safe harvest of shellfish to protect the public health.

Monitoring Hypotheses
The total acreage of open shellfish beds in the Peconic Estuary is increasing in response to improved water quality resulting from the implementation of nonpoint source controls and management practices.

The number of beach closures is decreasing due to the implementation of nonpoint source controls and management practices.

CCMP Measurable Goals
Maintain current acreage of areas available to shellfish harvesting, with the ultimate aim of re-opening lands currently closed to harvesting; Maintain and improve water quality of the estuary through a reduction of overall stormwater runoff, particularly key areas identified through the Regional Stormwater Runoff Study.

Attain a zero discharge of stormwater runoff in new subdivisions.

Lead Entity
New York State Department of Environmental Conservation (lead for the Shellfish Land Certification Program) and the Suffolk County Department of Heath Services (lead for the bathing beaches and swimming pools program).

Program Status
The New York State Department of Environmental Conservation Shellfish Land Certification Program and the Suffolk County Department of Heath Services' Bathing Beaches and Swimming Pools Program Surface Water Quality Monitoring Programs are existing efforts.

Monitoring Extent and Frequency
Monitoring takes place on a regular basis in the thirty shellfish growing areas under the Shellfish Land Certification Program (a minimum of six times per year at each sampling station). Suffolk County Department of Health Services (SCDHS) Bureau of Marine Resources routinely monitors for pathogen indicators at public beaches, and includes coliform sampling in the routine monitoring program estuary wide (32 stations) and year round (biweekly).

Program Description
New York State Shellfish Land Certification Program: The New York State Shellfish Land Certification Unit classifies all shellfish growing areas in the New York State Marine District. New York State defines shellfish as oysters, scallops, mussels and clams. There are seventy-five individual shellfish growing areas in New York State. Approximately thirty growing areas are located within the Peconic Estuary. The Shellfish Land Certification Unit classifies all shellfish growing areas using the guidelines established in the National Shellfish Sanitation Program (NSSP) Guide for the Control of Molluscan Shellfish. These guidelines require the establishment of water sampling stations to effectively evaluate all pollution sources that may affect a growing area.

New York State uses the NSSP Systematic Random Sampling (SRS) Method of water sample collection and the Total Coliform Standard to evaluate shellfish growing areas. SRS requires that water sample collection be

scheduled sufficiently far enough in advance to support random collection with respect to environmental conditions. Samples are collected under wet and dry weather conditions in warm and cold weather months. Surface and bottom temperature and salinity measurements are also collected at selected stations in each growing area in the Peconics. SRS samples are collected a minimum of six times per year at each station. Following the collection of thirty SRS water samples the area is evaluated to determine proper classification for shellfish harvesting based on the NSSP total coliform criteria for certified shellfish growing areas. It is imperative that all growing areas be properly classified for shellfish harvesting for the protection of public health.

SCDHS Bathing Beaches and Swimming Pools Program: In order to protect beach goers from the human health risks associated with pathogens, the Suffolk County Department of Health Services (SCDHS) Bureau of Marine Resources routinely monitors for pathogen indicators at public beaches. When water quality parameters fail to meet the established human health criteria, beaches are closed. In addition, the SCDHS generally recommends the closure of bay beaches for two tidal cycles after large rainfall events.

SCDHS Surface Water Quality Monitoring: The SCDHS Bureau of Marine Resources includes coliform bacteria counts in their suite of monitoring parameters for their sampling sites in the Peconic Estuary. Refer to the SCDHS Surface Water Quality Monitoring Section in the Nutrients Monitoring Workplan for more information about SCDHS' Program.

Costs

Base Program: The shellfish land certification monitoring is funded annually by the NYSDEC. The SCDHS Bathing Beaches and Swimming Pools Program is funded annually by SCDHS. The SCDHS Surface Water Quality Monitoring Program is funded in part by PEP Post-CCMP EPA funds and in-kind match from Suffolk County (see discussion under Brown Tide Issues in this document).

***Pfiesteria piscicida* and *Alexandrium tamarense* Monitoring**

Program Objective

To monitor for the presence of harmful algal blooms and ensure public health and safety. Harmful algal blooms may be due to poor water quality conditions in combination with meteorological events and other factors.

Monitoring Hypothesis

Pfiesteria piscicida and *Alexandrium tamarense* are not present in concentrations that are toxic or threaten public health and safety, due to improving water quality conditions in the Peconic Estuary.

CCMP Measurable Goal

Prevent the human ingestion and exposure to marine organisms that are affected by harmful algal blooms through routine monitoring.

Lead Entity

New York State Department of Environmental Conservation, in cooperation with the Suffolk County Department of Health Services for *Pfiesteria piscicida*; Suffolk County Department of Health Services for *Alexandrium tamarense*.

Program Status

The existing program of *Pfiesteria piscicida* sampling was conducted in 1999-2000; it is recommended this program be expanded to be conducted annually. Sampling for *Alexandrium tamarense* has been performed periodically; it is recommended this program be expanded to be conducted annually

Monitoring Extent and Frequency

A comprehensive characterization survey for *Pfiesteria piscicida* in the Peconic Estuary was conducted in 1999-2000. The Suffolk County Department of Health Services is currently estimating the concentration of *Alexandrium* at seven sites in the Peconic Estuary.

Program Description

Pfiesteria: The unusual dinoflagellate, *Pfiesteria piscicida*, has been implicated in major fish kills in the brackish coastal waters of North Carolina and several areas within the Chesapeake Bay. It has also been implicated in human health effects, the severity of which are apparently dependent on the length of contact with the organism, or an airborne toxin released by the organism. *Pfiesteria* normally occurs in non-toxic forms unless triggered to develop into a toxic form; the exact conditions triggering toxin production are poorly understood.

Preliminary studies by SCDHS in 1998 showed the organism to be present at seven of the sixteen sites sampled within Suffolk County and at two of the three sites sampled within the Peconic Estuary. In the summer of 1999, the NYSDEC and the Nassau and Suffolk County Health Departments (SCDHS) and the Town of Hempstead undertook a comprehensive monitoring effort to assess the marine waters of the state for the presence of *Pfiesteria* cells. The *SCDHS Surface Water Quality Monitoring Standard Operating Procedure* (SCDHS, 2000) and the *Quality Assurance Project Plan for the Peconic Estuary Program Surface Water Monitoring Program* (SCDHS, 1994) contain the standard operating procedures and the QA/QC methods for *Pfiesteria* monitoring.

Water samples were tested for *Pfiesteria* along with a suite of other parameters, including dissolved oxygen, water temperature, and salinity. The test, using a molecular probe in the laboratory, detects the presence of *Pfiesteria* but not the toxicity. Water samples are shipped to Dr. Parke Rublee of the University of North Carolina where they are analyzed for *Pfiesteria* using their rigorously established QA/QC standards.

The SCDHS is currently testing for the presence of *Pfiesteria* at fifteen sites, three of which are located in the Peconic Estuary. This project is meant to provide a comprehensive temporal analysis as samples are being collected from each of the fifteen stations on a biweekly basis from April to October 2000. Differential phytoplankton counts and water quality analysis (including tests for nutrient levels) will be conducted in the lab. This monitoring is a cooperative effort with the NYSDEC and is being coordinated with funds from a Federal Program. It is recommended that monitoring for *Pfiesteria piscicida* continue annually.

Alexandrium: Paralytic shellfish poisoning (PSP) red tides caused by the organism *Alexandrium tamarense* have been a problem mainly in the northern New England states. The organism produces a neurotoxin that can be concentrated by shellfish which, when consumed by humans can result in PSP. In a four year monitoring study, from 1986 to 1989, SCDHS found that a spring bloom of *A. tamarense* consistently occurred in Reeves Bay and also noted blooms in Terry's and East Creeks in 1989, the one year in which they were investigated. No other stations in the Peconic Estuary were sampled.

The SCDHS Bureau of Marine Resources is currently estimating the concentration of *Alexandrium* at seven sites in the Peconic Estuary. The investigation entails the placement of mussels (*Mytilis edulis*) at the study sites, and their collection at specified intervals for PSP toxin analysis. The *SCDHS Surface Water Quality Monitoring Standard Operating Procedure* (SCDHS, 2000) and the *Quality Assurance Project Plan for the Peconic Estuary Program Surface Water Monitoring Program* (SCDHS, 1994) contain the standard operating procedures and the QA/QC methods for PSP monitoring.

The present study is limited to the Peconic Estuary. Present plans are to investigate the south shore bays of the County in 2001 and the north shore bays the following year.

Costs

Base Program: The estimated cost for handling and analyzing the water samples for this year's *Pfiesteria* monitoring project is $25,000. The estimated cost for handling and analyzing the samples for this year's *Alexandrium* monitoring project is $35,000. Neither estimate includes the cost of labor and boat maintenance.

New Costs: Additional funding is needed ($25,000 for *Pfiesteria* and $35,000 for *Alexandrium*) to annually continue these projects.

Vessel Waste No Discharge Areas

Program Objective

To determine the amount of vessel waste collected in pump-out facilities as the result of education/outreach programs and the designation/implementation of a vessel waste no discharge area for the Peconic Estuary. The collection of such wastes may improve water quality in poorly flushed areas.

Monitoring Hypothesis

The amount of vessel wastes collected in pump-out facilities will increase, as a result of education/outreach programs and the designation/implementation of a vessel waste no discharge area for the Peconic Estuary.

CCMP Measurable Goal

Eliminate all vessel waste discharges to the estuary upon adoption of the Vessel Waste No Discharge Area.

Lead Entity

(proposed) Peconic BayKeeper, in cooperation with the New York State Department of State, the east end towns, public and private marinas, and the Peconic Estuary Program Office. (Note: This monitoring program element should be coordinated with Coliform Monitoring also contained in this monitoring plan).

Program Status

Proposed new program.

Monitoring Extent and Frequency

Annual monitoring of boat waste collected from pump out facilities estuary-wide.

Program Description

The Peconic Estuary may be designated as a No Vessel Waste Discharge Area by the 2001 boating season. The volume of boat waste collected from pump-out facilities within the Peconic Estuary each year should be monitored with trend analysis. In addition, a comparative study evaluating the effectiveness of Vessel Waste No Discharge Areas at improving water quality should be done. An evaluation of the pertinent parameters to be measured is necessary, and the statistical analyses employed to compare these zones should be fully replicated.

Costs

New Costs: A funding source for this monitoring has not been identified yet. Monitoring of boat waste collected from pump out facilities is estimated at a cost of $5,000 annually.

Toxics Issues

Sediment Monitoring

Program Objective
To monitor the quality of estuarine sediments to determine the levels of specific toxic substances and overall sediment toxicity.

Monitoring Hypotheses
The quality of estuarine sediments is improving; New or emerging pollutants of concern or areas will be detected by monitoring sediments.

CCMP Measurable Goal
Improve the quality of the ambient environment (surface waters, groundwater, sediments and biota) where there is evidence that human inputs impair or threaten these resources.

Lead Entity
U.S. Environmental Protection Agency, in cooperation with the Suffolk County Department of Health Services.

Program Status
Sediment surveys were conducted in 1998, 2000 and 2001, and will be conducted annually hereafter.

Monitoring Extent and Frequency
Up to 30 estuarine locations will be sampled annually. To date, bulk chemistry and overall toxicity data is available on approximately 60 embayments, harbors and tributaries. Sediment quality does not change rapidly. The Peconic Estuary Program is pursuing a program whereby depositional areas are monitored to identify areas of concern for follow up work.

Program Description
Peconic Estuary sediments are now being regularly collected and analyzed for a broad range of contaminants and overall or cumulative toxicity. In the fall of 1994, the PEP contracted with the firm of A.D. Little, Inc. to analyze field collected sediments for toxic contaminants. In all, sediments from 12 sites were analyzed. In 1998, the USEPA Region II conducted a survey that involved the collection and sampling of sediments for chemical contaminants and overall sediment toxicity from 34 sites representative of a range of typical land uses across the estuary (see Figure 8). Toxicity testing is a valuable gauge, in addition to chemical specific analyses, because the results provide an assessment of the overall toxicity resulting from exposure to multiple contaminants. In August 2000, EPA conducted a survey similar to the 1998 survey, again involving the collection and sampling of sediments for chemical contaminants and overall sediment toxicity. Some previously sampled sites were revisited for follow-up work and some new sampling locations were selected (see Figure 9). Additional sites were sampled in 2001 (see Figure 10).

Future monitoring efforts should be used to describe trends in sediment quality (both for individual contaminants and overall toxicity) at previously sampled sites and the sediment quality status at any newly sampled sites. Sediment sampling, collection, analysis, and testing procedures should be consistent with those employed previously by EPA and are described in *Peconic Estuary Tributaries Sediment Toxics Survey Field Sampling Plan/Quality Assurance Project Plan* (USEPA Region II, August 1998) and the *2000 Peconic Estuary Tributaries*

Sediment Toxics Survey - Field Sampling Plan/Quality Assurance Project Plan (USEPA Region II, August 2000). The EPA target analyte list of polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), pesticides, and metals, should also be matched, to the extent possible, but supplemented with any toxic substances of emerging concern, particularly with respect to pesticides.

Costs

Sample collection and analysis for toxic substances and toxicity is relatively expensive. Analysis alone can be several hundreds dollars to over one thousand dollars per sample, particularly if substances such as dioxins or furans are on the target analyte list. Typically more than one sample per location is necessary and QA/QC samples must also be analyzed. Analysis alone for a limited survey can be upwards of $25,000 with additional resources necessary for sample collection. Interpretation of the results must be conducted after the analysis is complete.

To the extent possible, the PEP should seek to undertake annual sediment sampling until all major embayments in the estuary are sampled, and areas of concern are re-sampled. Base programs of the USEPA and the SCDHS can provide sample collection and preparation costs.

New Costs: An estimated $25,000 per year will be necessary over three years to complete sample collection and analysis.

Coastal 2000

Program Objectives

Assess the health or condition of the estuarine waters of the United States and trace changes in that condition through time.

Utilize the approach to identify reference conditions for estuarine waters in the United States.

Utilize existing state monitoring programs as appropriate.

CCMP Measurable Goal

Improve the quality of the ambient environment (surface waters, groundwater, sediments and biota) where there is evidence that human inputs impair or threaten these resources.

Lead Entity

U.S. Environmental Protection Agency, in cooperation with the New York State Department of Environmental Conservation.

Program Status

Program will be conducted in 2000-01.

Monitoring Extent and Frequency

Twelve sites in the Peconic Estuary will be sampled, six in 2000 and the remaining six in 2001.

Program Description

Coastal 2000 is a Federal EPA program to assess the ecological condition of our nation's estuarine resources using EPA's EMAP designs and methodologies. Unlike EMAP, which took on the entire task itself, Coastal 2000 has worked with the coastal states to form partnerships, incorporating the monitoring needs of the individual states into the overall design and providing funding to build up infrastructure for monitoring in the future. Such monitoring

may be ideally suited to Clean Water Act Section 305(b) reporting. The EPA NHEERL laboratory in Narragansett, RI has worked with New York to develop probabilistic monitoring plans, and identified who will take the lead in carrying out the sampling. A number of core indicators will be monitored at each station; however, individual states can add to this list as they desire. The core suite includes water quality parameters, sediment chemistry, sediment toxicity, benthic community composition, fish community composition, fish pathology, and contaminants in fish. Twelve sampling stations were planned for the Peconic Estuary.

Update as of August 2000: The monitoring plan was developed in cooperation with the NYSDEC, the EPA Long Island Sound Program, and the State University at Stonybrook. Karen Chytalo, Chief, Estuary Management Unit of NYSDEC initiated the cooperative agreement. Larry Swanson, Marine Science Research Unit of the Waste Reduction and Management Institute at Stonybrook has taken the lead for monitoring. He will be assisted by county and New York City monitoring staff.

Future Action: The Narragansett staff will meet with the agencies from New York in the early fall of 2000 to discuss how the monitoring went and what improvements or changes need to be made for the monitoring that will be done in 2001.

Costs

Base Program: Current funding levels have allowed for sampling at half the stations in New York in 2000 with the other half planned for monitoring in the summer of 2001. All the cooperative agreements have been awarded and sampling has begun by all entities involved. All analyses will be provided by the Coastal 2000 Program.

Biota (Fish, Shellfish and Crustacean) Monitoring

Program Objective

To monitor the quality of estuarine biota with respect to individual toxic substances, and provide updated information to be used in the establishment of Human Health Advisories.

Monitoring Hypotheses

The quality of estuarine biota is improving; New or emerging pollutants of concern can be detected using biota.

Lead Entity

U.S. Environmental Protection Agency, in cooperation with the New York State Department of Environmental Conservation, the New York State Department of Health and the Suffolk County Department of Health Services.

Program Status

In 1999 EPA conducted a one time survey involving the collection of finfish and shellfish samples for toxic analyses. Any efforts including compiling, evaluating and interpreting data for the Peconic Estuary Study Area represents a new program activity.

Monitoring Extent and Frequency

Conducted as a one time survey of finfish and shellfish quality. Various species of finfish and shellfish were collected from locations throughout the Peconic Estuary. No further biota sampling is recommended until data analysis, evaluation and data interpretation is completed.

CCMP Measurable Goal
Improve the quality of the ambient environment (surface waters, groundwater, sediments and biota) where there is evidence that human inputs impair or threaten these resources.

Program Description
At present, no entity has established a program whereby Peconic Estuary biota is regularly collected and analyzed for a broad range of contaminants. In 1999, EPA Region II conducted a Peconic Estuary Fish, Shellfish and Crustacean Survey. A primary objective of this survey was to determine whether the toxic compounds identified by the New York State Department of Health as being important for the issuance of human health advisories for the consumption of aquatic species are relevant in edible tissues of selected fish and shellfish, and tissues and hepatopancreas (tomalley) of selected crustacean species in the Peconic Estuary.

Future monitoring efforts should be used to describe trends in biota quality and to identify new or emerging chemicals of concern. Biota sampling, collection, analysis, and testing procedures should be consistent with those employed previously by EPA and described in the *Peconic Estuary Fish, Shellfish and Crustacean Toxics Survey Quality Assurance Project Plan for Field Collection Effort* (USEPA Region II, 1999). The EPA target analyte list of dioxins and furans, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), pesticides, metals, and radionuclides should also be matched, to the extent possible, but supplemented with any toxic substances of emerging concern, particularly with respect to pesticides. Target species in any future efforts should be carefully selected and may focus on bivalves.

Costs
Sample collection and analysis for toxic substances is relatively expensive. Analysis alone can be several hundreds dollars to over one thousand dollars per sample, particularly if substances such as dioxins or furans are on the target analyte list. Typically more than one sample per location is necessary and QA/QC samples must also be analyzed. Analyses alone for EPA's 1999 survey was approximately $100,000 with additional resources necessary for sample collection and preparation. Interpretation of the results must be conducted after the analysis is complete.

No further biota sampling is recommended until analysis is completed for the 1999 EPA samples and data interpretation is completed.

NOAA Mussel Watch Program

Program Objective
The objective of the NOAA Mussel Watch Program is to measure concentrations of a broad suite of trace metals and organic chemicals in the whole soft parts of mussels and oysters.

Monitoring Hypotheses
A nationwide program of monitoring mussels and oysters can address national concerns over the quality of the coastal marine environment and identify chemicals of concern.

CCMP Measurable Goal
Improve the quality of the ambient environment (surface waters, groundwater, sediments and biota) where there is evidence that human inputs impair or threaten these resources.

Lead Entity
U.S. Environmental Protection Agency, using NOAA data

Program Status
The NOAA Mussel Watch Program is an existing program. Compiling, evaluating and interpreting data represents a new program activity.

Monitoring Extent and Frequency
One site in Gardiners Bay is included in this national program, which is sampled annually.

Program Description
The NOAA Mussel Watch Program is part of the NOAA National Status and Trends (NS&T) Program, the purpose of which is to measure concentrations of a broad suite of trace metals and organic chemicals in surface sediments and the whole soft parts of mussels and oysters. At present, one sampling site in Gardiners Bay is included in this national program. See *Chemical Contaminants in Oysters and Mussels* (Tom O'Connor, National Oceanic and Atmospheric Administration (NOAA), 1998 (on-line)) and NOAA's State of the Coast Report (Silver Spring, MD: NOAA. URL: http://state-of-coast.noaa.gov/bulletins/html/ccom_05/ccom.html) for more information.

Costs
Base Program: Sampling and analysis at this site is part of a national program.

Surface Water Monitoring

Program Objective
To monitor the quality of the surface waters with respect to individual toxic substances and overall toxicity.

Monitoring Hypotheses
The quality of surface waters is improving due to the implementation of point and nonpoint source control programs; new or emerging pollutants of concern or areas will be detected by monitoring.

CCMP Measurable Goal
Improve the quality of the ambient environment (surface waters, groundwater, sediments and biota) where there is evidence that human inputs impair or threaten these resources.

Lead Entity
(no lead entity has been identified at present)

Program Status
No existing programs. Various programs, typically of limited duration and scope, have been conducted in the past, investigating tidal creeks and the freshwater Peconic River. Compiling, evaluating and interpreting data for the Peconic Estuary Study Area represents a new program activity.

Monitoring Extent and Frequency
Various programs, typically of limited duration and scope, have been conducted in the past including sampling of tidal creeks on the North Fork and the freshwater Peconic River. The need and specifications for a new ongoing surface water monitoring program should be investigated/determined, and any effort should be coordinated with other monitoring efforts, particularly groundwater monitoring.

Program Description

At present, no entity has established a program whereby surface water samples are regularly collected and analyzed for a broad range of contaminants and overall or cumulative toxicity. Monitoring for toxics in surface waters has occurred on a limited basis in the Peconic Estuary System. Detailed new investigations have focused on sediments and fish tissues where toxics tend to accumulate. Notably, the pesticide Aldicarb also has been detected in the surface waters of East Creek and other North Fork Creeks. While Aldicarb is no longer in use, its presence is likely due to the drainage of agricultural areas containing residues of Aldicarb. Another emerging concern is MTBE (methyl *tert*-Butyl Ether), an octane booster in gasoline, which has been showing up in surface water samples, including Sag Harbor Creek near Havens Beach (perhaps related to an active recovery operation nearby), the Peconic River, and other surface waters. An ongoing North Fork Creek Study and other programs are described below.

North Fork Creeks Study: The SCDHS Office of Ecology samples sixteen north fork creeks, located from Sawmill Creek to Narrow River, bimonthly with eight locations done each month. Sampling is done during the last of the ebb tide at each station in an attempt to quantify impacts that the stream may have on the estuary. Samples from each site are analyzed for 109 organic solvent and pesticide compounds.

Other Programs: In 1997, New York State and the U.S. Geological Survey began a cooperative effort to monitor pesticides in State waters, including one station in the Peconic River. Samples were analyzed for 47 pesticides, including herbicides, insecticides and their degradation products. The pesticide concentrations measured in this survey probably do not reflect maximum annual concentrations because most of the samples were collected during base flow (low-flow) conditions. While no pesticides with water quality criteria available were identified present in excess of the applicable criteria, two pesticides (atrazine and simazine) were detected in surface water samples (USGS, 1997).

Some trace metals analysis has been performed on Peconic Estuary waters (see *Distribution of Trace Metals and Dissolved Organic Carbon in a Brown Tide Influenced Estuary: The Peconics,* E. Breuer, May 1997). Results for the metals sampled for which New York State has adopted and EPA has approved aquatic life based water column criteria (cadmium, copper, lead, nickel, and silver), while showing evidence of anthropogenic (man-made) inputs, did not exceed the established criteria.

Recommendations for Monitoring: Periodic surface water sampling should continue and special projects supported, particularly investigations on pesticides. Such studies should, to the extent possible, be done in conjunction with sediment surveys and sample collection and analysis procedures should be consistent with those employed by EPA. The EPA target analyte list of polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), pesticides, and metals, should also be matched, to the extent possible, but supplemented with any toxic substances of emerging concern, particularly pesticides. Overall water toxicity testing should also be employed. Toxicity testing is a valuable gauge, in additional to chemical specific analyses, because the results provide an assessment of the overall toxicity resulting from exposure to multiple contaminants. See *Pesticide Concentrations in Surface Waters of New York State in Relation to Land Use - 1997* (U.S. Geological Survey, June 1998) and *Pesticides in Streams in New Jersey and Long Island, New York and Relation to Land Use* (U.S. Geological Survey, May 1999) for additional information.

Costs

Base Program: The North Fork Creeks Study is funded by the Suffolk County Department of Health Services.

Sample collection and analysis for toxic substances and toxicity is relatively expensive. Analysis alone can be several hundreds dollars to over one thousand dollars per sample, particularly if substances such as dioxins or furans are on the target analyte list. Typically, more than one sample per location is necessary and QA/QC samples

must also be analyzed. Analysis alone for a limited survey can be upwards of $50,000 with additional resources necessary for sample collection. Interpretation of the results must be conducted after the analysis is complete.

No new surface water sampling programs for toxics are recommended at the present time.

Groundwater Monitoring

Program Objective
To monitor the quality of groundwater (in the groundwater contributing area of the Peconic Estuary) with respect to individual toxic substances to determine public health and ecological threats.

Monitoring Hypotheses
The quality of groundwater is improving in the Peconic Estuary Program study area in response to the implementation of point and nonpoint source control programs.

Monitoring of groundwater will identify chemicals of concern in the raw water supply (and ultimately chemicals that may be of concern in the estuarine environment). New or emerging pollutants of concern will be detected by monitoring these media.

CCMP Measurable Goal
Improve the quality of the ambient environment (surface waters, groundwater, sediments and biota) where there is evidence that human inputs impair or threaten these resources.

Lead Entity
Suffolk County Department of Health Services, with support from the New York State Department of Environmental Conservation.

Program Status
Numerous studies have been conducted in the past. At present, the SCDHS to is carrying out a three year pesticides in groundwater monitoring program. It is likely that it will be recommended this program be continued annually thereafter.

Monitoring Extent and Frequency
Groundwater is sampled throughout the study area. The Suffolk County Health Department has identified thousands of private wells in the Peconic Estuary Study Area that should be monitored due to the high risk of pesticide contamination.

Program Description
The Suffolk County Department of Health Services Bureau of Groundwater Resources monitors the quality and quantity of the groundwater supply and conducts studies and investigations of the county's hydrology. Suffolk County is completely dependent on its groundwater resource for drinking water supply. The focus of groundwater protection measures has been on contamination caused by humans, from sewage to chemicals such as petroleum, solvents, degreasers, fertilizers, pesticides and herbicides. In eastern Suffolk County, agricultural chemicals are the primary contaminant of concern.

Groundwater discharge provides the base flow for the County's rivers and streams. Relatively small fluctuations in water table elevations can have a significant effect on wetlands, stream flow and lake levels. Stream flow and groundwater underflow to embayments influence the salinity of surface waters and effect the ecology, having impacts on the ability of shellfish and finfish to reproduce. The Bureau of Groundwater Resources is involved with several active groundwater investigations, contaminant studies and at superfund and hazardous waste sites. The Bureau of Groundwater Resources' Pesticide Monitoring Program is especially important, including investigations done in conjunction with the USGS and NYSDEC. There is an ongoing program involving public and private well monitoring. Groundwater impacts from vineyards and golf courses are being specifically evaluated. See *Pesticides and their Metabolites in Wells of Suffolk County, New York 1998* (U.S. Geological Survey, June 1999) and *Water Quality Monitoring Program to Detect Pesticide Contamination in Groundwaters of Nassau and Suffolk Counties, NY* (Suffolk County Department of Health Services, June 1999) for more information.

The Suffolk County Health Department has identified thousands of private wells in the Peconic Estuary Study Area that should be monitored due to the high risk of pesticide contamination. Significant funding is needed to monitor for pesticide residues in potentially impacted residential and public water supply wells in the study area.

Costs

Groundwater monitoring is occurring under many specially funded studies and investigations as well as an ongoing program involving public and private well monitoring. The SCDHS has requested that the NYSDEC accelerate funding to test all 6,000 to 7,000 wells at risk in high pesticide use areas under the Pesticide Reporting Law.

The NYSDEC has been funding the SCDHS pesticide groundwater monitoring program for three years at about $100,000 per year. The NYSDEC recently agreed to a three-year one million-dollar contract with the SCDHS to expand the monitoring program, but funding is based on approval of an annual work plan. The SCDHS has requested that the full one million dollars be allocated to expand the monitoring program.

Hazardous Waste Site Monitoring

Program Objective

Perform monitoring as part of remedial investigations and following the implementation of remedies at hazardous waste sites; monitor compliance with clean-up schedules.

Monitoring Hypothesis

Discharges of toxic substances entering the Peconic Estuary Program study area from hazardous waste sites are decreasing in response to clean-ups and remedial actions.

CCMP Measurable Goals

Comply with schedules for conducting site characterizations, remedial actions and post-remedial monitoring at hazardous waste sites; effectively characterize risks and protect human health and the environment at hazardous waste sites; ensure compliance with permit limits for point source discharges.

Lead Entity

U.S. Environmental Protection Agency, New York State Department of Environmental Conservation, and the Suffolk County Department of Health Services.

Program Status

Permittees, property owners, potentially responsible parties, and government agencies are investigating various sites and performing monitoring to document the effectiveness of remedial measures as part of existing programs. Compiling, evaluating and interpreting data for the Peconic Estuary Study Area represents a new program activity.

Monitoring Extent and Frequency
At numerous sites throughout the study area, site investigations and post-remedial monitoring is taking place according to compliance schedules, workplans and records of decisions.

Program Description
Federal and State hazardous waste laws require monitoring as part of the remedial investigation process and once remedial actions are undertaken. The current program is effective to assess human health and ecological risks at hazardous waste sites.

Costs
Base Programs: Costs are borne by permittees, property owners, potentially responsible parties, or the government. At this time, no new or additional investigations or monitoring is being recommended in the Peconic CCMP, outside of that required by existing authorities. The PEP will monitor compliance with schedules, as described in the Toxics Chapter in the PEP Comprehensive Conservation and Management Plan.

Point Source Monitoring

Program Objective
Perform monitoring of regulated point sources to determine compliance with permit limitations and conditions.

Monitoring Hypothesis
Discharges of toxic substances entering the Peconic Estuary Program study area from point sources are decreasing in response to improved treatment practices and process substitutions.

CCMP Measurable Goals
Comply with schedules for conducting site characterizations, remedial actions and post-remedial monitoring at hazardous waste sites; effectively characterize risks and protect human health and the environment at hazardous waste sites; ensure compliance with permit limits for point source discharges.

Lead Entity
U.S. Environmental Protection Agency, New York State Department of Environmental Conservation, and the Suffolk County Department of Health Services.

Program Status
Permittees perform monitoring of discharges part of existing programs. Compiling, evaluating and interpreting data for the Peconic Estuary Study Area represents a new program activity.

Monitoring Extent and Frequency
Permittees perform monitoring of discharges at various locations throughout the estuary at a frequency specified in their permits.

Program Description
National Pollutant Discharge Elimination System (NPDES/SPDES) Program: The National and State Pollutant Discharge Elimination System (NPDES/SPDES) Programs establish thresholds on discharges (concentration or mass based) for toxic (and other) pollutants in the form of permit limitations and conditions. Permittees are also required to self-monitor their discharge and demonstrate compliance status with these limits/conditions. This information is reported to regulatory agencies in the form of Discharge Monitoring Reports (DMRs). The NYSDEC also inspects and samples discharges for compliance with permit requirements.

Costs
Base Programs: Sampling and reporting costs are borne by permittees and ongoing compliance programs of regulatory agencies. At this time, no new or additional investigations or monitoring is being recommended in the Peconic CCMP, outside of that required by existing authorities.

Federal Toxics Release Inventory

Program Objective
To monitor major releases of toxics to the environment

Monitoring Hypothesis
Releases of toxic substances to the Peconic Estuary Program study area are decreasing in response to the implementation of best management practices, product substitutions, etc.

CCMP Measurable Goal
Decrease overall emissions of reportable toxics from the five east end towns.

Lead Entity
U.S. Environmental Protection Agency.

Program Status
Reporting is required as a part of an existing program. Compiling, evaluating and interpreting data for the Peconic Estuary Study Area represents a new program activity

Monitoring Extent and Frequency
A limited number of facilities in the Peconic Estuary watershed report annually under the requirements for the Toxics Release Inventory.

Program Description
Existing Federal program and reporting requirement.

Costs
Base Program: Reporting costs are borne by regulated entities. At this time, no new or additional monitoring is being recommended in the Peconic CCMP, outside of that required by existing authorities.
New Costs: A mechanism needs to be established by the PEP to assemble and interpret the Federal Toxics Release Inventory data for the Peconic Estuary.

Pesticide Use Monitoring

Note: This monitoring program element does not focus on direct environmental measurements.

Program Objective

Measure types and quantities of pesticides used, and unneeded and unwanted pesticides that are collected for proper disposal. Information should also be used to identify priority areas for monitoring based on pesticide usage data.

Monitoring Hypothesis

Pesticide use and proper disposal, including trends in types and quantities, can be measured by various means.

CCMP Measurable Goals

Eliminate to the maximum extent practicable, pesticide applications on turf grass on all publicly held land by 2003; Eliminate holdings of banned, unneeded and unwanted pesticides (and other hazardous substances) by 2005; Decrease overall agricultural/residential/institutional pesticide applications in the five East End towns.

Lead Entity

(proposed) New York State Department of Environmental Conservation and the U.S. Environmental Protection Agency.

Program Status

Reporting is required as a part of an existing program. Compiling, evaluating and interpreting data for the Peconic Estuary Study Area represents a new program activity.

Monitoring Extent and Frequency

Information is available annually for the Peconic Estuary Program Study Area.

Program Description

The existing New York State Pesticide Reporting Law allows information about the amounts and types of pesticides being applied in the State to be obtained by health researchers. Under the Law, certified pesticide applicators are required to report for each pesticide application the name of the product applied, the product's U.S. Environmental Protection Agency (EPA) Federal registration number, the quantity applied, the product's unit of measure, the date of application, the county, street address, municipality and zip code of the application. Commercial permittees who sell pesticides to private applicators at wholesale and retail, must report for each sale the name of the product purchased, its EPA Federal registration number, the quantity sold, the product's unit of measure, the date sold, as well as the county, street address, municipality and zip code of the intended application.

There may be other useful mechanisms for monitoring pesticide use and the safe disposal of unneeded or unwanted pesticides, including surveys of farmers/commercial landscapers/homeowners, point-of-sale surveys, residential use surveys, commercial applicator tallies, collections during "Clean Sweep" programs, or household hazardous waste collection programs and events, or resolutions passed (or equivalent) by state or local government to eliminate or reduce pesticide usage. These other mechanisms must be more fully developed by the Peconic Estuary Program.

Costs

Base Program: Reporting costs under the State Pesticide Reporting Law are borne by regulated entities.
New Costs: The cost and details of the other potential monitoring mechanisms has not been fully developed at this point by the Peconic Estuary Program. A preliminary estimate for compiling, evaluating and interpreting data is

$25,000 annually.

Two Stroke Marine Engine Inventory

Note: This monitoring program element does not focus on direct environmental measurements.

Program Objective

To monitor the progress of conversion/replacement from 2 stroke to 4 stroke marine engines in the estuary.

Monitoring Hypothesis

Hydrocarbon loadings to the estuary will be reduced as the number of 2 stroke marine engines used in the estuary is reduced.

CCMP Measurable Goal

Reduce the number of 2 stroke marine engines in use in the estuary.

Lead Entity

(proposed) Peconic Estuary Program Office

Program Status

New proposed program

Monitoring Extent and Frequency

Monitoring will be collected annually for the Peconic Estuary Program Study Area

Program Description

Federal requirements require the manufacturers of marine engines to phase in cleaner burning 4 stroke engines. The progress of the conversion from 2 stroke to 4 stroke marine engines takes place in the estuary can be monitored. If the pace of conversion/replacement appears slow, the PEP may establish or recommend incentives to speed the conversion. A potential monitoring mechanism is harbormaster-conducted surveys. The costs or details of the potential monitoring mechanism have not been fully developed at this point by the Peconic Estuary Program.

Costs

New Costs: The costs or details of this potential monitoring mechanism have not been fully developed at this point by the Peconic Estuary Program. A preliminary estimate is $10,000 annually.

Underground Storage Tank Inventory

Note: This monitoring program element does not focus on direct environmental measurements.

Program Objective

To monitor the progress of underground storage tank removal, retirement and replacement.

Monitoring Hypotheses

The threats and occurrences of leaking underground storage tanks are being reduced as the number of tanks exempt from current removal/replacement retirement requirements in use in the estuary's watershed is reduced.

CCMP Measurable Goal

Eliminate underground storage tanks exempt from current replacement requirements.

Lead Entity
(proposed) Peconic Estuary Program Office

Program Status
New proposed program

Monitoring Extent and Frequency
Monitoring will be collected annually for the Peconic Estuary Program watershed.

Program Description
No program is currently in place to establish a baseline on the number of tanks currently in use that are exempt from current removal/replacement/retirement requirements or to track the number of tanks that are removed, retired and replaced. A potential monitoring mechanism is to establish a baseline and then track the number of underground storage tanks that are removed, retired and replaced.

Costs
New Costs: The costs or details of these potential monitoring mechanisms have not been fully developed at this point by the Peconic Estuary Program. Estimate for establishing baseline: $50,000; estimate for updating inventory: $10,000 per year.

Treated Lumber in the Marine Environment Inventory
Note: This monitoring program element does not focus on direct environmental measurements.

Program Objective
To monitor the extent of treated lumber installed in the marine environment.

Monitoring Hypotheses
Reducing the amount of treated lumber installed in the marine environment is reducing the toxic impacts in the estuary.

CCMP Measurable Goal
Decrease the cumulative amount of treated lumber installed in the marine/estuarine environment.

Lead Entity
(proposed) Peconic Estuary Program Office

Program Status
New proposed program (in conjunction with shoreline hardening monitoring also described in this Plan)

Monitoring Extent and Frequency
Monitoring will be collected annually for the Peconic Estuary Program Study Area

Program Description

A potential monitoring mechanism would need to include both establishing a baseline on the amount of treated lumber presently installed in the marine environment and updating this baseline to reflect changes due to new installations, replacements, and removals. A portion of this potential mechanism is included in the section of this Plan addressing monitoring for Habitat and Living Resource concerns (under the heading "Shoreline Hardening"). This proposed monitoring mechanism will need to be expanded to further include information on whether the existing shoreline hardening material is treated lumber.

Costs

New Costs: Costs of these potential monitoring mechanisms are included in the Shoreline Hardening discussion of this Environmental Monitoring Plan.

Monitoring Program Summary

Monitoring Program	Base Programs		New Costs	
	One-Time	Annual	One-Time	Annual
Aquaculture and Transplanting Activities		X	$710,000	$5,000
Bay Scallops (recruitment success and survival dynamics)			$200,000 (over three years)	
Benthic Macroinvertebrate Surveys		X	TBD	TBD
Biota (Fish, Shellfish, Crustacean) Monitoring for Toxics	X			
Brown Tide Research Initiative		X		
Brown Tide Steering Committee		X		
Coastal 2000		X		
Dredging			$37,500	$7,500
Endangered Species Program		X		
Federal Toxics Release Inventory		X		
Hazardous Waste Site Monitoring		X		
National Pollutant Discharge Elimination System (NPDES) Program		X		
NMFS Commercial Landings Program		X		
Vessel Waste No Discharge Areas				$5,000
NOAA Mussel Watch Program		X		
NYS Pesticide Reporting Law		X		
NYS Pollutant Discharge Elimination System (SPDES) Program		X		
NYS Shellfish Land Certification Program		X		
NYSDEC Juvenile Finfish Survey		X		$645,000*
NYSDEC Wetlands Inventory	X		$500,000	$50,000*
Osprey, Terns and Waterfowl				TBD
Pesticide Use Monitoring		X		$25,000
Restoration Monitoring			$35,000	$15,000
SCDHS Alexandrium Monitoring	X			$35,000
SCDHS Bathing Beaches and Swimming Pools Program		X		
SCDHS Groundwater Monitoring (for nitrogen and pesticides)		X		
SCDHS North Creeks Study		X		
SCDHS Pfiesteria Monitoring	X			$25,000
SCDHS Routine Point Source Monitoring		X		
SCDHS Surface Water Quality Monitoring		X		
SCPD Land Use Monitoring		X		
Sediment Monitoring				25,000
Shoreline Hardening Monitoring	X			35,000
Submerged Aquatic Vegetation Long Term Monitoring	X			$30,000
Suffolk County Groundwater Model	X			
Surface Water Monitoring for Toxics	X			
Two Stroke Marine Engine Inventory				$10,000
Underground Storage Tank Inventory			$50,000	$10,000
USFWS National Wetlands Inventory	X			
Total			**$1,332,500**	**$922,500**

* Additional costs for other elements to be determined.

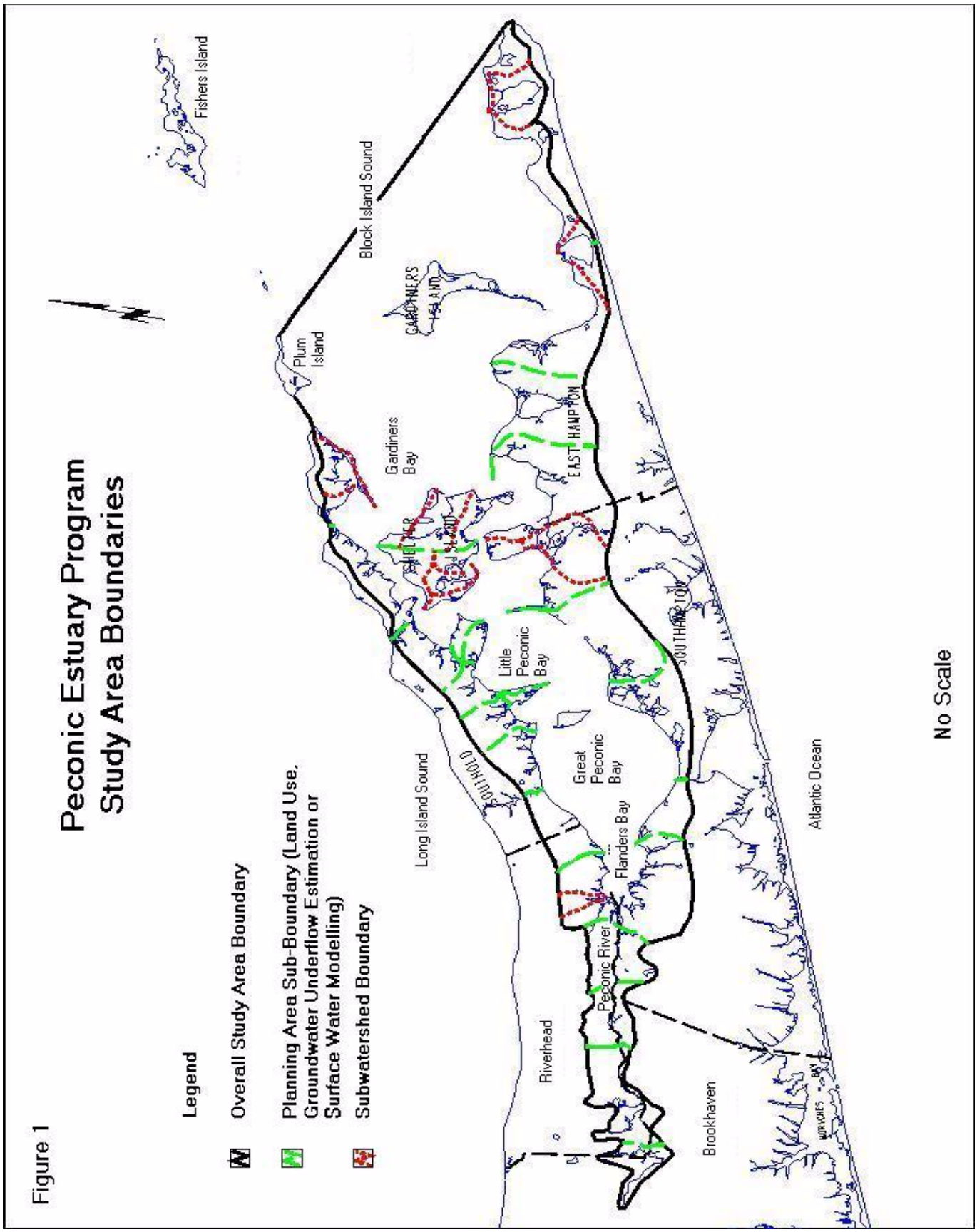
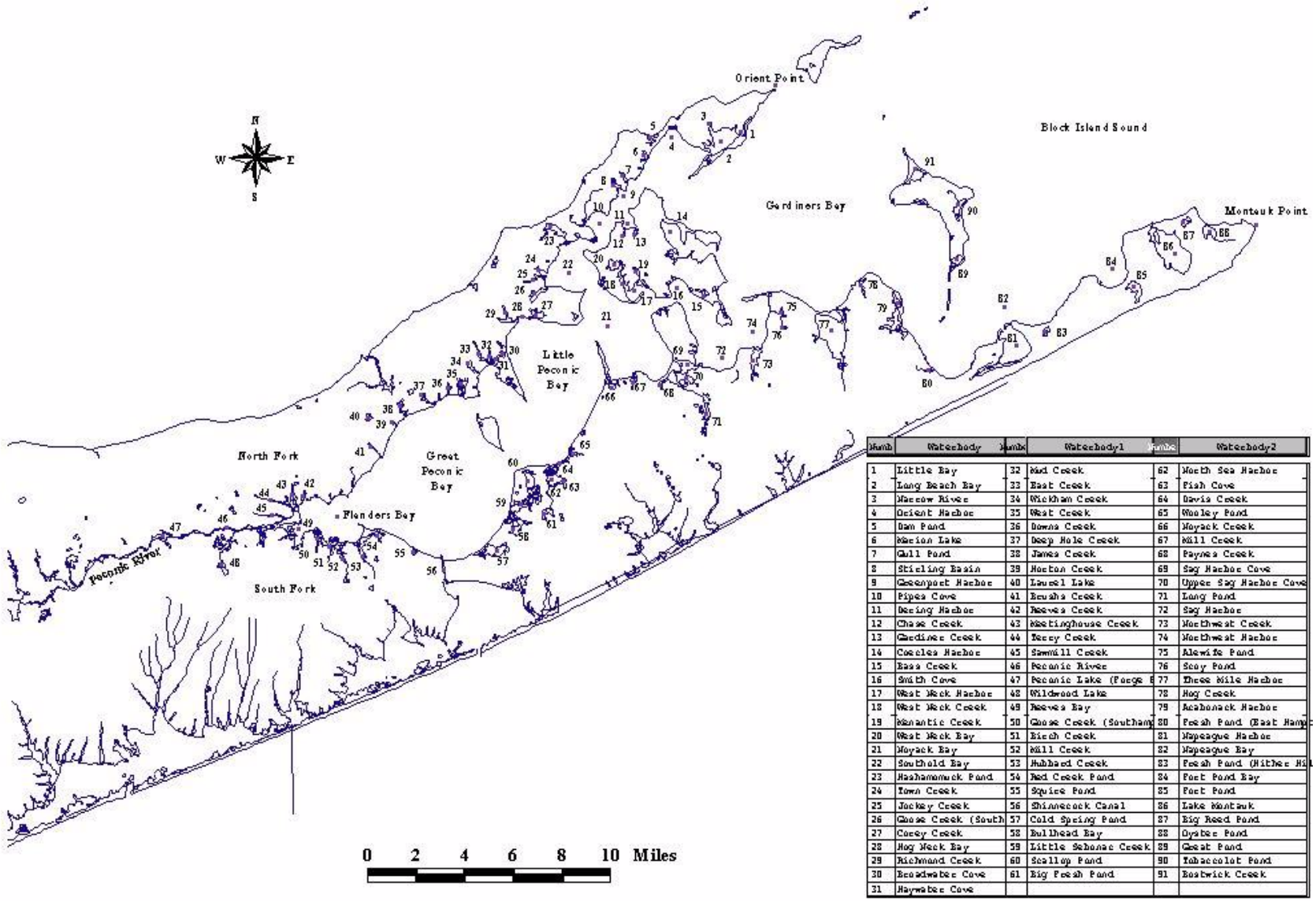


Figure 1
Peconic Estuary Program
Study Area Boundaries
Legend
Overall Study Area Boundary
Planning Area Sub-Boundary (Land Use, Groundwater Underflow Estimation or Surface Water Modelling)
Subwatershed Boundary
Fishers Island
Block Island Sound
Plum Island
Gardiners Bay
Long Island Sound
Little Peconic Bay
Great Peconic Bay
Flanders Bay
Peconic River
Riverhead
Brookhaven
Atlantic Ocean
No Scale

Figure 2

Peconic Estuary Program Study Area
Harbors, Embayments, Tidal Creeks, Ponds and Lakes



Numb	Waterbody	Numb	Waterbody1	Numbe	Waterbody2
1	Little Bay	32	Mud Creek	62	North Sea Harbor
2	Long Beach Bay	33	East Creek	63	Fish Cove
3	Marcow River	34	Wickham Creek	64	Davis Creek
4	Orient Harbor	35	West Creek	65	Wooley Pond
5	Dam Pond	36	Downs Creek	66	Moyack Creek
6	Marion Lake	37	Deep Hole Creek	67	Mill Creek
7	Gull Pond	38	James Creek	68	Paynes Creek
8	Stirling Basin	39	Horton Creek	69	Sag Harbor Cove
9	Greenport Harbor	40	Laurel Lake	70	Upper Sag Harbor Cove
10	Pipes Cove	41	Reusha Creek	71	Long Pond
11	Dering Harbor	42	Reeves Creek	72	Sag Harbor
12	Chase Creek	43	Meetinghouse Creek	73	Northwest Creek
13	Cheditmo Creek	44	Terry Creek	74	Northwest Harbor
14	Coecles Harbor	45	Sawmill Creek	75	Alewife Pond
15	Bass Creek	46	Peconic River	76	Scoy Pond
16	Smith Cove	47	Peconic Lake (Forge R	77	Three Mile Harbor
17	West Neck Harbor	48	Wildwood Lake	78	Hog Creek
18	West Neck Creek	49	Reeves Bay	79	Acabonack Harbor
19	Menantic Creek	50	Goose Creek (Southam	80	Fresh Pond (East Hamp
20	West Neck Bay	51	Birch Creek	81	Napeague Harbor
21	Moyack Bay	52	Mill Creek	82	Napeague Bay
22	Southold Bay	53	Hubbard Creek	83	Fresh Pond (Hither Hi
23	Hashamomuck Pond	54	Red Creek Pond	84	Fort Pond Bay
24	Town Creek	55	Squire Pond	85	Fort Pond
25	Jockey Creek	56	Shinnecock Canal	86	Lake Montauk
26	Goose Creek (South	57	Cold Spring Pond	87	Big Reed Pond
27	Corey Creek	58	Bullhead Bay	88	Oyster Pond
28	Hog Neck Bay	59	Little Sebonac Creek	89	Great Pond
29	Richmond Creek	60	Scallop Pond	90	Tobaccolot Pond
30	Broadwater Cove	61	Big Fresh Pond	91	Eastwick Creek
31	Haywater Cove				

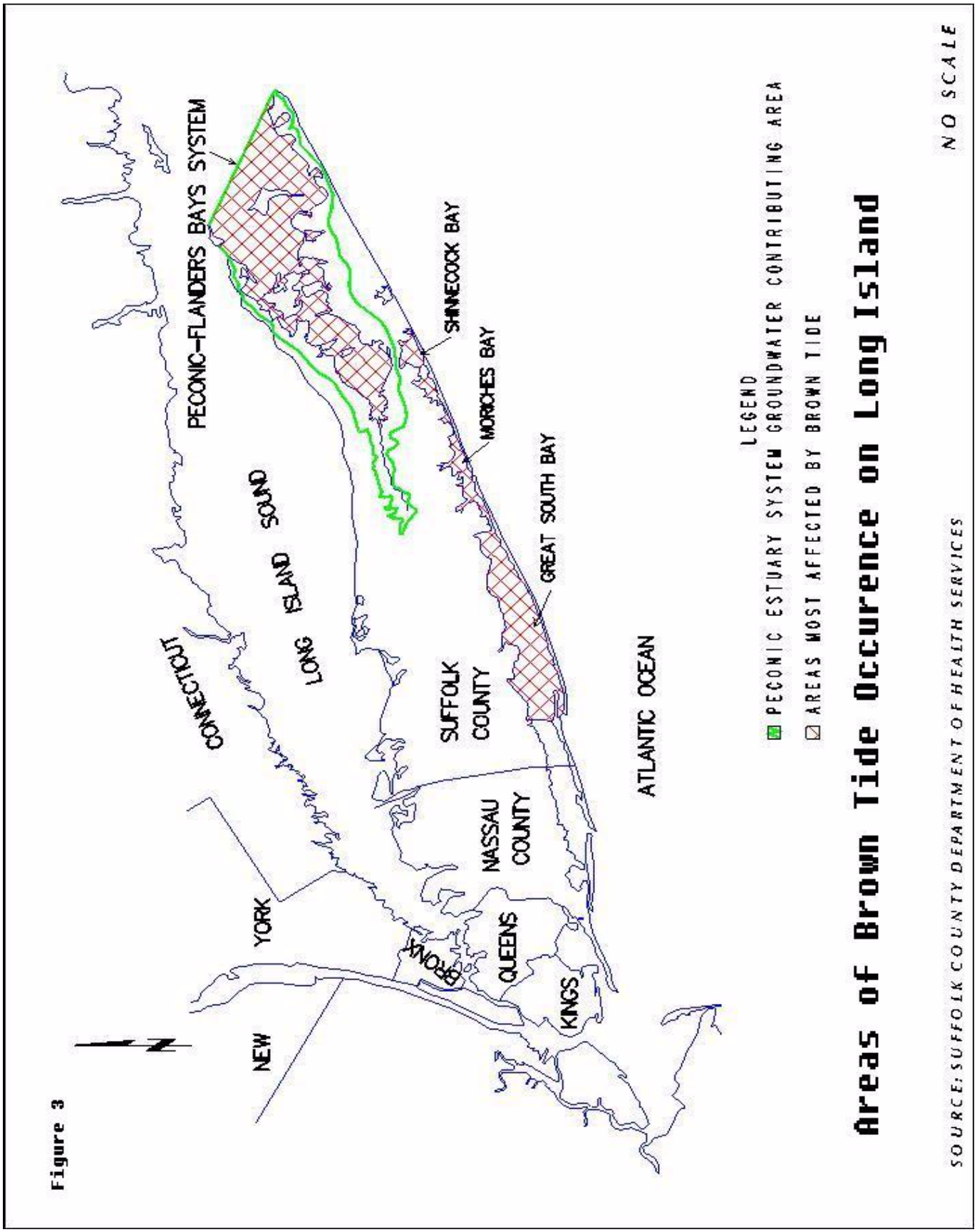

Areas of Brown Tide Occurence on Long Island
NO SCALE
LEGEND
PECONIC ESTUARY SYSTEM GROUNDWATER CONTRIBUTING AREA
AREAS MOST AFFECTED BY BROWN TIDE
SOURCE: SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
PECONIC-FLANDERS BAYS SYSTEM
SHINNECOCK BAY
MORICHES BAY
GREAT SOUTH BAY
LONG ISLAND SOUND
CONNECTICUT
SUFFOLK COUNTY
NASSAU COUNTY
ATLANTIC OCEAN
NEW YORK
BRONX
QUEENS
KINGS

Figure 3

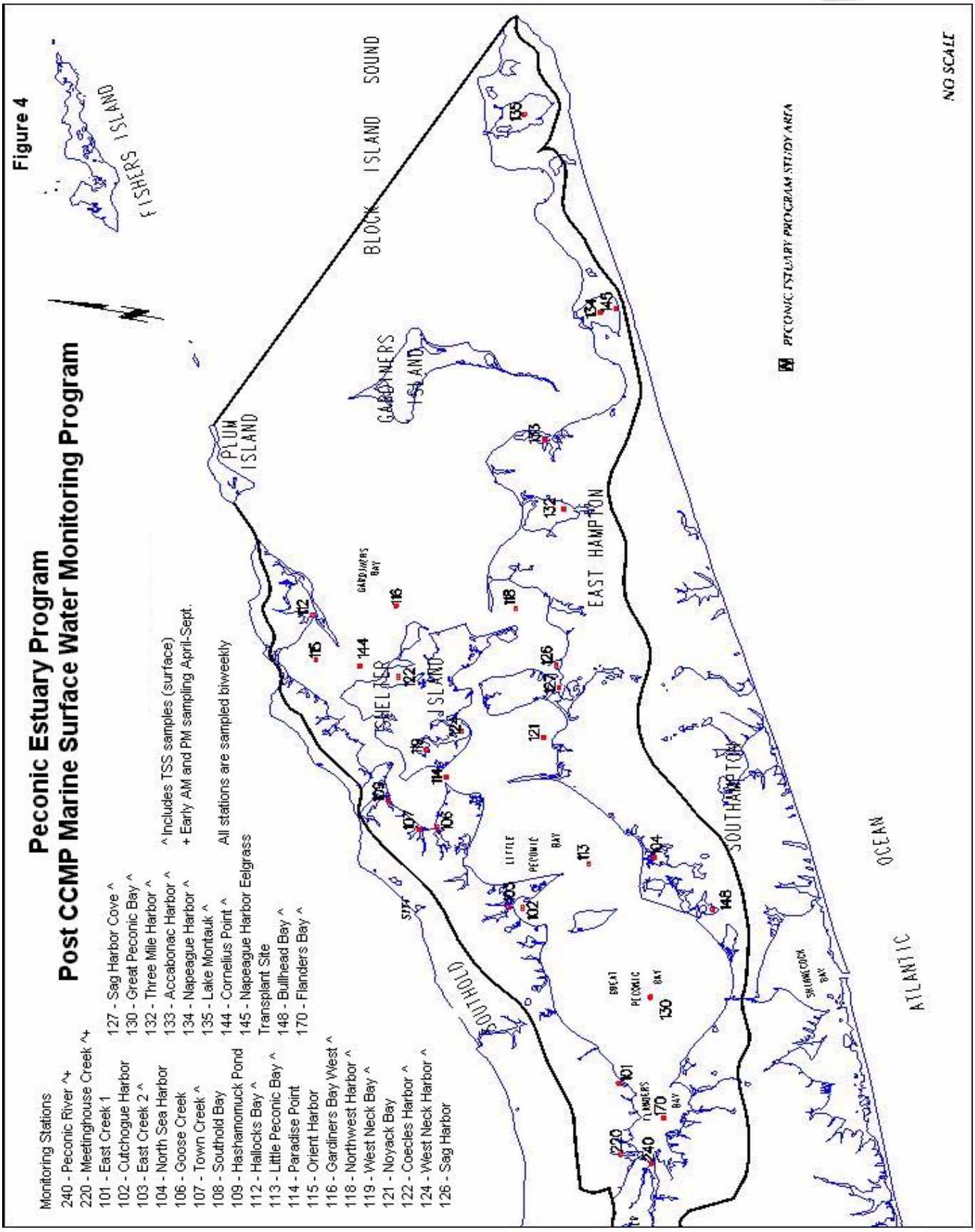


Figure 4
Peconic Estuary Program
Post CCMP Marine Surface Water Monitoring Program
Monitoring Stations
240 - Peconic River ^+
220 - Meetinghouse Creek ^+
101 - East Creek 1
102 - Cutchogue Harbor
103 - East Creek 2 ^
104 - North Sea Harbor
106 - Goose Creek
107 - Town Creek ^
108 - Southold Bay
109 - Hashamomuck Pond
112 - Hallocks Bay ^
113 - Little Peconic Bay ^
114 - Paradise Point
115 - Orient Harbor
116 - Gardiners Bay West ^
118 - Northwest Harbor ^
119 - West Neck Bay ^
121 - Noyack Bay
122 - Coecles Harbor ^
124 - West Neck Harbor ^
126 - Sag Harbor
127 - Sag Harbor Cove ^
130 - Great Peconic Bay ^
132 - Three Mile Harbor ^
133 - Accabonac Harbor ^
134 - Napeague Harbor ^
135 - Lake Montauk ^
144 - Cornelius Point ^
145 - Napeague Harbor Eelgrass Transplant Site
148 - Bullhead Bay ^
170 - Flanders Bay ^
^ Includes TSS samples (surface)
+ Early AM and PM sampling April-Sept.
All stations are sampled biweekly
PECONIC ESTUARY PROGRAM STUDY AREA
NO SCALE
FISHERS ISLAND
BLOCK ISLAND SOUND
PLUM ISLAND
GARDINERS ISLAND
EAST HAMPTON
SOUTHAMPTON
SOUTHOLD
ISLAND
GARDINERS BAY
LITTLE PECONIC BAY
GREAT PECONIC BAY
SHINNECOCK BAY
FLANDERS BAY
OCEAN
ATLANTIC

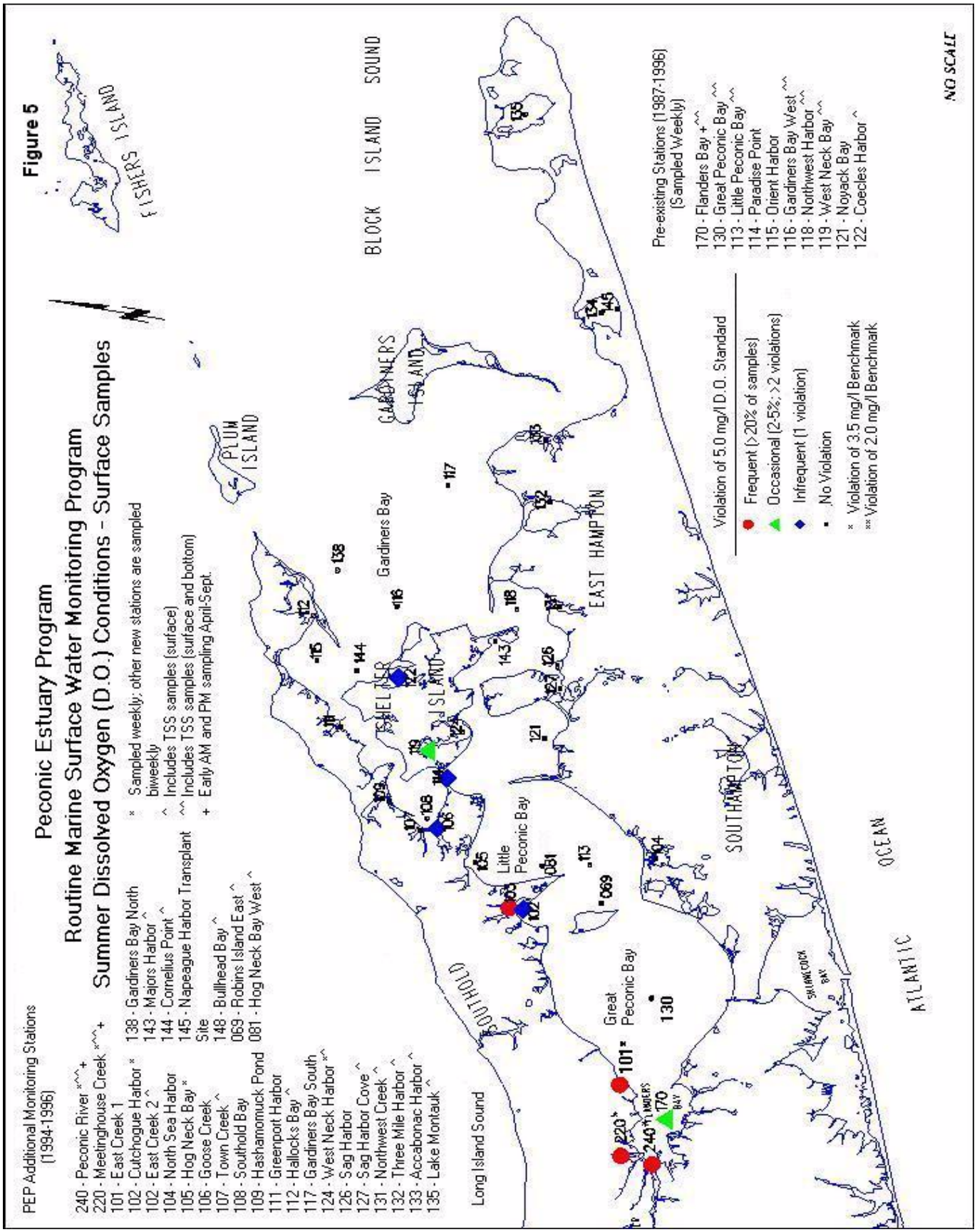


Figure 5
Peconic Estuary Program
Routine Marine Surface Water Monitoring Program
Summer Dissolved Oxygen (D.O.) Conditions - Surface Samples
PEP Additional Monitoring Stations (1994-1996)
240 - Peconic River *^^+
220 - Meetinghouse Creek *^^+
101 - East Creek 1
102 - Cutchogue Harbor *
102 - East Creek 2 ^
104 - North Sea Harbor
105 - Hog Neck Bay *
106 - Goose Creek ^
107 - Town Creek ^
108 - Southold Bay
109 - Hashamomuck Pond
111 - Greenport Harbor
112 - Hallocks Bay ^
117 - Gardiners Bay South
124 - West Neck Harbor *^
126 - Sag Harbor
127 - Sag Harbor Cove ^
131 - Northwest Creek ^
132 - Three Mile Harbor ^
133 - Accabonac Harbor ^
135 - Lake Montauk ^
138 - Gardiners Bay North
143 - Majors Harbor ^
144 - Cornelius Point ^
145 - Napeague Harbor Transplant Site
148 - Bullhead Bay ^
069 - Robins Island East ^
081 - Hog Neck Bay West ^
* Sampled weekly; other new stations are sampled biweekly
^ Includes TSS samples (surface)
^^ Includes TSS samples (surface and bottom)
+ Early AM and PM sampling April-Sept.
Violation of 5.0 mg/l D.O. Standard
Frequent (> 20% of samples)
Occasional (2-5%; >2 violations)
Infrequent (1 violation)
No Violation
* Violation of 3.5 mg/l Benchmark
** Violation of 2.0 mg/l Benchmark
Pre-existing Stations (1987-1996) (Sampled Weekly)
170 - Flanders Bay + ^^
130 - Great Peconic Bay ^^
113 - Little Peconic Bay ^^
114 - Paradise Point
115 - Orient Harbor
116 - Gardiners Bay West ^^
118 - Northwest Harbor ^^
119 - West Neck Bay ^^
121 - Noyack Bay
122 - Coecles Harbor ^
NO SCALE
Long Island Sound
SOUTHOLD
Great Peconic Bay
Little Peconic Bay
Gardiners Bay
PLUM ISLAND
GARDINERS ISLAND
SHELTER ISLAND
SOUTHAMPTON
EAST HAMPTON
BLOCK ISLAND SOUND
FISHERS ISLAND
OCEAN
ATLANTIC

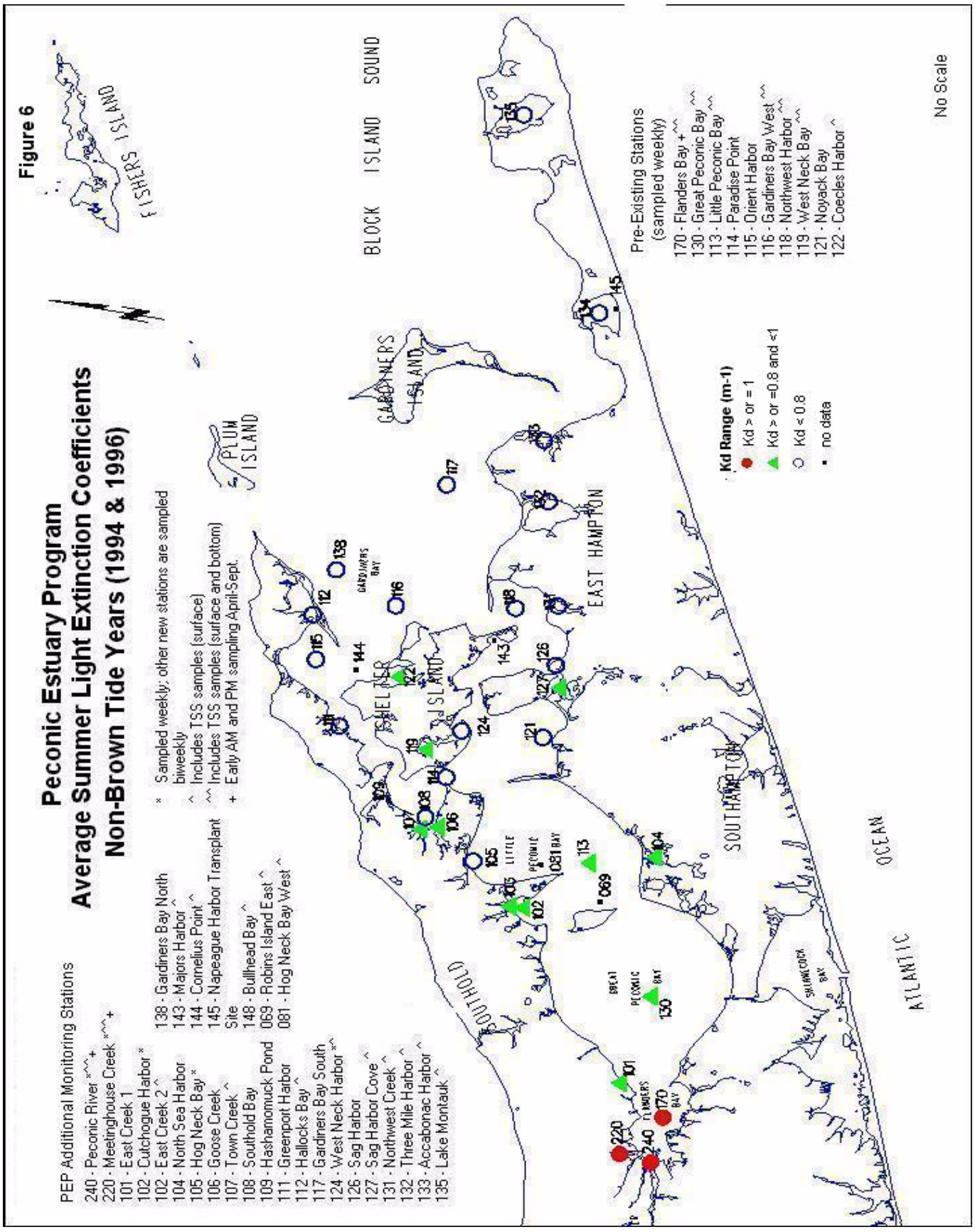
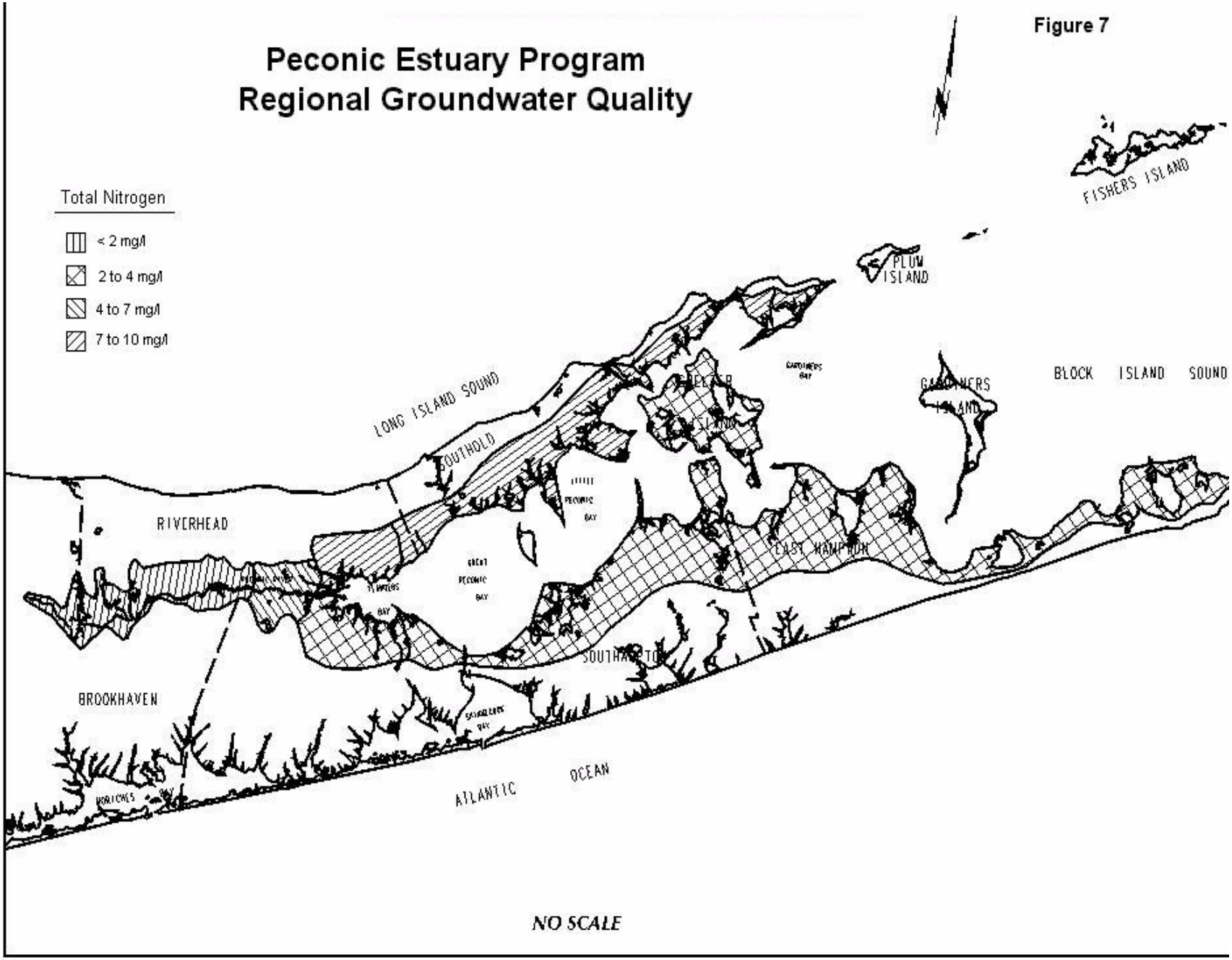


Figure 6
Peconic Estuary Program
Average Summer Light Extinction Coefficients
Non-Brown Tide Years (1994 & 1996)
PEP Additional Monitoring Stations
240 - Peconic River x^^+
220 - Meetinghouse Creek x^^+
101 - East Creek 1
102 - Cutchogue Harbor x
102 - East Creek 2 ^
104 - North Sea Harbor
105 - Hog Neck Bay x
106 - Goose Creek ^
107 - Town Creek ^
108 - Southold Bay
109 - Hashamomuck Pond
111 - Greenport Harbor
112 - Hallocks Bay ^
117 - Gardiners Bay South
124 - West Neck Harbor x^
126 - Sag Harbor
127 - Sag Harbor Cove ^
131 - Northwest Creek ^
132 - Three Mile Harbor ^
133 - Accabonac Harbor ^
135 - Lake Montauk ^
138 - Gardiners Bay North
143 - Majors Harbor ^
144 - Cornelius Point ^
145 - Napeague Harbor Transplant Site
148 - Bullhead Bay ^
069 - Robins Island East ^
081 - Hog Neck Bay West ^
x Sampled weekly; other new stations are sampled biweekly
^ Includes TSS samples (surface)
^^ Includes TSS samples (surface and bottom)
+ Early AM and PM sampling April-Sept.
Pre-Existing Stations
(sampled weekly)
170 - Flanders Bay + ^^
130 - Great Peconic Bay ^^
113 - Little Peconic Bay ^^
114 - Paradise Point
115 - Orient Harbor
116 - Gardiners Bay West ^^
118 - Northwest Harbor ^^
119 - West Neck Bay ^^
121 - Noyack Bay
122 - Coecles Harbor ^
Kd Range (m-1)
Kd > or = 1
Kd > or =0.8 and <1
Kd < 0.8
no data
No Scale
BLOCK ISLAND SOUND
FISHERS ISLAND
PLUM ISLAND
GARDINERS ISLAND
SHELTER ISLAND
EAST HAMPTON
SOUTHAMPTON
SOUTHOLD
ATLANTIC OCEAN

Figure 7

Peconic Estuary Program
Regional Groundwater Quality

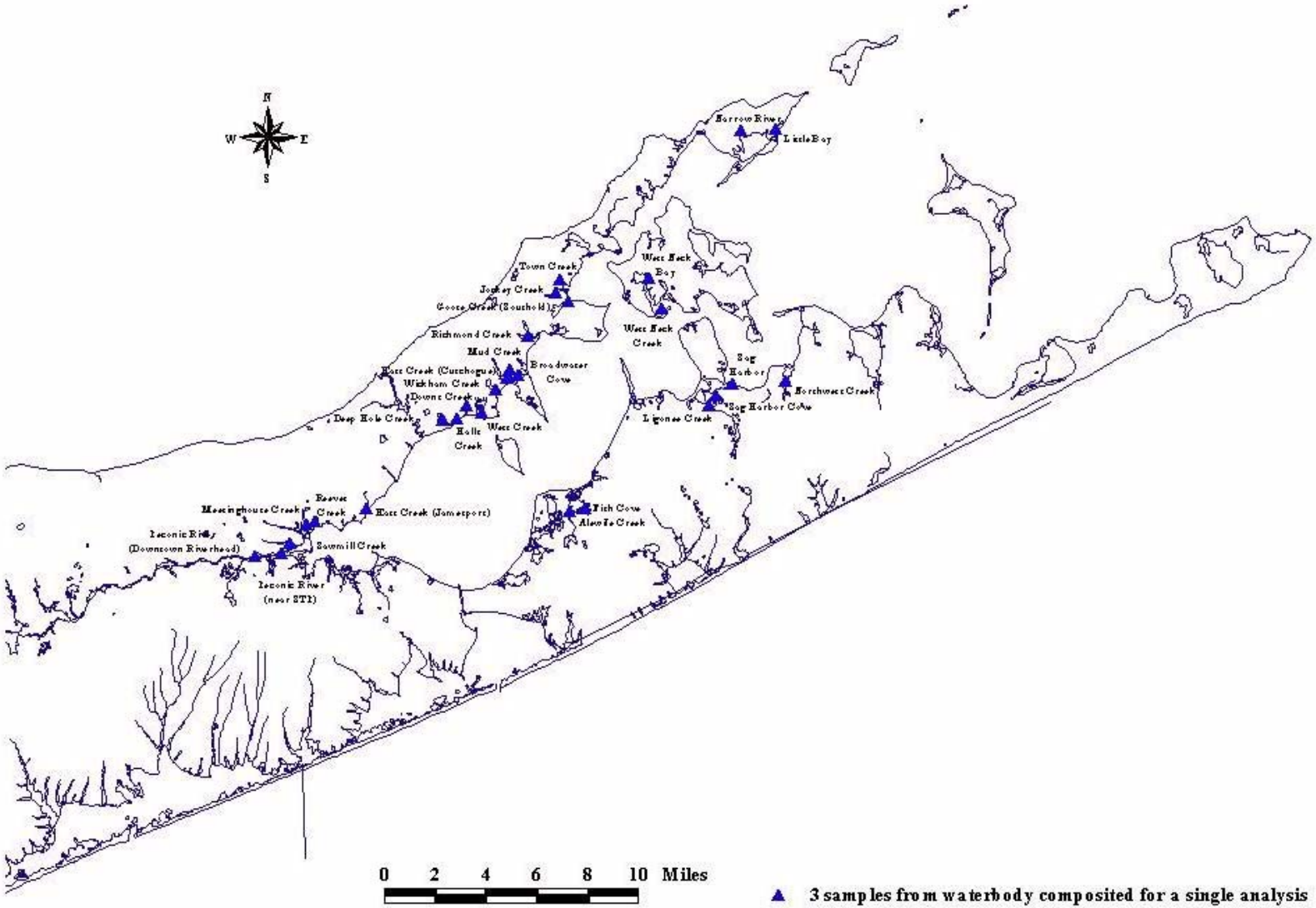


plot file pep-rgqbw1.gra

TJK - 2/99

Figure 8

Peconic Estuary Program Study Area
May 1998 Sediment Monitoring Sites



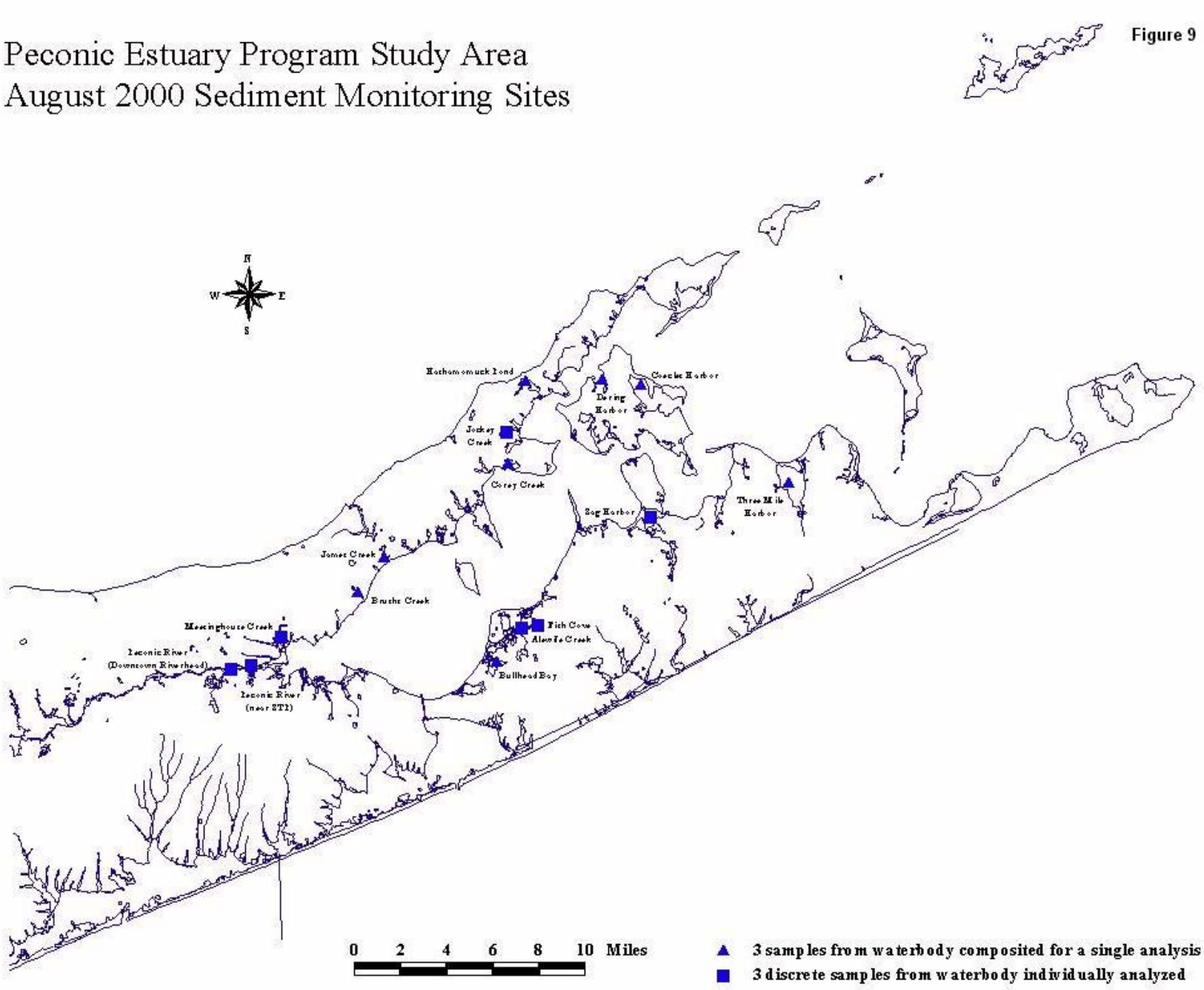
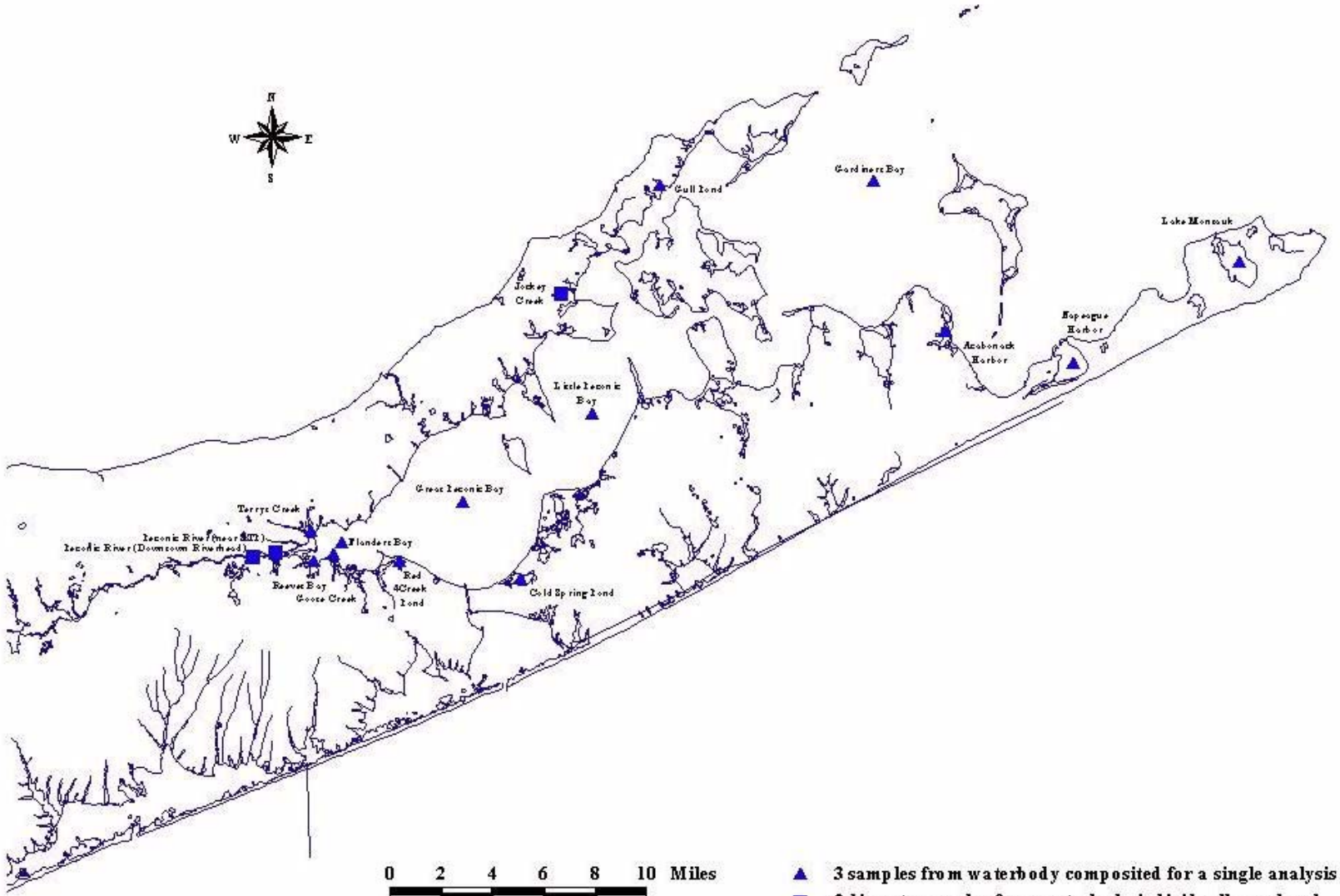

Peconic Estuary Program Study Area
August 2000 Sediment Monitoring Sites
Figure 9
N
W
E
S
Hashamomuck Pond
Cedar Island Harbor
Jockey Creek
Corey Creek
Sag Harbor
Three Mile Harbor
James Creek
Brushe Creek
Mescinghouse Creek
Iseonic River (Downtown Riverhead)
Iseonic River (near ST2)
Fish Cove
Alewife Creek
Bullhead Bay
0 2 4 6 8 10 Miles
3 samples from waterbody composited for a single analysis
3 discrete samples from waterbody individually analyzed

Figure 10

Peconic Estuary Program Study Area
Proposed 2001 Sediment Monitoring Sites



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ATTACHMENT I-1

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Research, Monitoring and Assessment Priorities for Habitats and Living Resources of the Peconic Estuary

Natural Resources Subcommittee
Peconic Estuary Program

October 2000

Marci Bortman, Ph.D.
Marine Conservation Planner
The Nature Conservancy

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Research, Monitoring, and Assessment Priorities for Habitats and Living Resources of the Peconic Estuary

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1. INTRODUCTION

The National Estuary Program was established in 1987. The purpose of the National Estuary Program is to develop and implement comprehensive conservation and management plans (CCMP) for "Estuaries of National Significance." The CCMP is a framework for managing an estuary based on recommendations to reduce ecosystem threats and protect estuarine resources. To date, the National Estuary Program consists of 28 estuaries in various phases of developing and implementing CCMPs.

In 1992, the Peconic Estuary was included in the National Estuary Program and the Peconic Estuary Program (PEP) was created to develop a CCMP for the Peconic bays. PEP participants include federal, state and local government, citizens' groups, academia, environmental groups, and private organizations. A draft CCMP was developed in September 1999. A final CCMP is expected by December 2000.

As part of developing the CCMP, the PEP identified the need to create a living resources research and monitoring program. The PEP recognizes that there continue to be numerous gaps in our information about the ecology of the estuary and the relationship of human impacts to ecosystem health and biodiversity. One of the objectives in the habitat and living resources chapter of the PEP Comprehensive Conservation and Management Plan (CCMP) is to:

> Develop and maintain an estuary-wide research and monitoring program to guide and evaluate management decisions concerning the estuary and to ensure management and policy decisions are based on the best available information.

Two priority actions in the habitat module are to:

> Develop and implement a research plan for the Peconic Estuary and its watershed to investigate natural processes, impairments and links to water quality, maintenance of systems and species and effects of recreation and pollution on biodiversity, among other research needs.
>
> Develop a long term plan for monitoring living resources in the Peconic Estuary that is coordinated with the development of a research plan and ongoing research and monitoring efforts.

Therefore, as a first step, this document provides a framework for integrated, system-wide ecological research, monitoring, and assessment to understand the dynamic, multi-scale ecological patterns and processes that sustain biota and their supporting natural systems in the Peconic Estuary.

An important aspect of this document will be its coordination with ongoing water quality monitoring, juvenile finfish monitoring, and brown tide research. Efforts will be made to link these recommendations for research, monitoring, and assessment with the Suffolk County Department of Health Services (SCDHS) surface water monitoring program, the NYS DEC finfish and macroinvertebrate survey (by small-mesh otter trawl), and the Brown Tide Research Initiative (BTRI) administered by New York State Sea Grant. This Living Resources Research, Monitoring, and Assessment Framework would be the fourth major initiative and would round out efforts in the Peconics to provide a more complete evaluation of the system.

Priorities for research, monitoring, and assessment included in this document are based on information gaps identified in the Characterization Report of the Living Resources of the Peconic Estuary (Bortman and Niedowski 1998), the Habitat Module of the CCMP, PEP Natural Resources Subcommittee meetings, and recommendations made in the Living Resources Research and Monitoring (LRRM) workshop held on June 24, 1998 by the PEP Natural Resources Subcommittee at The Nature Conservancy's Mashomack Preserve on Shelter Island, NY.

2. BACKGROUND

Estuaries are where land and sea meet with both contributing to an ecosystem of specialized plants and animals all interacting within a complex food web. Beaches and dunes, salt marsh, intertidal mud and sand flats, tidal creeks, and eelgrass meadows are only some of the important habitats found in estuaries. These habitats provide food, shelter, spawning and nursery areas to a wide range of animals. People are attracted to estuaries because of their beauty, for their recreational opportunities, and the potential to make a living from the rich resources estuaries provide.

With population increasing in the watershed, the Peconic Estuary is being threatened by over-development and overuse of its resources. To fully realize the impacts of people and their activities on this system, there must be a better understanding of how the Peconic Estuary functions ecologically. This knowledge can only be achieved through comprehensive research, monitoring, and assessment of the entire ecosystem.

Ecological research, monitoring, and assessment are essential components for guiding management decisions. Research is performed to answer particular questions and fill information gaps. Monitoring, which involves the multi-year collection of data, is carried out to evaluate trends in natural variability as well as changes that may occur due to management or other influences. Data from monitoring can act as an "early warning" system about the health of the estuary. Assessment is the characterization of a resource through synthesis of existing data or new surveys to obtain baseline information. In the Peconic Estuary Program (PEP), assessments have often been the first step in obtaining scientific information, which has spurred the development of specific research questions or the identification of monitoring needs.

Research, combined with ongoing monitoring of certain sensitive species and communities as overall indicators of ecosystem health, is essential to better understand the natural dynamics of the Peconic Estuary and to target effective management activities. The information gained from research and monitoring can be used to plan, manage, and improve estuary protection programs at all levels of government and the private sector, assess progress being made and inform the public of status and trends. Therefore, a properly designed research and monitoring program should provide important and useful information to scientists, managers and citizens. In fact, the purpose of developing research monitoring and assessment priorities for habitats and living resources is to better understand the Peconic ecosystem by linking research and monitoring, fostering partnerships among scientists, government agencies, and the public, and ensuring that research and monitoring results are synthesized into useful products.

3. GOAL

The long-term goal of this PEP initiative is to develop a strategy of coordinated research, monitoring, and assessment to fill significant information gaps and assist in the planning, conservation, and management of the Peconic Estuary. A key component of this strategy is to develop an applied, multi-scale, integrated approach to gain a better understanding of the estuary. To achieve this goal, this document sets up guidelines for a detailed Living Resources Research, Monitoring, and Assessment Plan to set priorities, define issues, identify novel research questions, and create a compelling living resources research, monitoring, and assessment program. The short-term goal of this initiative is to provide a stimulus for funding agencies and organizations and researchers.

The objectives of this document are to:

(1) Establish a process to develop and implement a living resources research, monitoring, and assessment program;

(2) Identify priority living resources targets (i.e., particular organisms and habitats) qualified in the CCMP as important either due to their commercial or recreational value or their role in the food web and ecosystem;

(3) Identify threats (i.e., stresses and sources of stress) to the targets so as to improve resource protection through management and conservation;

(4) Develop an initial set of research, monitoring, and assessment priorities to better understand the targets and threats to targets.

4. STRUCTURE OF A RESEARCH, MONITORING, AND ASSESSMENT PROGRAM

It is important that a research, monitoring, and assessment program be well-designed in order to maximize its effectiveness in environmental management. Sound science is the foundation for effective planning, management, and regulation. A well-designed research, monitoring, and assessment program fits needs that are defined *a priori* rather than simply collecting data and determining later how it is to be evaluated. Data are more meaningful when evaluated not only qualitatively but also quantitatively and can withstand statistical rigor. Thus, a program that is well-designed and well-planned has a much higher likelihood of success.

The following bullets outline 10 characteristics of a successful environmental monitoring program adapted from the National Research Council (1990).

- Authority and control of the program should be clearly established and fiscal controls should be compatible with program goals and objectives
- Know clearly how data are to be used -- ensure a link between research and monitoring information and decision making
- Goals should be clearly defined and achievable scientifically, technologically, logistically, and financially
- Before any data are collected, feedback loops should be clearly established between a decision making system and a research and monitoring program
- Communication channels should be interconnected and functional among agencies and other participating groups and individuals
- Regulatory, data and management needs and responsibilities of local, state and federal agencies should be integrated to optimize use of available resources
- Mechanisms should be established to involve the scientific community and the public as program participants early and often
- Mechanisms should be established to ensure that data results are communicated to decision makers and the public in language they can understand and act on
- Mechanisms should be established for periodic review and easy alteration of redirection of efforts when results or new information from other sources justifies a change

- Management action(s) recommended in response to both expected results and unexpected but possible outcomes should be identified in advance

These elements should be incorporated in the development of a Living Resources Research, Monitoring, and Assessment Plan. Figure 1 illustrates the relationship among research, monitoring, and assessment objectives, methods, and evaluation of a research and monitoring program along with management goals and information needs.

A coordinator is needed to implement recommendations made in this document. A coordinator could (1) provide strong leadership, (2) help seek and direct funds from existing grant programs to research and monitoring efforts in the Peconic Estuary, (3) find new funds from public and private groups, and (4) leverage funds wherever possible. A coordinator would focus efforts on applied research and monitoring necessary to effectively implement components of the CCMP. Under the auspices of this framework, a coordinator would focus scientific attention on management concerns of the estuary, lead the periodic update and next phase of research and monitoring priorities, coordinate and target funding, and assure that research and monitoring results are available to agencies, decision makers and the community at large.

In addition to needing a coordinator for this program, a science advisory panel should be developed. This panel should consist of experts both in and outside of the region who can help establish and evaluate research, monitoring, and assessment priorities. Scientists are necessary to review program design and evaluate research and monitoring results. The coordinator would be responsible for organizing the science advisory panel and incorporating their comments in the Living Resources Research, Monitoring, and Assessment Plan.

At present, there is no established fund for this living resources coordination or specific research and monitoring projects. It is expected that there will be multiple sources of funds; but to date, there is no established agency or organization to administer or coordinate grants for research and monitoring. A coordinator is needed. This position, along with a science advisory panel, should be established as part of the implementation phase of the CCMP.

5. LIVING RESOURCE TARGETS

It is an insurmountable effort to study every aspect of the Peconic Estuary ecosystem. Therefore, focusing efforts on living resource targets that are commercially or recreationally significant or are of ecological importance to the Peconic Estuary ecosystem is one of the most feasible methods to understand ecological effects caused by human activities or the likelihood that adverse effects might occur.

The following seven habitat and living resource targets are a good representation of the

Peconic Estuary system. These targets correspond to species or habitats that are of regional importance, highly threatened or have special conservation or management requirements, or represent biodiversity (Bortman and Niedowski 1998). These living resource targets are recognized in the CCMP as important either due to their commercial or recreational value or their role in the food web and ecosystem. The seven living resource targets are:

1. **Beach, Bluff, and Dune Complex** – sandy and cobbly beaches, spits, bluff and dunes

2. **Tidal Wetlands** – vegetated and non-vegetated wetlands

3. **Seagrass** -- eelgrass and widgeon grass

4. **Resident Finfish** -- Those species that spend a large portion of their lifecycle in the estuary (i.e., spawning, nursery). Examples include: weakfish, forage fish, flounder, scup, porgy, tautog, bluefish, alewife, American eel

5. **Beach-Dependent Species** -- Piping plovers, and least, common, and roseate terns and horseshoe crabs

6. **Shellfish** -- bay scallop, hard and soft clams

7. **Diverse Phytoplankton Community** – encompasses full range of diverse phytoplankton populations typically found in temperate estuaries (diatoms and dinoflagellates and smaller pico- and nano-plankton). Phytoplankton in the Peconics have not been well-inventoried. Therefore, composition is unknown. A healthy phytoplankton community is diverse, varying daily, seasonally and annually.

6. THREATS TO LIVING RESOURCE TARGETS

Threats such as localized poor water quality, shoreline stabilization, brown tide and invasive species are only a few of the concerns currently threatening the living resources of the Peconic Estuary. Because many small, persistent disturbances can lead to widespread cumulative damage of natural communities throughout the system, it is important to focus research on measuring cumulative impacts. Understanding the extent of these threats through research and monitoring can guide management actions to lessen, and in some cases, eliminate their impacts. Tables 1, 2, and 3 in the PEP living resources threats analysis (Sclafani and Bortman 1999; in the appendix) show some of the threats identified in the Peconics and their relationship to causes of different stresses. Any research and monitoring efforts related to understanding these threats and lessening or eliminating them is considered to be a high priority. Assessment of management recommendations in the CCMP is also required to determine their effectiveness and evaluate progress of CCMP implementation.

7. INITIAL RESEARCH, MONITORING, AND ASSESSMENT PRIORITIES

Listed below are an initial set of priority research, monitoring, and assessment projects that were developed as a result of the Characterization Report of the Living Resources of the Peconic Estuary (Bortman and Niedowski 1998), the Habitat Module of the CCMP, PEP Natural Resources Subcommittee meetings, and recommendations made in the Living Resources Research and Monitoring (LRRM) workshop. The level of description of these priority projects range from being relatively general in some instances to specific in others.

Priority projects will be refined further as the CCMP is finalized, a conceptual ecological model is completed, and sampling protocols are fully developed to ensure quality assurance and quality control as well as some degree of consistency among projects. As priorities are finalized, project costs will also be estimated to determine the amount of funding needed to perform the work.

This section divides the priorities into three categories: (1) threats, (2) biology and ecology of living resource targets and system-wide studies of the Peconic ecosystem; and (3) restoration. Within each category, priorities are numbered and identified as either research, monitoring, or assessment. The living resource target(s) addressed by each priority is also listed. Other important research, monitoring, and assessment initiatives are provided in bullet form in the appendix. Cost estimates of specific projects are also in the appendix; however, it is important to note that these estimates are very rough and need to be revised as proposals are developed for each project.

7.1. LIVING RESOURCE THREATS-RELATED RESEARCH, MONITORING AND ASSESSMENT PRIORITIES

(1) SHORELINE ENGINEERING & HARDENING

Targets: **Beach, Bluff, and Dune Complex**
Tidal Wetlands
Beach-Dependent Species

Assessment

Purpose: To quantify estuarine-wide shoreline engineering or manipulation from seawalls,

bulkheads, docks and other hard structures, assess impacts on habitat and living resources, and develop "environmentally friendly" systems to assist in implementing a CCMP priority of "no net increase" in shoreline engineering and hardening throughout the estuary.

Brief description: Development in the Peconic Estuary watershed has been occurring at a rapid pace. In many instances, seawalls, bulkheads, docks and other hard structures are being erected following the construction of homes and other structures along the Peconic Estuary shore. The cumulative impact of these hard structures is of concern. Quantitative mapping is an important first step and will be carried out through aerial photo interpretation by the US Fish and Wildlife Service under contract to the PEP during the year 2000. The Peconic BayKeeper and the NYS DEC PEP Program Coordinator will assist in ground truthing. An assessment of detrimental effects of hardened shoreline and docks on the Estuary is also needed to fully understand impacts on habitat and natural resources. Included in this analysis should be a characterization of all shoreline hardening found in the Peconics and an investigation of "environmentally friendly" systems.

(2) SEA LEVEL RISE

Target: Tidal Wetlands

Assessment

Purpose: To assess the viability of salt marshes in the Peconics by evaluating their response to sea level rise and large-scale storm events.

Brief description: Salt marsh wetlands are critical to the viability of the Peconics and other marine ecosystems because they provide habitats and breeding grounds for a variety of marine organisms and serve as filters to prevent contaminants from entering the system. Yet these wetlands are increasingly stressed by both sea level rise and development pressures. Development can effectively prevent the landward migration of salt marshes as a response to rising sea level (currently about 3 mm per year in the New York area). Thus an important step in characterizing the health of salt marshes in the Peconics is to determine their response to sea level change and unusual events such as hurricanes. One method for assessment could include using radionuclides (e.g., Pb-210) to establish the chronology of marsh accretion, determine whether the accretion rate is sufficient to keep pace with sea level rise, and evaluate historical accretion patterns.

(3) *CODIUM FRAGILE*

Targets: Seagrass
Shellfish

Research

Purpose: To understand the influence of the introduced species *Codium fragile* on the ecology of the estuary, particularly its effect on eelgrass (*Zostera marina*) and species dependent on eelgrass.

Brief description: The macroalgae *Codium fragile* was introduced to the Peconics in the 1950s. Since that time, the species has become widespread throughout the entire estuary and is the dominant macroalgal species. Its impact on eelgrass abundance and distribution is unclear. There are also questions related to its effects on survival and growth of some benthic (e.g., bay scallop larval settlement/recruitment habitat) and pelagic species. Given the vast extent of *Codium fragile*'s occurrence in the estuary, and the PEP interest in eelgrass preservation and restoration, it is critical to begin answering these questions now to better understand the influence of this macroalgae on the ecology of the estuary. This research would be integrated into the SAV priority research described later in this document.

(4) *PHRAGMITES AUSTRALIS*

Target: Tidal Wetlands

Research

Purpose: To understand: (1) the causes of *Phragmites* expansion; (2) ecological effects on communities, species, and food webs; (3) its adequacy in stormwater control; and (4) whether there are differences in genotype.

Brief description: The common reed, *Phragmites australis*, is an invasive herbaceous grass. The plant can reach up to approximately 7 m (20 ft) tall. Associated with disturbed areas, *Phragmites* can spread rapidly, far beyond its original bounds. *Phragmites* tends to form dense, monotypic stands after invasion of an area resulting in a reduction in species diversity and availability of critical nesting habitat for certain species. However, some researchers have found that *Phragmites* may provide habitat of comparable value as *Spartina* spp. for fiddler crabs, grass shrimp, and larval mummichogs (J. Weis, personal communication, 1998). An investigation of its ecological effects, effectiveness of current control efforts, and possible biological controls should also be incorporated into studies.

(5) TOXIC CONTAMINANTS

Targets: **Seagrass**
Resident Finfish
Shellfish

Research

Purpose: To understand the impacts of lethal, sublethal, and synergistic effects of toxic contaminants on (1) eelgrass and (2) sensitive stages of species in the estuary such as larval and juvenile finfish and shellfish. This priority should be broken down into multiple research projects that further specify research on impacts of particular toxic contaminants on eelgrass, finfish, and shellfish.

Brief description: Toxic contaminants from pesticides, herbicides, road runoff, sewage, boats, and other sources may be impacting Peconic estuarine organisms impairing growth, reproduction, spawning, recruitment, settlement, or other sensitive stages in their lifecycle. Lytle and Lytle (1998) found a correlation in the use of the pesticide, atrazine, and growth inhibition of the estuarine marsh plant *Juncus roemerianus*. Other studies focusing on phytoplankton and SAV macrophytes found declines with increased use of atrazine. Atrazine is one of the pesticides used by farmers in Suffolk County. Recent pesticide use data from the NYS DEC indicates that Suffolk County has the greatest pesticide usage in the entire state of New York.

Eelgrass in the Peconics has been in decline at least since 1985 when brown tide first occurred. Pesticides may be playing a role in the overall decrease of eelgrass throughout the estuary, particularly in areas west of Shelter Island. Toxic contaminants may also be having effects on organisms that use the estuary during critical life stages such as when they are larvae or juveniles or during periods of reproduction, recruitment, and settlement. There is a paucity of data on this type of information in the Peconics and it is therefore in need of further study.

7.2 RESEARCH, MONITORING, AND ASSESSMENT FROM SYSTEMS TO SPECIES

Natural systems are vastly complex assemblages of species with elaborate internal and external biotic and abiotic processes and interactions that help maintain the entire system (Noss *et al*. 1997). System-wide research and monitoring of biotic and abiotic processes are essential for understanding ecosystem productivity, land-bay-ocean linkages, benthic-pelagic coupling, biological links to water quality and other interconnections that drive habitat functions and biodiversity. More specific research, monitoring, and assessment of living resource targets is also needed to further understand their role in the larger Peconic Estuary system.

(1) CONCEPTUAL ECOLOGICAL MODEL

Targets: **Beach, Bluff, and Dune Complex**
Tidal Wetlands
Seagrass
Resident Finfish
Beach-Dependent Species
Shellfish
Diverse Phytoplankton Community

Assessment

Purpose: To describe relationships among biotic, abiotic, and anthropogenic components of the Peconic Estuary system and highlight information gaps in order to help prioritize research and monitoring needs.

Brief description: A conceptual ecological model is needed to establish a baseline from which we can identify the importance of various estuarine species, energy flows and key linkages among human perturbations, physical processes, habitats, and biological elements of the system in need of management. One recommended approach is to follow Odum (1971), which is a systems-based method that describes the flow of energy among external forces and inputs, producers, consumers, storages, and interaction among these components. Because of its potential to help focus research and monitoring efforts, the development of a conceptual ecological model is one of the highest priorities.

A conceptual ecological model is needed as part of this Living Resources Research and Monitoring framework. A conceptual ecological model is a presentation of ecosystem components and linkages among components in a schematic format (Montagna *et al*. 1996). The model would link the categories of research and monitoring in this framework by describing major components of the Peconic ecosystem and the interrelationship among them. A model would highlight known information – our understanding of the biotic and abiotic factors affecting the estuary and their linkages, and what is not known about the system – the gaps that exist in our understanding that may limit effectiveness in developing strategies and managing the Peconic Estuary. Therefore, the development of a conceptual ecological model is an important organizing principle to help direct research and monitoring priorities.

(2) ROLE OF WETLANDS

Target: Tidal Wetlands

Research

Purpose: To understand the role of wetlands in the Peconics as habitat, sites of nutrient flux, and shoreline stabilization.

Brief description: Along the Peconic Estuary coast, salt marsh wetlands are found around small embayments especially in areas where tidal creeks enter the estuary. It is one of the most productive habitats in terms of biomass while also playing a critical role in the detrital food web. Wetlands are also sensitive hydrologic indicators of water quality parameters such as turbidity, pH, nutrient, and presence of various pollutants. According to Tiner *et al*. (2000 [draft]), approximately 2,271 ha (5,679 ac) of the Peconic estuary consists of wetland (salt marshes and intertidal flats) habitat. To improve our understanding of this critical habitat, it is important to obtain information on its habitat importance to commercial, recreational, and rare species as well as its role in nutrient cycling, and shoreline stabilization.

(3) WETLANDS MONITORING

Target: Tidal Wetlands

Monitoring

Purpose: To monitor the abundance, distribution, diversity and quality of fresh and saltwater wetlands in the Peconic Estuary.

Brief description: In 1997, the U. S. Fish and Wildlife Service surveyed wetlands in the Peconic Estuary watershed as part of the National Wetlands Inventory. The data was GIS mapped and useful for tracking wetland trends over time. The NYS DEC has also performed GIS mapping of saltwater wetlands in the Peconic Estuary East of Shelter Island only (includes spatial distribution, acreage, and marsh types). The NYS DEC performs such GIS mapping through a combination of aerial photo surveys and ground truthing. This effort should be extended to complete the survey west of Shelter Island and routinely track the trends of wetland coverage approximately every 5 years. This is particularly important in light of the increasing rate of developmental pressure and sea-level rise.

(4) SUBMERGED AQUATIC VEGETATION ECOLOGY

Target: Seagrass

Research

Purpose: To assess community importance of different SAV to understand their role in primary production, habitat value, nutrient cycling, and sediment stabilization.

Brief description: Eelgrass once flourished throughout the Peconic Estuary. Largely as a result of wasting disease in the 1930s and more recently brown tide in the 1980s and 1990s, eelgrass is now found only along the eastern end of the estuary (with exception of Bullhead Bay, Southampton). Since the introduction of *Codium fragile* in the 1950s, this invasive macroalgae is now found widely throughout the estuary near eelgrass beds and in areas where there used to be eelgrass. Eelgrass in the Peconic Estuary may also be effected by other SAV species (epiphytic or non-epiphytic algal species). Given the changes in SAV abundance and distribution, it is important to assess community importance of SAV and rank each in terms of their community importance individually and as a whole to focus efforts on: (1) arresting current declines in SAV habitat value and function; (2) managing in favor of natural species; and (3) restoring historic species and distributions. Assessments of historic locations should follow rigorous, scientific methods such as sediment core analyses (e.g., pollen counts).

(5) EELGRASS

Target: Seagrass

Monitoring

Purpose: To adequately monitor aerial extent of eelgrass to assess trends.

Brief description: Adequate mapping and monitoring of SAV to track trends in areal extent and quality of eelgrass is a priority. In 1997, Cornell Cooperative Extension began monitoring SAV at three sites (see section 5.1.4.). This was expanded to a total of six sites in 1999. Aerial photo analysis is being undertaken in 2000-2001. In the LRRM workshop, annual aerial photo interpretation and ground truth information using transect surveys at 10-12 sites (for eelgrass) and up to a total of 20 sites for all SAV was recommended. All SAV should be surveyed every couple of years to assess the spatial and temporal variability of (1) depth of edges; (2) incidence of disease; (3) elemental tissue composition (of nitrogen); (4) general anatomical measures; (5) crown density; (6) light attenuation; and, (7) overall abundance.

(6) FORAGE FISH

Target: Resident Finfish

Research

Purpose: To determine (1) forage fish temporal and spatial distribution and abundance in the nearshore habitats included in the shallow water zone (≤ 3 m) of the Peconic Estuary, and (2) to evaluate the effects of land use patterns, water dependent activities, and urbanization on these habitats.

Brief description: The Peconic Estuary provides particularly valuable habitat for commercially and recreationally important finfish because of the availability of prey such as forage fish (e.g., larval and juvenile finfish, adult mummichog, sand lance, silversides, bay anchovy, herring spp.). However little is known about their distribution and abundance in the estuary, particularly at inshore areas such as the small embayments and tidal creeks of the system. An investigation of forage fish and invertebrates would provide an understanding of their importance and aid in development of management strategies to identify and address the impacts of land use and other activities in areas adjacent to these habitats.

Work should initially begin on a subset of the tidal creeks described and studied in past surveys (i.e., the PEP tidal creek survey), selected as representative of tidal creeks that were rated overall as "highly impacted systems" or "low impacted systems." Diurnal and seasonal use of various creek segments by larval, juvenile, and adult forage fish species should be investigated. Sampling will need to occur at least biweekly, at sampling locations progressing from the head to the mouth of the creek and out into surrounding nearshore areas adjacent to the mouth of the creek. Sampling should take into account tidal stage, and will require the evaluation and use of a variety of sampling gears (e.g., stop nets, seines, plankton nets, beam trawls) to ensure capture and identification of the different life stages of forage species that inhabit these nearshore areas.

The second component of this priority research is to evaluate the possible effects of adjacent land use and degree of urbanization on the use of these creeks by forage fish species. Results of surveys of forage fish abundance and distribution within selected creeks should be compared to individual and overall ratings of water quality, macrobenthic invertebrates, and land use ratings developed in the PEP tidal creek study to identify possible impacts and provide information for developing management strategies to maintain and enhance tidal creek productivity.

(7) FINFISH AND MACROINVERTEBRATES

Target: Resident Finfish

Monitoring

Purpose: To determine the temporal and spatial distribution, abundance, and different life stage habitat requirements of finfish and macroinvertebrate species throughout the Peconic Estuary.

Brief description: Monitoring of targeted finfish and macroinvertebrate species should be performed through: (1) habitat utilization mapping (subtidal habitats including SAV beds), (2) seine surveys, and (3) trawl surveys to develop a species occurrence list throughout their life cycle and identify sensitive recruitment and spawning areas. While there are currently no monitoring efforts in the Peconics for the adult stages of finfish, the NYS DEC runs an annual monitoring survey of juvenile finfish west of Shelter Island since 1987. The NYS DEC should expand their annual monitoring and analysis of juvenile finfish by trawling to the east of Shelter Island. This information is essential to better understand the importance of the Peconics to important finfish, crustacean, and other species. Efforts should focus on resident species such as winter flounder (*Pleuronectes americanus*), tautog (*Tautoga onitis*), as well as transient species such as alewife (*Alosa pseudoharengus*), weakfish (*Cynoscion regalis*), scup (*Stenotomus chrysops*), windowpane flounder (*Scopthalmus aquosus*), summer flounder (*Paralichthys dentatus*), northern puffer (*Sphoeroides maculatus)*, butterfish (*Peprilus triacanthus*), etc. Data on invertebrate species vulnerable to these gear types such as squid, horseshoe crabs, lady, blue, and green crabs, mantis shrimp, whelk, etc. should also be reported. Trawl data should be entered into a geographic information system (GIS) to analyze spatial aspects of the data and to enable comparisons with habitat maps.

(8) WINTER FLOUNDER

Target: Resident Finfish

Assessment

Purpose: To identify and map specific locations within the Peconic Estuary that provide critical spawning habitat for local populations of winter flounder.

Brief description: Winter flounder spawning in inshore waters is known to occur from December through April. Spawning occurs at temperatures of 1º C to 10º C and bottom salinities of 10 ppt to 35 ppt. Eggs are adhesive and demersal, attaching to each other and various substrates,

resulting in concentrations of eggs on spawning grounds. To identify critical spawning areas within the estuary, a fall and winter survey to collect egg and larval winter flounder should be performed biweekly at locations throughout the estuary during peak spawning times for a minimum of two sampling seasons. Sampling gear should include appropriate icthyoplankton sampling gear, such as bongo nets and epibenthic sleds. Egg and larval spatial and temporal distribution should be mapped and can be used to identify winter flounder spawning habitats and to provide specific information for managers in developing optimal seasonal windows for dredging that will minimize mortality of local stocks of winter flounder.

(9) PIPING PLOVERS

Target: Beach-Dependent Species

Assessment

Purpose: To determine piping plover habitat use, availability, and prey abundance in the Peconic Estuary and to assess affects of habitat changes to make recommendations to enhance plover breeding and productivity.

Brief description: Initial review of piping plover productivity data indicates that populations are down at a number of Peconic Estuary sites. The reasons are unclear as there are multiple factors that can play a role in breeding success and overall productivity. Throughout Long Island, there is an interest in "enhancing" habitat to improve shorebird productivity. Therefore, baseline data on prey abundance and shorebirds' microhabitat (i.e., intertidal zone -- sand and cobble patches, wrack, areas where there is sparse vegetation, beach berm, and moist swales) preferences is important information, particularly in the Peconic Estuary, which consist of habitats that do not readily fit typical habitat descriptions found in the literature.

(10) HORSESHOE CRABS

Target: Beach-Dependent Species

Assessment

Purpose: To identify and protect potential spawning habitat of horseshoe crabs in the Peconic Estuary.

Brief description: The 1998 Fishery Management Plan (FMP) for Horseshoe Crabs (*Limulus polyphemus*) adopted by the Atlantic States Marine Fisheries Commission (ASMFC) has identified habitat destruction and modification, overharvesting, and anthropogenic environmental changes as potential causes of concern relating to the status of horseshoe crab populations along the east coast. Horseshoe crabs are important to migrating shorebirds and sea turtles as sources of food, are critical to biomedical research and pharmaceutical testing, and are commercially harvested as bait for American eel, conch (or whelk), and baitfish. Horseshoe crabs have been

reported to spawn primarily during spring tidal phases, at the height of the daily tides on the upper intertidal zone of protected beaches with well-drained sandy substrates. The ASMFC has developed guidelines for delineation and assessment of horseshoe crab spawning habitat which include the following: using coastal zone management erosion data and topographic and navigational charts to predict potential spawning habitat; public participation using volunteers to provide information on time and location of observed spawning activity; aerial overflights at low tide; interviews with harvesters; and ground truth with surveys for nighttime spawning and for monitoring juvenile presence throughout the summer. Water quality degradation, bulkheading and sea wall and groin construction, dredging and beach renourishment, beach front development, and increased boat traffic and all-terrain vehicle use have all been identified as possible factors affecting horseshoe crab reproductive success. Initial landings data collected by the NYSDEC indicates that the Peconic/Gardiners Bay system is the major source of commercial landings of horseshoe crabs in New York, and presumably provides the largest concentration of productive spawning habitat in our local waters. This study would provide specific information for managers for protecting important spawning sites as required in the FMP.

(11) HARD CLAM, SOFT SHELL CLAM, BAY SCALLOP

Target: Shellfish

Assessment

Purpose: To assess hard clam, soft shell clam, bay scallop, and oyster temporal and spatial distribution; spawning, recruitment, and settlement; and population growth rates for improved management of these species.

Brief description: Shellfish are extremely vital to the Peconic estuary both ecologically and commercially. Shellfish can filter incredible volumes of bay water over relatively short time periods. Therefore, decreased shellfish abundance may be resulting in significant ecological changes to the system. For example, preliminary findings by Caron and Lonsdale (Dooley 1999) have resulted in a working hypothesis that the rapid decline in the shellfish population prior to the first brown tide may have led to significant reduction in grazing pressure on phytoplankton, thereby allowing the onset of brown tide. Understanding abundance and population growth rates as well as spawning, recruitment, and settlement of these important shellfish species is key to restoring shellfish populations and promote sustainable harvesting of these species.

(12) BAY SCALLOP

Target: Shellfish

Research

Purpose: To perform a distribution-focused study of the survival dynamics of bay scallops including an examination of settlement, recruitment, and size frequency and year class abundance of bay scallops located inside and outside of eelgrass beds.

Brief description: Anecdotal information indicates that adult bay scallops were once abundant enough that they were found outside of eelgrass beds in deeper waters where they were harvested by dredging. In some of these deeper areas, scallops may have been be two-years old, surviving to spawn two successive years. These two-year old scallops may have played an important role in the persistence of scallop populations, particularly following years in which brown tide interfered with normal recruitment resulting from the spawning of one-year old scallops. Today, bay scallops are harvested almost entirely in eelgrass beds because they are not as abundant and are no longer found in deeper waters. Given the huge fluctuations that have occurred in bay scallop populations as a result of brown tide, it is important to perform a distribution-focused study of the survival dynamics of bay scallops.

(13) SLIPPER SHELL

Target: Shellfish

Research

Purpose: (1) To understand slipper shell (*Crepidula* spp.) temporal and spatial distribution; spawning, recruitment, and settlement; and population growth rates to understand the role they play in the estuary; and, (2) to use slipper shells as a model for understanding benthic filter feeder dynamics with planktonic communities.

Brief description: Based on Lewis *et al*. (1997) and Lewis and Rivara (1997), slipper shells are in great numbers throughout the Peconics with maximum abundances of 5,840 individuals pr 9.29 sq. meters. *Crepidula* spp. were found at 48% of the stations sampled in 1995 as compared to only 11% by NYS DEC in 1979 Lewis *et al*. (1997). In fact, *Crepidula fornicata* was the most abundant species surveyed by Lewis *et al*. (1997). It is not clear whether populations have increased in response to ecological changes to the system such as brown tide and decreases in bay scallop abundances. More information is needed on slipper shells as well as on benthic-pelagic coupling occurring in the estuary. Slipper shell would be a good model to understand the ecological relationship between benthic filter feeders and planktonic communities.

(14) BENTHOS

Targets: **Seagrass**
Shellfish

Assessment

Purpose: To obtain baseline information on bay bottom structure, substrate, and benthic community structure for evaluating changes that may occur over time for better management of benthic resources and the estuary as a whole.

Brief description: Mapping of the bay bottom using a high resolution remote sensing system will provide information on shellfish, submerged aquatic vegetation, and sediment characteristics. Such information is essential for proper management of Peconic estuarine resources, improving shellfish productivity, restoring degraded benthic habitat, and improving shellfish harvest in the system. Maps will also be useful for linking land usage (e.g., developed vs. undeveloped areas) and water quality data to benthic habitat quality. Ultimately, benthic data will be employed as a long-term indicator of the overall "health" of the Peconic Estuary. It is also intended that the data be used to assess the spatial distribution of habitats and structures that are important to juvenile finfish survival and recruitment into the fishery. In addition to seafloor mapping with remote sensing equipment, ground-truthing will be performed to confirm occurrences of particular species and significant concentrations of species and habitats.

(15) CRITICAL NATURAL RESOURCE AREAS

Targets: **Beach, Bluff, and Dune Complex**
Tidal Wetlands
Seagrass
Resident Finfish
Beach-Dependent Species
Shellfish

Assessment

Purpose: To organize existing data, collect new data to fill information gaps, and perform a threat assessment for each Critical Natural Resource Area (CNRA) in order to fulfill recommendations made in the draft CCMP and develop an implementation strategy by the Towns to protect these important areas of high biodiversity.

Brief description: The CCMP identifies CNRAs within the Peconic Estuary watershed (spanning

land and estuarine waters) that represent the highest quality remaining natural resources. All existing information on the different habitat and organisms of importance and their diversity of function found in the CNRAs needs to be collected and organized into one inventory. Biological data need to be quantified and information gaps need to be filled through additional data collection and geographic information system (GIS) analysis. This analysis can then be used to modify or confirm boundaries and develop buffer and core areas within CNRAs. A detailed threats assessment is also needed. The threats assessment can then be linked to the CNRA inventory and protection measures can be developed to reduce impacts and maintain their high quality.

(16) ECOSYSTEM STRUCTURE AND PRODUCTIVITY

Targets: **Beach-Dependent Species**
Shellfish
Diverse Phytoplankton Community

Monitoring

Purpose: To obtain baseline information on the trophic structure through monitoring and to perform analyses to determine whether there are changes, if any, in ecosystem productivity as a result of changes in species composition.

Brief description: The PEP has identified there is a paucity of information on the dynamics of the food web in the Peconic Estuary. In order to determine whether there are shifts in food sources (including submerged aquatic vegetation and plankton) related to habitat degradation, water quality changes, invasive species, or other factors, and whether these shifts have led to alterations in species composition, comprehensive assessment and monitoring of the different trophic levels is needed. More specific research questions related to cause and effects of changes in trophic structure need to be developed. Monitoring needs include: (1) phytoplankton production, abundance, and identification and distribution of species assemblages (including picoplankton); (2) microzooplankton abundance and identification and distribution of species assemblages; (3) mesozooplankton abundance and identification and distribution of species assemblages; (4) abundance and distribution of dominant benthic invertebrate species assemblages; (5) abundance, distribution, density and size/weight of selected shellfish and finfish species; (6) abundance and distribution of selected colonial waterbirds, shorebirds, and wintering waterfowl; and (7) sightings/occurrences of marine mammals and sea turtles.

(17) BIOINDICATORS

Targets: **Tidal Wetlands**
Seagrass
Resident Finfish
Beach-Dependent Species
Shellfish
Diverse Phytoplankton Community

Research & Monitoring

Purpose: To identify and use a suite of indicator species at different trophic levels (e.g. plankton, finfish [nekton], benthos) to assess estuarine diversity and abundance and productivity in the Peconics and evaluate habitat changes and environmental stresses at varying multiple temporal and spatial scales.

Brief description: Bioindicators consist of organisms that reflect changes to their habitat in a predictable and repeatable manner. Bioindicators can represent changes at different scales, ranging from biomolecular responses to population-level and community-level responses. These are typically used to assess the effects of environmental stresses on the diversity and abundance of marine organisms. These bioindicators need to be linked to the conceptual ecological model representing different temporal and spatial scales. The indicators should provide technical information about the condition of the estuary and be capable of linking improvements to particular management actions undertaken or help identify management actions that are needed to improve conditions. Examples of specific indicators may include: bay scallops, winter flounder, tautog, osprey, eelgrass, sponges, and diamondback terrapins.

7.3 RESEARCH, MONITORING, AND ASSESSMENT RELATED TO RESTORATION

(1) RESTORATION

Targets: **Beach, Bluff, and Dune Complex**
Tidal Wetlands
Seagrass
Resident Finfish
Beach-Dependent Species
Shellfish

Assessment & Research

Purpose: To assess restoration projects to measure success of restoration efforts and to identify novel techniques to improve restoration efforts.

Brief description: An action in the CCMP recommends evaluating the success of restoration efforts. There have been examples in the Peconics of restoration efforts that have not resulted in actual long-term recovery of the targeted habitat. Therefore, it is essential to both assess and monitor restoration projects in order to take steps, if necessary, to correct any problems. A number of restoration projects are now underway as a result of available funding from the NYS Clean Air Clean Water Bond Act. More restoration projects are expected to be funded in the future. It is critical for restoration projects to build in the capacity to monitor sites upon completion of restoration. Restoration assessment needs to be linked to the reference sites in order to make quantitative comparisons of functionality. As part of assessment, monitoring before, during, and after restoration is also needed to evaluate success of restoration efforts and is considered a priority. Restoration projects should also strive to set aside a certain amount of effort in performing experimental methods to improve efforts and identify key restoration priorities. Also, research is needed to assess functional attributes necessary for restoration of natural communities.

(2) EELGRASS CULTURING

Target: Seagrass

Research

Purpose: To develop a nondestructive method of culturing eelgrass to prevent impacts to existing beds.

Brief description: Eelgrass restoration has been identified as a priority in the CCMP and the Habitat Restoration Plan. It is important to preserve existing beds while restoring eelgrass to other areas. Therefore nondestructive methods need to be pursued and national research protocols on tissue culture and seed base need to be followed. As part of this research, there should be an examination of flowering phenology, seed production and viability, eelgrass colonization of unvegetated areas, sediment deposition due to eelgrass and possible changes in sediment type after loss of eelgrass.

(3) REFERENCE SITES

Targets: **Beach, Bluff, and Dune Complex**
Tidal Wetlands
Seagrass
Resident Finfish
Beach-Dependent Species
Shellfish

Assessment

Purpose: To develop a suite of reference sites that represent different habitats as controls for gauging restoration projects as well as for comparative analyses.

Brief description: One of the most common assessment designs involves the comparison of a control or reference site (i.e., a place far enough from an activity under investigation to be relatively unaffected by it) and an impact site (near an activity under investigation and therefore assumed to show signs of an effect if one exists). Control-Impact and Before-After-Control-Impact (BACI) are two examples of important sampling designs used in coastal ecology that require the establishment of reference sites (Osenberg and Schmitt 1996). Sites used in previous research, monitoring, and characterization efforts such as the SCDHS surface water quality monitoring (Figure 2), tidal creek characterization (Figure 4), and Natural Heritage Program sites need to be taken into consideration when reference sites are chosen. Pristine versus impacted sites need to be identified and characterized as reference sites. Reference sites should represent the functional value of different habitats (e.g., saltmarsh, eelgrass beds) in order to assess success of habitat/resource restoration. Location maps need to be developed. Reference site data should be made accessible to anyone involved in research, monitoring and restoration in the Peconics.

8. IMPLEMENTATION STRATEGY

A key aspect of implementing a research and monitoring program is to have continued interest by decision makers as well as an adequate and continuous funding source. Periodic review of the program and redirection of effort by decision makers may also be necessary if new information justifies a change in the research and monitoring program. A successful research and monitoring program will also rely on participation by both the local scientific community and the public.

Involvement of the scientific community over and above the creation of a science advisory panel can spark opportunities for associated research and monitoring. A management recommendation made in the CCMP Habitat Module is to promote research and monitoring opportunities in the Peconic Estuary at local schools, colleges, universities, and institutes by establishing funding and scientific platforms and other incentives to facilitate basic and applied marine research.

One management recommendation in the CCMP is to seek opportunities to link research and monitoring in the Peconics to related estuaries and regional studies. Other National Estuary Programs have embarked on research projects, which have resulted in significant findings about marine systems that are applicable to many estuaries. The PEP should participate in coordinated research and information exchange with other National Estuary Programs as well as other estuaries where coordinated, large-scale research and monitoring efforts are underway.

Public participation is also beneficial for successful program implementation. Citizens as advisory representatives ensure that the scope of the program addresses the needs of the community and that information is in an understandable format. There are numerous examples of programs having effective volunteer citizen monitoring programs as part of a larger research and monitoring initiative. The Peconic Baykeeper intends to develop a volunteer citizens monitoring effort, coordinated with this framework, that will focus on monitoring shoreline changes.

8.1. LINKS TO OTHER PROGRAMS

A key aspect of the Living Resources Research and Monitoring program will be its coordination with brown tide research efforts, the existing SCDHS surface water monitoring program, NYS DEC annual trawl survey, and Cornell Cooperative Extension's SAV monitoring to minimize redundancy and leverage efforts wherever possible. The following is a brief description of each of the four programs.

8.1.1. SCDHS SURFACE WATER MONITORING

A major finding stressed at the LRRM workshop was the importance of the SCDHS surface water monitoring program and the need to expand its efforts or develop partnerships with other entities to incorporate a larger living resource component to its monitoring efforts. There are already a number of living resource PEP projects (e.g., tidal creek study, SAV monitoring, eelgrass/water quality) that are designed to work with SCDHS monitoring to obtain the most complete information while minimizing unnecessary redundancy in water quality data collection. A second recommendation made in the LRRM workshop was for the SCDHS to expand its efforts to monitor groundwater flow and content such as nutrients and toxic contaminant levels. Given the prevailing hypothesis by La Roche *et al*. (1997), which associates brown tide with nutrient inputs from groundwater, monitoring ground water seepage and nutrient levels would be an important expansion to SCDHS efforts.

Since 1986, the SCDHS has routinely analyzed samples for a broad array of water quality and other parameters at 35 stations and 10 point source stations (Figure 2). Several intensive

water collection surveys have also been performed at Sag Harbor and West Neck Bay. The SCDHS surface water monitoring program consists of weekly water sampling of 15 sites with the remaining 20 sites sampled on an alternating biweekly schedule and biweekly sampling of 10 point source stations. Sample analyses include nutrients (NH_3, NO_2 + NO_3, TPO_4, $TDPO_4$, OPO_4, TKN, DKN, urea, TOC, DOC, Si), total and fractionated (< 10 μm) chlorophyll-a, salinity, total suspended solids, total and fecal coliform bacteria, and the brown tide organism *Aureococcus anophagefferens*. Field measurements include temperature, dissolved oxygen, secchi depth, and photosynthetically active radiation by irradiometry. Three stations are sampled each week on a diurnal (morning and afternoon) basis in an effort to relate diurnal dissolved oxygen concentrations to chlorophyll-a and nitrogen levels. Special sampling events include wet weather sampling to determine changes in water quality due to rainfall (in Sag Harbor and West Neck Bay), intensive sampling of every two to four hours over a 24-hour period to investigate diurnal dissolved oxygen variation (in Peconic River, Meetinghouse Creek and Flanders Bay), and intensive sampling along the eastern boundary of the Peconic Estuary for input to the water quality model being developed by Tetra Tech on behalf of the PEP.

8.1.2. BROWN TIDE RESEARCH

In the decade following the first brown tide in 1985, New York Sea Grant and Suffolk County funded brown tide research performed by scientists at SUNY Stony Brook, Brookhaven National Laboratory (BNL), Southampton College and elsewhere. In 1996, the NOAA Coastal Ocean Program funded $1.5 million for brown tide research as part of the Brown Tide Research Initiative (BTRI) administered by New York Sea Grant. An additional $1.5 million for brown tide research was funded by the Coastal Ocean Program of NOAA as part of the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) program. ECOHAB is an interagency program consisting of NOAA, Sea Grant, National Science Foundation, Environmental Protection Agency, Office of Naval Research, and National Aeronautics and Space Administration. Studies supported by BTRI, New York Sea Grant, and the NOAA Coastal Ocean Program have included:

- Physiological characteristics of brown tide
- Phytoplankton productivity and zooplankton dynamics (predator-prey relationships)
- Viral activity
- Environmental factors enhancing brown tide blooms
- Impact of brown tide on microbial food web
- Susceptibility of shellfish to brown tide
- Physical oceanographic study on the causative factors in the initiation of brown tide blooms
- Genetics
- Historical occurrence of brown tide blooms
- Reconstruction of the effects of brown tide blooms on the growth of hard clams

8.1.3. NYS DEC FINFISH & MACROINVERTEBRATE TRAWL SURVEY

Since 1987, the NYS DEC has performed annual trawl surveys west of Shelter Island. The original intent of the surveys was to develop an annual index of recruitment of juvenile weakfish and examine the relationship between parental stock size and environmental factors on year class strength for weakfish (Weber *et al*. 1998). Data collection was later expanded to derive similar information on several other finfish species including winter flounder, scup, bluefish, tautog, butterfish, and northern puffer. The surveys also provide important data on more than 70 other species of finfish and crustacea (Weber *et al*. 1998).

8.1.4. CORNELL COOPERATIVE EXTENSION SAV MONITORING

In 1997, Cornell Cooperative Extension's Marine Program began SAV monitoring at 3 sites in the Peconic Estuary: Orient Harbor, Town of Southold, Northwest Harbor, Town of East Hampton, and Bullhead Bay, Town of Southampton. A minimum of three stations were sampled per site for SAV, sediment analysis, and water quality analysis. SAV measurements include: species composition, dry weight biomass of algae and eelgrass, depth and position of deep edge of eelgrass bed, shoot density, presence and dry weight biomass of epiphytes, and presence of wasting disease. Samples for SAV were taken 2 times per year. Cornell Cooperative Extension uses water quality data from SCDHS surface water monitoring program (see above). These data consist of the following parameters: chlorophyll-a, total suspended solids, dissolved inorganic nitrogen, dissolved inorganic phosphorus, and light attenuation. In addition, water temperature, salinity, and light measurements at the surface and at one meter increments are taken at the time of SAV sampling. Sediment measurements include grain size and percent organic matter.

Upon completion of the 1997 SAV monitoring report, two recognized experts in the field were asked to review the monitoring program. As a result of this expert review, the monitoring program was revised and the following 1998 sampling program was initiated: SAV sampling was performed once per year during the summer, the number of samples collected per site was increased to 12, and sediment sampling will be repeated every five years for each site. In 1999, Cornell Cooperative Extension expanded its monitoring program to include three additional sites in Gardiners Bay, Town of Shelter Island, Three Mile Harbor, Town of East Hampton, and Southold Bay, Town of Southold (Figure 3). Underwater video of each site was also taken in 1998 and 1999. Aerial photo analysis of eelgrass coverage estuary-wide will be performed in 2000 in cooperation with the US Fish and Wildlife Service. Aerial photos will provide a more extensive view of existing eelgrass beds and provide estimates of percent cover.

9. PRODUCTION & DISSEMINATION OF INFORMATION

Dissemination of research and monitoring information is essential to evaluate progress made in restoration and conservation efforts, to develop improved methods for research, monitoring, and stewardship of our important natural resources, and to provide public with information about the state of the estuary. Results of research and monitoring should be available in peer reviewed scientific journals and conferences as well as in newsletter and other formats that are understandable to the public and decision makers.

9.1. DATA MANAGEMENT

A Living Resources Research and Monitoring program would generate a vast amount of data over a relatively short period of time. How these data are managed and their availability will influence how the information is used. A database manager must be identified early on in the development of this program. Database management could be undertaken by Suffolk County under the auspices of the PEP Program Coordinators, NYS DEC, or could be contracted out to a university or private entity.

Regardless of which entity manages the data, the information must be available in different formats depending on how it will be used. The program coordinator should be required to set up a procedure on how the scientific data are transformed into information and made available in various forms that can be used not only by other scientists, but also by resource managers, decision makers, and the public at large. For example, different forms in which information is needed include raw data of field and laboratory results, summary results from data analyses, highly summarized data designed to explain generally about the health of the Peconics, technical reports and publications on analyzed data, and public information such as news accounts and press releases based on results from data analyses. Periodic fact sheets distributed in a newsletter or made available electronically on the PEP web site are other important information dissemination tools that should be provided by a living resources research and monitoring coordinator.

One recommendation made in the CCMP Habitat Module is to organize an annual or biennial conference to report research and monitoring results to the public and guide management decisions. Such a biennial conference will provide an opportunity for scientists to meet along with managers and the public to review and discuss findings.

9.2. GEOGRAPHIC INFORMATION SYSTEMS

A geographic information system (GIS) is a computer system for the entry, management, display, and analysis of geospatial data. Information is in the form of maps, or data layers, with related tables of descriptive information that are linked to the graphic features on the map. Uses of GIS parallel and support three of the major functions of the living resources research and monitoring framework: information gathering, communication, and scientific analysis. Examples of GIS applications include habitat delineation and assessment, threats assessment, change analyses, process and flow modeling, and spatial measurements, as well as publication and presentation graphics and data management. Some of the priorities discussed in this document call for the use of GIS in developing maps and performing spatial analyses.

Some GIS applications are best performed by specialists with advanced systems, while others can be done by individuals with minimal training and desktop systems. Given that GIS is such a powerful tool for managing and analyzing data, it would be imperative that GIS be used for various aspects of the Living Resources Research and Monitoring program activities related to data management, map production, spatial analysis, and information dissemination.

10. IDENTIFICATION OF FINANCIAL RESOURCES

The cost of implementing a comprehensive research and monitoring program can be wide-ranging depending on the scope of projects and staff needed to administer the program. At least $500,000 annually would be needed to adequately perform only a few of the research and monitoring projects identified as priorities in the CCMP. An additional $100,000 annually would be required for program administration, oversight and coordination, and public involvement and outreach. At least $3 million over the next five years would be required to adequately implement a comprehensive living resources research and monitoring program.

The PEP Management Conference should aggressively seek funding as part of its budget process for implementation of this program. Funding sources could be existing or new sources from NYS DEC, NYS DOS, USEPA (including NEP implementation), NOAA, National Science Foundation, Suffolk County, and private sources. Initial seed money could be sought from an allocation by the New York State Legislature as a Member item or by federal representatives.

10.1. COORDINATION WITH EXISTING GRANT PROGRAMS

Coordination and partnership of individual competitive grants will play a major role in the success of this program. Examples of competitive grants include but are not limited to: (1) National Science Foundation grants; (2) US EPA Sustainable Development Challenge Grant; (3) US EPA Project EMPACT (Environmental Monitoring for Public Access and Community Tracking); (4) US EPA Water and Watershed Research; (5) US EPA Coastal 2000; (6) US EPA NCERQA; (7) NOAA ECOHAB; (8) NOAA Essential Fish Habitat; (9) NOAA Coastal Services Center Coastal Change Analysis Program; (10) US Fish and Wildlife Service Aquatic Nuisance

Species program; (11) Coastal Intensive Network Sites (CISNet); and, (12) National Environmental Monitoring Initiative -- Committee on the Environment and Natural Resources, White House Office of Science & Technology Policy.

Special designations of sites in the Peconics could make funding available from NOAA National Estuarine Research Reserve and/or National Science Foundation Land Margin Ecological Research program.

11. CONCLUSION & NEXT STEPS

Research and monitoring should be used as tools in environmental decision- making to provide technical assessments of problems while the wider public is involved in determining the desirability of action based on the scientific evidence (Fairweather 1993). This document which highlights research, monitoring, and assessment priorities for habitats and living resources of the Peconic Estuary could provide the appropriate science needed to help decision makers implement the recommended management actions in the CCMP and fill information gaps needed to modify existing or develop new strategies to protect and conserve the estuary.

Living resources research and monitoring coordination, advocacy, and fundraising is necessary to make this framework a reality. Strong leadership will be essential for success of this program. A coordinator is needed to effectively implement this framework, focus research and monitoring needs highlighted in the CCMP, and coordinate existing efforts. One of the most important responsibilities of a coordinator will be to ensure that scientific results generated by this framework be tailored into information that managers and the public can understand and use.

The ideas recommended in this document are consistent with new paradigms in biodiversity conservation and management that embrace species, ecosystems, and the dynamic multi-scale ecological processes that sustain them (Peters *et al*. 1997).

Next steps include identifying a coordinator, raising funds for specific projects, and developing specific “scope of work” descriptions, cost estimates, and timelines for projects that fall under each research and monitoring priority. The results of each priority project must ultimately fulfill a management need identified in the CCMP. Therefore, specific management needs must be finalized.

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APPENDICES

A1. SAMPLING PROTOCOLS

Cost effective sampling protocols are needed to ensure consistency among projects, quality assurance and quality control, and allow comparisons of results from different projects. Since the intent of this program is to support long-term research and monitoring, sampling protocols are especially important for trend analyses. Until an expert panel is convened to develop specific sampling protocols, sampling should follow methods found in Puget Sound Estuary Program's *Estuarine Habitat Assessment Protocol* (Simenstad *et al.* 1991). Sampling stations should be consistent with sites used in the SCDHS surface water quality monitoring program (Figure 2), eelgrass monitoring by Cornell Cooperative Extension (Figure 3), the PEP tidal creek characterization study (Figure 4), and the Critical Natural Resource Areas (Figure 5) described later in this report.

A2. PAST & ONGOING EFFORTS

A2.1. WATER QUALITY AND SEDIMENT DYNAMICS

The PEP is supporting the development of a hydrodynamic water quality model of the Peconic Estuary. Model results are expected in the near future.

The NYS DEC Bureau of Shellfisheries Shellfish Sanitation Unit is responsible for water quality monitoring for the harvest of bivalve molluscs. Water samples are collected and analyzed for total and fecal coliform bacteria. The Systematic Random Sampling Method is used whereby NYS DEC samples at least six times per year (ideally once every two months) at each shellfish growing area. Sampling can occur either during wet or dry weather but must be taken on an ebbing tide. Shellfish growing areas are closed on a "temporary emergency basis" after three inches of rainfall (or greater) within a continuous 36-hour period. When this occurs, the affected growing area is closed to harvesting and must be tested to document that water quality has returned to acceptable coliform levels. The area can then be re-opened to shellfish harvesting. NYS DEC does not currently monitor coliform bacteria in all areas in the estuary closed to shellfish harvesting.

In 1997, the PEP funded an eelgrass habitat water quality criteria study to correlate water quality conditions with health of eelgrass beds. Water and sediment quality and general hydrodynamic trends were evaluated in areas where eelgrass density was highest, lowest, transitional, stressed, and non-existent. Data were compared to criteria developed for Long

Island Sound and Chesapeake Bay. Additional work included an analysis of eelgrass transplant techniques to determine the most successful methodology for the Peconics.

The PEP funded a survey by Howes *et al*. (1998) on sediment nutrient flux at 10 stations in the Peconic Estuary. Rates of sediment and water column oxygen consumption and nutrient regeneration were measured throughout the system to determine the potential for occurrences of bottom water hypoxia and the magnitude of organic matter cycling throughout the system. Using radionuclides, Cochran *et al*. (1999) evaluated sediment mixing and accumulation patterns at the same 10 sites. Carbon burial rates were estimated to be 0.3 to 1.8 mg $C/cm^2/y$.

A2.2. TOXIC CONTAMINANT ANALYSES

In 1994, Arthur D. Little (1996), Inc. was contracted by the PEP to survey bottom sediment for toxic contaminants throughout the estuary. Sediment samples were collected from 12 locations and analyzed for a wide range of naturally occurring and human-made substances. Pollutant concentrations were compared to "Effects Range-Low" and "Effects Range-Median" values developed by NOAA. Both the low and median values correspond to concentrations below which contaminant induced effects are unlikely. None of the samples exceeded the medium range values. Arsenic and lead concentrations exceeded the low values at 10 stations. Copper, mercury, silver, cadmium, and zinc exceeded low values in East Creek.

Recently, in 1998 and 2000, the U. S. Environmental Protection Agency performed a survey to sample sediment toxicity (e.g., metals, pesticides, organics) at 28 sites throughout the estuary. Typically, most measurements were low to below detection. There were detectable levels of pesticides including DDT and its breakdown products in Jockey Creek and Sawmill Creek in Southold. The U.S. EPA also completed a survey in 1999 to examine possible bioaccumulation of contaminants, including radionuclides, in finfish and shellfish. Results are not yet available.

A2.3. BIOLOGICAL INVENTORIES

D. Lonsdale and G. Taylor, scientists from the Marine Sciences Research Center, State University of New York , Stony Brook, are currently performing a taxonomic survey of phytoplankton and microzooplankton including temporal and spatial patterns in composition and biomass, at three sites in the Peconics. The sites are at SCDHS water quality sampling stations in Flanders Bay (#170), West Neck Bay (#119), and Great Peconic Bay (#130).

The Peconic Estuary Program contracted EEA, Inc. to survey macrobenthic invertebrate communities of 10 tidal creeks. Land use, water quality, bathymetry, hydrodynamics, physical chemistry, sediment grain size, and wildlife was also evaluated. The data collected suggest an interesting relationship between a diverse benthic community and presence of surrounding salt marsh, even in instances where there was only a fringe of salt marsh between the creek and development in the watershed (EEA, Inc. 1999).

The New York Natural Heritage Program (NYNHP) inventoried rare and endangered species and natural communities in the Peconic Estuary watershed. Results of their inventory are

found in Pleuthner (1995). The U. S. Fish and Wildlife Service mapped critical natural resource areas, including habitat and species distribution maps, which reflect the results of two PEP experts workshops in 1996.

The NYS DEC performs ongoing wetland status and trends in the Peconic Estuary watershed. In 1997, the U. S. Fish and Wildlife Service also surveyed wetlands in the Peconic Estuary watershed as part of the National Wetlands Inventory (Tiner et al. 2000 [draft]).

In 1995, the PEP funded a deep (1.8 to 8.5 m) water shellfish survey by Lewis *et al*. (1997) and in 1997, a shallow (0.3 to 1.85 m) water shellfish survey by Cornell Cooperative Extension (Lewis and Rivara 1997) to evaluate distribution and abundance of sediment type, shellfish, and other macrofauna. In the deep water survey, sampling was performed at 124 stations spaced approximately 0.5 nautical miles apart. An earlier shellfish survey was performed in 1979 and 1980 by NYS DEC in the deep waters of the Peconic Estuary from Flanders Bay to Shelter Island Sound at 246 stations. Sampling methods were the same as the deep water survey performed by Lewis *et al*. (1997). Therefore, comparisons between surveys were made in some areas.

The East End towns monitor a variety of finfish populations on different scales at different locations. Commercial landings of finfish and crustaceans are also documented annually by the National Marine Fisheries Service.

The PEP funded a SAV survey performed by Cashin Associates (1996). They reviewed historical patterns of SAV abundance and distribution and performed field surveys throughout the estuary. Their survey encompassed stations throughout the estuary in areas where shellfish growing areas or eelgrass beds currently exist or may have occurred in the past based on anecdotal and qualitative information from marine scientists, harbor masters, bay constables, and other local officials. More detailed surveys were performed in North Sea Harbor, Three Mile Harbor, West Neck Harbor, and Long Beach Bay. They also used aerial photos from October 1994 to add stations around Shelter Island and to the east and to determine spatial extent of eelgrass beds and other SAVs between sampling stations. A total of 214 stations were sampled between September and October 1994. Aerial coverage was estimated by visual surveys within an approximately 30 m (100 ft) radius of each sampling station.

The PEP will be funding a second set of aerial photo interpretation by the U.S. Fish and Wildlife Service in cooperation with Cornell Cooperative Extension and the Peconic BayKeeper as part of eelgrass long-term monitoring. Unlike Cashin (1996), photos will be collected according to protocols developed by NOAA to obtain the most accurate interpretation of eelgrass characteristics using aerial photography. The photos will also be used to obtain quantitative, baseline information on the amount of shoreline hardening that currently exists along the Peconic Estuary.

A2.4. LAND USE ANALYSES

In 1995, the PEP supported the Suffolk County Department of Planning to inventory land use and population and develop parcel-specific land use maps for every Suffolk County Tax Map parcel in the PEP. Maps were also developed to show land available for development and underwater ownership of submerged lands.

A2.5. GROUNDWATER STUDIES

From 1993 to 1996, the U. S. Geological Survey investigated the distribution and magnitude of ground water discharge to the Peconic Estuary and identified ground water flow paths and travel time to Meetinghouse Creek, Sag Harbor Cove and West Neck Bay. Water levels were measured at 246 wells during March-April 1994 and at 195 wells in March 1995. Modeling combined with hydrogeologic data from 43 observation wells and borehole-geophysical surveys at 24 wells were used to determine ground water flow paths, travel time and a water budget.

A continuously recording ultrasonic seepage meter was used by Paulsen *et al*. (1997) to measure ground water underflow 65 ft offshore in Coecles Harbor, Shelter Island in an effort to understand the relationship between tidal fluctuations and groundwater underflow and to locate the salt/fresh water interface.

A2.6. BROWN TIDE INVESTIGATIONS

In addition to the brown tide research and monitoring described earlier, BNL has initiated the Brown Tide Monitoring Network to deploy real-time in-situ fluorometers and examine basic photosynthetic physiology of brown tide in the field. BNL has also performed "hindcasting" and autoecological investigations.

Initial studies on brown tide include those of Bricelj and Kuenstner (1989) on the effects of brown tide on shellfish and Dennison *et al*. (1989) who investigated the effect of the brown tide algal bloom on eelgrass. Studies performed by Cosper *et al.* have included physiological analyses, ^{14}C productivity data, and the effects of macronutrients and micronutrients on bloom formation. Anderson *et al.* (1993) developed an immunoflourescent procedure for detecting brown tide cells. Lonsdale (1996) examined predator-prey relationships. New York State, local towns, baymen's groups and Cornell Cooperative Extension have been involved in shellfish reseeding and monitoring efforts (New York Sea Grant 1998).

A3. ADDITIONAL RESEARCH & MONITORING INITIATIVES

There were numerous recommendations made at the LRRM workshop and PEP Natural Resources Subcommittee meetings. Although not identified as priorities, the following research and monitoring recommendations are nevertheless important and should be considered further as

the development of this program evolves. There is some overlap of research and monitoring recommendations among each other and the priorities listed above.

A3.1. *LIVING RESOURCES THREATS-RELATED RESEARCH, MONITORING & ASSESSMENT*

- It is intended that this LRRM program be linked to ongoing brown tide research and monitoring efforts. Nevertheless, in discussions at the LRRM workshop and during Natural Resources Subcommittee meetings, it was identified that there is a need for efforts to focus on the *ecological effects* of brown tide. Some specific examples recommended are to: (1) research the changes in energy pathways as a result of the present occurrence of noxious/toxic algal blooms -- quantify the "ripple" effects of brown tide on living organisms throughout the estuary; (2) examine brown tide process studies and rate measurements such as nitrogen conversion; (3) investigate the role of benthos with respect to brown tide; and (3) research the lethal, sublethal, and synergistic effects of brown tide on the reproduction and behavior of finfish species.

- Integrated research on human impacts on "valued species" early life stages, productivity, and reproduction. Human impacts include (1) physical effects from tributary blocking (e.g., culverts), shoreline hardening, and dredging; (2) chemical effects from nutrients (e.g., carbon export, eutrophication) and toxics (e.g., PAHs, pesticides, herbicides, endocrine disrupters).

- Investigate changes in energy pathways as a result of anthropogenic inputs (e.g., pesticides). Quantify the "ripple" effects of nutrient and toxic inputs on living organisms throughout the estuary.

- Examine the effects of toxics in localized sediments on the food chain (bioaccumulation and any sublethal effects on eggs and/or larvae).

- Determine the effects of navigational dredging on shallow water communities and the recovery time of benthic communities exposed to dredging. Dredging currently being done in the Peconics should be examined on a site-specific basis to determine the magnitude of impacts on the natural community in comparison with the economic benefits of the activity.

- Monitor water quality and benthos of Flanders Bay (plus some control sites) to evaluate the effectiveness of upgrading the Riverhead sewage treatment plant.

- Evaluate impacts of navigational dredging on larval, juvenile, and adult fish and clams by sampling before, during and after a maintenance or navigational dredging operation.

- Develop environmental report cards to track improvements (both environmental and economic).

- Monitor coliform bacteria in closed shellfish areas with the goal of re-opening beds.

- Assess the intensity and extent of oyster disease in the Peconics.

- Evaluate the effects of boating, local fishing, and shellfish harvesting practices on eelgrass. As part of this research, best management practices (BMPs) should be developed and presented to each town in the Peconics.

- Assess the effects of swans and Canada geese on the use of shellfish resources in the Peconics for human consumption.

- Assess the improvement in habitat due to reduction in nonpoint source pollution in the western Peconics by management actions.

A3.2. *RESEARCH, MONITORING, & ASSESSMENT FROM SYSTEMS TO SPECIES*

- Study the ecological interactions of: (1) northern puffers and bay scallops; (2) lady crabs, hard clams, and tautog; (3) lady crabs and winter flounder; and, (4) bluefish, forage fish, and young of the year habitats for forage fish.

- Study the similarities and differences of the ecology of fish in Peconics and Gardiners Bays.

- Identify dredging windows compatible with life cycle and habitat of finfish in the estuary.

- Focus research to determine the effects of SAV on the growth, survival, and abundance of different fish species.

- Perform an evaluation of distribution, abundance, and role of higher trophic level organisms (e.g., diamondback terrapin) in the Peconic Estuary food web.

- Perform research on the ecology of food of sea turtles to evaluate the importance of the Peconic Estuary and potential threats to these endangered and threatened species.

- Monitor the impact of availability and quality of forage fish on seabirds and other fish-eating wildlife. Evaluate finfish grazing and other interactions and the needs of piscivorous birds, humans and others for improved management.

- Examine the importance of sponges in the in the Peconics by examining their distribution, abundance, and habitat preferences.

- Characterize the importance of crustacean grazing, their population trends and importance as a food source.

- Perform research and monitoring of conch and American eel throughout the estuary to understand their distribution (temporal and spatial), abundance, habitat preferences, and different life stage requirements to develop management strategies and importance to other species.

- Elucidate relationships among nutrients, SAV, and valuable resource species. This examination should include the quantification and determination of possible links between nitrogen loads west of Shelter Island and water quality requirements of SAV.

- Determine the effectiveness of monitoring eelgrass by monitoring occurrence and abundance of eelgrass in beach wrack.

- Determine economic values (market and non-market) of Peconics' ecological services and resources to help prioritize management endpoints.

- Evaluate how different Peconic Estuary management strategies may conflict and determine whether management endpoints should be prioritized.

- Consider marine sanctuaries as control sites and limit activity. Monitor sanctuaries and evaluate threats from development on these critical habitats.

- Perform "new production" (i.e., resulting from allocthonous or external sources of nitrogen such as riverine, terrestrial, and atmospheric inputs, and upwelling) studies to examine system-wide ecosystem changes whereby primary production is measured from nutrient sources coming into the system such as upwelling and atmospheric deposition. If it is assumed that only new production can be exported from the system, a nitrogen mass balance can be developed to determine how much is being exported. Data needs for this approach would be consistent with SCDHS water quality data collected.

- On a subwatershed basis, investigate correlations and study affects of adjoining land use on adjacent ecological communities.

- Evaluate nutrient recycling by grazing and decomposition.

- Perform specific local benthic processes studies. One approach may be to first stratify the system based on sediment type and identify sites that are representative of the spectrum to study local processes.

- Examine meroplankton as an indicator of health of economically important species. In addition, collect data on phytoplankton populations to determine what affects the base of the food chain such as: (1) viruses and bacteria; (2) sediment flux; and, (3) total suspended solids.

- Elucidate the plankton-benthic linkage as it relates to carbon and its role in the food web.

- Analyze the effectiveness of current wetland regulations and their implementation on wetland buffers.

A3.3. *RESEARCH, MONITORING, & ASSESSMENT RELATED TO RESTORATION*

- Determine whether particular species will return if the habitat is restored or enhanced, particularly in areas influenced by duck farms in the past as well as areas currently impacted by agricultural practices in existence today. There should also be an evaluation of water quality improvements and subsequent species utilization/recolonization of these improved habitats.

PECONIC ESTUARY PROGRAM

NATURAL RESOURCES SUBCOMMITTEE

APPENDIX 1: SUMMARY OF THREATS TO THE LIVING RESOURCES OF THE PECONIC ESTUARY

FINAL DRAFT: 6/17/99

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BACKGROUND

The Peconic Estuary Program's (PEP) Comprehensive Conservation and Management Plan (CCMP) has identified threats that have, or have the potential to, negatively impact the water quality and living resources in the Peconic watershed. The CCMP contains actions that address these threats to improve and protect the health of the Peconic ecosystem. The actions in the Habitat chapter of the CCMP specifically deal with threats to the living resources of the Peconic Estuary. In addition to the Habitat chapter, the literature-based Characterization Report of the Living Resources in the Peconic Estuary (Bortman and Niedowski 1998, *Herein referred to as*: Characterization report) also provides a detailed description of the Peconic ecosystem and the threats they have been subjected to.

The threats to the living resources in the Peconic Estuary are wide ranging and include both human and non-human factors that have negatively impacted many habitats and species. For example, the decline in eelgrass (*Zostera marina*) beds within the Peconic Estuary has been attributed to the reduction of light penetration during extensive brown-tide (*Aureococcus anophagefferens*) algal blooms, nutrient over-enrichment from fertilizers and failing septic systems, and competition with non-native macro-algae (*Codium fragile*). While any one of these threats could be responsible for the decline of eelgrass beds, it is also possible that the combination or interaction of all three threats lead to the reduction of eelgrass abundance. Additionally, cumulative losses from seemingly minor threats may only become noticeable over extended time periods; often when damage to the resources is very severe. Such threats are also of concern to the PEP.

A first step to managing these threats is to identify them and characterize their impacts to the biota in the watershed. The characterization report and habitat chapters have identified and characterized the threats and impacts to the living resources within the Peconic Estuary, but a summary of this information is lacking. Therefore, the goal of this document is to concisely present the threats and their impacts to living resources that have been identified in the Characterization report. We were also interested in determining if these threats were addressed by actions in the Habitat and Living Resources chapter of the CCMP. It was decided by the natural resources subcommittee (NRSC) that this document will be included as an Appendix to the Characterization Report of the Living Resources.

GENERAL THREATS AND ASSOCIATED IMPACTS

Our first goal was to extract all of the threats to the living resources in the Peconic Estuary that were identified in the Characterization report. We then listed the impacts that are "generally" associated with each threat in a matrix (Table 1). The major impacts associated with these threats fell into seven categories that were consistent with the impacts found in the Habitat chapter. However, this is not an exhaustive list of impacts that can result from each threat. It is also important to note that the impacts associated with each threat were not necessarily derived from studies in the Peconic Estuary. The impacts, however, are known to result from threats observed and studied elsewhere (e.g. Newell et al. 1998: dredge impacts). Additionally, many of the impacts in Table 1 have not yet been studied, or are not fully understood. We coded these *potential* impacts with a "P" (Table 1).

Table 1 should therefore, be viewed as an inventory list of identified threats to the living resources in the Peconic Estuary and the impacts that typically result from them. Table 1 does not reflect the extent or magnitude of the impacts to any particular habitat or species. An example of how to interpret Table 1 follows: navigation dredging has been identified as a threat to the living resources in the Peconic Estuary because it is known to cause a loss of benthic habitat, has the *potential* to reduce population abundance and recruitment of certain organisms (e.g. clams, worms), creates physical disturbances to the system, reduces water quality (e.g. turbidity plumes, resuspension of toxins) and has the *potential* to reduce food availability.

Table 1. Direct threats to the living resources of the Peconic Estuary and their resulting impacts. Asterik (*) denotes that these are observed or known impacts resulting from the threat, while a "P" indicates potential impacts that are not fully understood.

Threats	**Impacts**						
	Habitat loss & degradation	Reduced population abundance	Reduced recruitment of organisms	Physical disturbance	Alteration of genetic stock	Reduces Water Quality	Reduced food availability
Navigational dredging & spoil disposal	*	**P**	**P**	*		*	**P**
Shellfish dredging	*	*	**P**	*		*	*
Wasting disease	*	*			*		*
Brown tide	*	*	**P**	*	*	*	*
Codium & other invasive non-native sp.	*	*	**P**		**P**	**P**	*
Development	*	*	*	*		*	*
Water clarity (turbidity)	*	*	**P**	*		*	*
Excess nutrients	*	*	**P**			*	*
Shoreline hardening	*	**P**	**P**	*		**P**	*
Phragmites	*	*	*				*
(Over)harvesting fish		*	*		*		*
(Over) harvesting shellfish		*	*		*		*
Boating	*	**P**		*		*	
ORVs	*	*		*			
Beach use	*	**P**	**P**	*			
Predation imbalance		*			*		*
Aquaculture: Finfish	*			**P**	**P**	*	**P**
Aquaculture: Shellfish	**P**			**P**	**P**		**P**
Artificial reefs	**P**	**P**	**P**	*			**P**
Toxic contamination	*	*	*		**P**	*	*
Marinas, docks & mooring areas	*	*	*	*		*	
Tidal flow Obstruction	*	*	*	*		*	**P**
Mosquito control	*	**P**	**P**	*		**P**	
Sea level rise	*	**P**	**P**	*			
Marine debris	*			*			

CONSEQUENCES OF THREATS TO LIVING RESOURCES

While Table 1 provides an inventory of the threats to the living resources in the Peconic Estuary and their associated impacts, it is also important to consider how these impacts affect the different types of living resources in the Peconic Estuary. Table 2 gives examples of consequences that can result from the impacts, or "Stressors", on particular habitats and species ("Targets"). Although the list of "Targets" in Table 2 is not exhaustive, it covers a range of living resources that are of interest to the NRSC and can easily be applied to other species and habitats as needed. As previously mentioned, many of the threats and their consequences have not been studied in the Peconic Estuary. Therefore, we relied on examples from the literature and personal observations to determine the expected effects, or consequences on some of the targets in Table 2. An example from Table 2 follows: saltmarshes can be stressed from direct losses and degradation (e.g. filling, reduced connectivity with tidal flow), which has the consequences of reducing primary productivity, decreasing buffer zones for wildlife and lowering nutrient-uptake from runoff.

Table 2. Examples of consequences from different stressors on particular targets

TARGETS	STRESSORS	CONSEQUENCES/EFFECTS OF STRESS
Interconnected land and seascape	Habitat loss & degradation	•Loss of interconnectedness between land and sea environments •Loss of buffer & land/sea gradation
Beach & dunes	Habitat loss & degradation	•Reduced nesting habitat for piping plovers and terns •Reduced suitable habitat for sea beach knotweed •Less egg-laying habitat for horseshoe crabs and other wildlife •Reduced ability to withstand storms, reduced erosion and flood protection
Saltmarsh, tidal creek & sand/mudflat complex	Loss & degradation of saltmarsh	•Reduction in primary productivity and detrital-based energy •Loss of buffer leading to greater impact to land from storms & increased runoff to bays •Reduction in nonpoint source nutrient uptake •Loss & degradation of spawning, breeding & feeding habitat for shellfish, invertebrates, finfish, diamond-backed terrapins, shorebirds and mammals •Reduced vigor and ability to withstand storms •Loss of rare plants (saltmarsh loosestrife, swamp sunflower, saltmarsh bulrush)
	Alteration of tidal creeks	•Loss of spawning and nursery habitat for a variety of marine organisms •Loss of shorebird and terrapin nesting habitat
	Loss of mud/sandflats	•Loss of feeding habitat for shellfish and other invertebrates, wading and shorebirds
Eelgrass	Habitat loss & degradation	•Increased suspended sediment and reduced storm/flood protection to coastline •Loss of shelter & feeding habitat for bivalves, crabs & other invertebrates, sea turtles, finfish •Loss of spawning and nursery areas for juvenile bay scallops and other bivalves, grass shrimp and other invertebrates, Atlantic silversides and other finfish •Loss of feeding habitat for diamond-backed terrapins & shorebirds •Reduction of detrital-based energy •Conversion of eelgrass beds to macroalgae (including *Codium*?)
Forage fish	Reduced forage	•Decreased food availability for predatory fish and birds

Table 2. Examples of consequences from different stressors on particular targets (continued)

TARGETS	STRESSORS	CONSEQUENCES/EFFECTS OF STRESS
Commercial & recreational fish	Poor recruitment of winter flounder, scup & weakfish	•Decreased commercial & recreational landings
	Low levels of spawning stock of winter flounder, scup & weakfish	•Reduced recruitment, reduced genetic diversity and shift in community structure •Changes in trophic dynamics
Piping plovers & least terns	High level of physical disturbance	•Mortality of plover and tern adults and chicks •Reduced nesting & feeding of plovers and terns leading to reduced productivity
	Habitat loss & degradation	•Fragmentation of large tern colonies which reduces their ability to repel predators •Reduced nesting & feeding of plovers and terns leading to reduced productivity
Sea turtles	Physical disturbance	•Sublethal and lethal harm
Bay scallops	Habitat loss and degradation	•Increased mortality and reduced recruitment
	Alteration of genetic stock	•Less able to withstand temporary, localized disturbances. Increased susceptibility to diseases?
	Poor water quality	•Reduction in stock abundance and quality
Osprey	Loss and degradation of available food	•Reduced productivity •Mortality of chicks

SUMMARY TABLE OF THREATS TO PECONIC ESTUARY LIVING RESOURCES

The previous two tables provided a list of the threats, the general impacts associated with them and some expected consequences to the living resources in the Peconic Estuary. We decided to provide a more comprehensive table of the identified threats with respect to the different habitats and living resources in the Peconic Estuary. Table 3 was developed with the intention of assessing threats that are known to be impacting, or have the potential to impact the living resources within the Peconic Estuary as identified within the Characterization report.

The threats listed in Table 3 are the same as those in Table 1, except that we added the following threat: domestic animals/pets. We included a wide range of habitat complexes and living resources in the Peconic watershed, including those of particular interest to the NRSC. Several of the living resources of particular interest to the NRSC, however, were not specifically discussed as a category in the Characterization report and they required special coding[1]. These were: connectivity of land/sea, tidal creeks, sand/mudflat complexes and bay scallops. We coded each cell in the table with one of the following:

I= Identified as a known threat within the Characterization report that is impacting the living resources in the Peconic Estuary.

P= Potential threat to living resources (limited evidence/data) of which impacts are known from other study areas, but not directly documented for the Peconic Estuary.

Empty= The resource is assumed to be unaffected by this threat.

Finally, we used Table 3 as a means to determine if the identified and potential threats to each living resource were addressed by an action plan in the Habitat chapter. If an action was addressed within the Habitat chapter, the matrix cell was shaded in Table 3. If an action was addressed within a chapter other than the Habitat chapter, the matrix cell was shaded diagonally.

CONCLUSIONS

This report has summarized the threats and impacts to the living resources of the Peconic Estuary that were discussed in greater detail within the Characterization report and Habitat chapter of the CCMP. Although the analysis of threats was not quantitative it provides us with a concise and comprehensive overview of the threats and the impacts to the living resources in the Peconic watershed. Unfortunately, we were unable to rank the magnitudes or extent of the impacts due to the lack of studies in the Peconic Estuary. Additional investigations and monitoring that determine the extent of these threats would be of great value to the PEP, particularly since the watershed is experiencing rapid increases in growth and development. Studies should be quantitative to provide "baseline" information for analyzing long-term status and trends of the resources, and to determine the successes of implemented CCMP actions.

This report has also identified which of the threats to the living resources in the estuary have been addressed by management actions in the Habitat and Living Resources chapter. Many of the actions in the Habitat chapter are intended to reduce and eliminate the threats and to protect, restore and enhance the impacted resources. Clearly, the threats that have not been covered in the Habitat chapter or by other chapters should be examined for future consideration as new actions. Additionally, those threats classified as "*potential*" warrant further research and monitoring to determine if they are having a significant impact on the living resources.

Finally, this report has also indicated the paucity of studies that directly examined the threats and the extent of impacts to the living resources in the Peconic Estuary. The tables also provide a quick reference to areas that require further investigation. For example, in Table 3, although shoreline-hardening

structures are distributed throughout the estuary, their extent and impacts to the habitats and living resources the Peconic Estuary remains unknown. It is also important to recognize that each threat on its own may not be causing a noticeable impact to the resource, but the combination of various stressors or their interactions may be adversely affecting them. Additionally, sub-lethal effects to organisms from threats at "low" or "background" levels (e.g. low concentrations of oil, toxins, brown-tide) may also be reducing the overall health of the ecosystem over time. Such effects can further be confounded or go undetected because they often target the early life history stages of organisms that are not commonly monitored such as: eggs and larvae. In support of this, recent studies of marine fish eggs and larvae exposed to extremely low concentrations of crude oil yielded significant effects on their behaviors and development, which ultimately decreased their overall survival. We must also be prepared for new and unexpected threats to living resources within the estuary. This is perhaps best exemplified by the appearance of the brown-tide algae, which can be argued as a major impetus for establishing the Peconic Estuary Program.

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[1]The following habitats and living resources were included in Table 3, but were not specifically categorized or discussed in the Characterization report: a) connectivity of land and sea, b) tidal creeks, c) sand/mudflat complex and d) bay scallops They were included in this chart since they are of special concern to the PEP and we handled the coding (i.e. "*I*" or "*P*") as follows:

a) Impacts from the threats to Connectivity of Land and Sea category were equated with those of Beach and Dunes since beaches and dunes are a connection between the land and sea. Therefore, threats assigned to beaches and dunes were also assigned to the Connectivity of Land and Sea category, unless specified otherwise in the Characterization report.
b) We treated Tidal Creeks as a having impacts associated with both the benthos (e.g. tide creek beds) and salt marsh (e.g. fringe marsh) habitats and therefore, they received similar impact codes as these two habitats. If the codes were different between the two categories for a particular threat (e.g. an "*I*" for benthos and a "*P*" for salt marsh) we would use our best judgement to decide which code to assign for that particular threat category. This happened in only three cases.
c) Impacts from threats to the Sand/Mudflat complex were treated as the Benthos habitat and therefore, were equated with them for coding.
d) Bay scallops are expected to experience similar impacts from threats to Suspension Feeders and, therefore, were equated with them.

REFERENCES

Bortman, M. and N. Niedowski (1998) Characterization report of the living resources of the Peconic Estuary. Peconic Estuary Program Office, SCDHS.

Newell, R.C., Seiderer L.J. and D.R. Hitchcock (1998) The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. Ocean. and Mar. Biol.: Annual Review: 36: 127 178

Table 3. Summary table of threats listed within the Characterization of Living Resources Report.

Direct Threats	Habitat								Living Resources									
	Connectivity of Land and Sea	Beach & dunes	Saltmarsh	Tidal creeks	Sand/mudflat complex	Eelgrass Beds	Upland /Terrestrial	Freshwater Wetlands & River	Finfish & Forage Fish	Shorebirds (plovers, terns)	Waterfowl & other birds	Diamondback terrapins	Sea turtles	Plankton	Benthos	Suspension feeding organisms (bay scallops, clams, etc.)	Bay scallops	Marine mammals
Navigational dredging &/or spoil disposal	P	P	I	I	I	P	P	P	P	P	P		P		I	I	P	
Shellfish dredging			P	P	P	I			P		P				I	P	P	
Wasting disease						P											P	
Brown tide				P	P	I			P		P			P	I	I	I	
INVASIVE SPECIES		P	I	I		P	I	I							I	P		
Development	I	I	I	I	P		I	I		P	I	I			I	P	P	
Excess turbidity						I		P	P	P				I	I	P	I	
Excess nutrients			I	I	P	P		I	P				P	I	I	P	P	
Shoreline hardening	I	I	P	P	P				P			I	P		P			
(Over)harvesting fish				P				P	I	P			P		P			P
(Over)harvesting shellfish			I	P	I	P			P						I	P	P	
Boating			P	P	P	P		P	P	P	P	P	I		P	P		P
ORVs	P	I					P			P		P	P					
Beach use										P		P						
Predation imbalance				P	P	P	P	P	P	I	P		P	P	P	P	P	P
Aquaculture: Shellfish				P	P						P		P					
Aquaculture: Finfish				P	P	P			P		P		P	P	P	P	P	P
Artificial reefs						P			P		P		P		P	P	P	P
Toxic contamination			P	I	I			I	P	P	I				P	P	P	

Table 3. Summary table of threats listed within the Characterization of Living Resources Report (continued).

Direct Threats	Habitat								Living Resources									
	Connectivity of Land and Sea	Beach & dunes	Saltmarsh	Tidal creeks	Sand/mudflat complex	Eelgrass Beds	Upland /Terrestrial	Freshwater Wetlands & River	Finfish & Forage Fish	Shorebirds (plovers, terns)	Waterfowl & other birds	Diamondback terrapins	Sea turtles	Plankton	Benthos	Suspension feeding organisms (bay scallops, clams, etc.)	Bay scallops	Marine mammals
Marinas, docks & moorings	P	P	I	I	I	P									I	P	P	
Tidal flow /Hydrologic Obstructions			I	I	I			I	I							P		
Mosquito control			I	I	I										I	P		
Oil spills: Catastrophic	P	P	P	P	P	P			P	P	P	P	P	P	P	P	P	P
Marine debris		P		P						P	P	P						P
Domestic Animals/Pets				P			I			P		P						

I: Identified as a known threat within the "Characterization of Living Resources" report for the Peconic Estuary, **P**: Potential threat to Peconic living resources (i.e. limited evidence/data), of which the impacts are known from studies in other areas. **Light Shading** : Indicates that a CCMP Management action has been desi in the Habitat & Living Resources Module**.** **Dark Shading**: Indicates that a CCMP Management action has been designated in a chapter other than the Habitat & Living Resources Module.

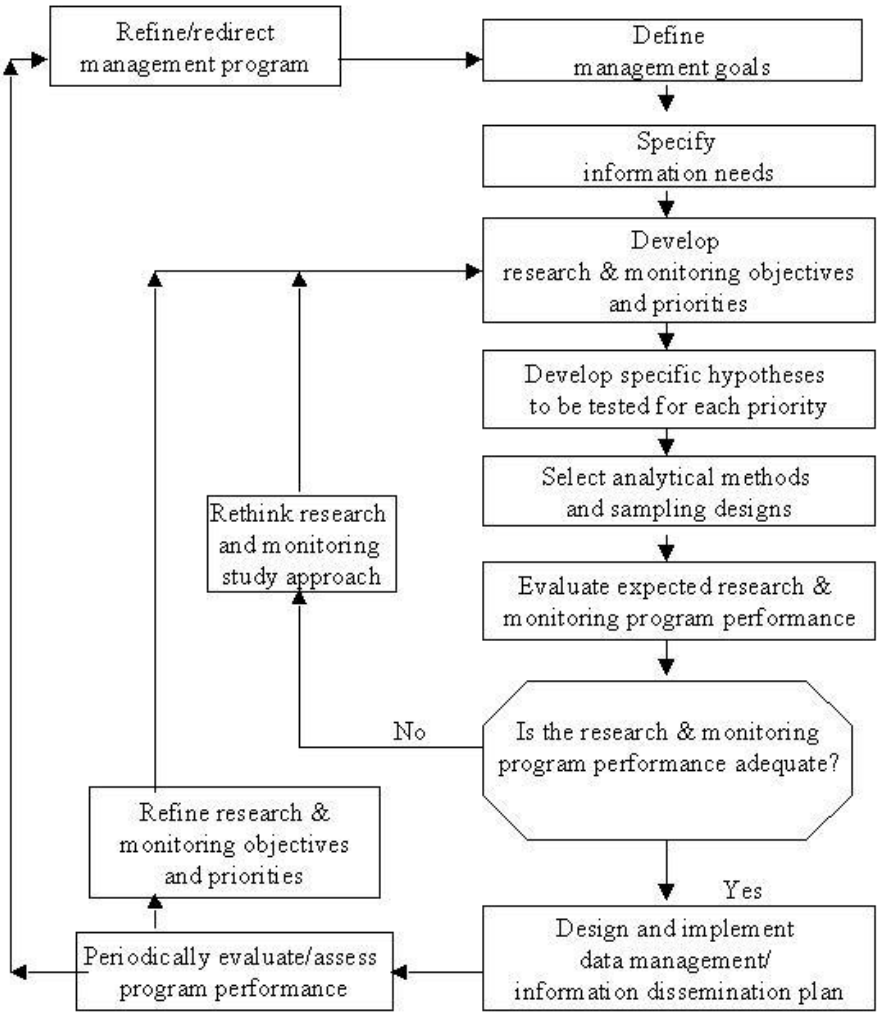
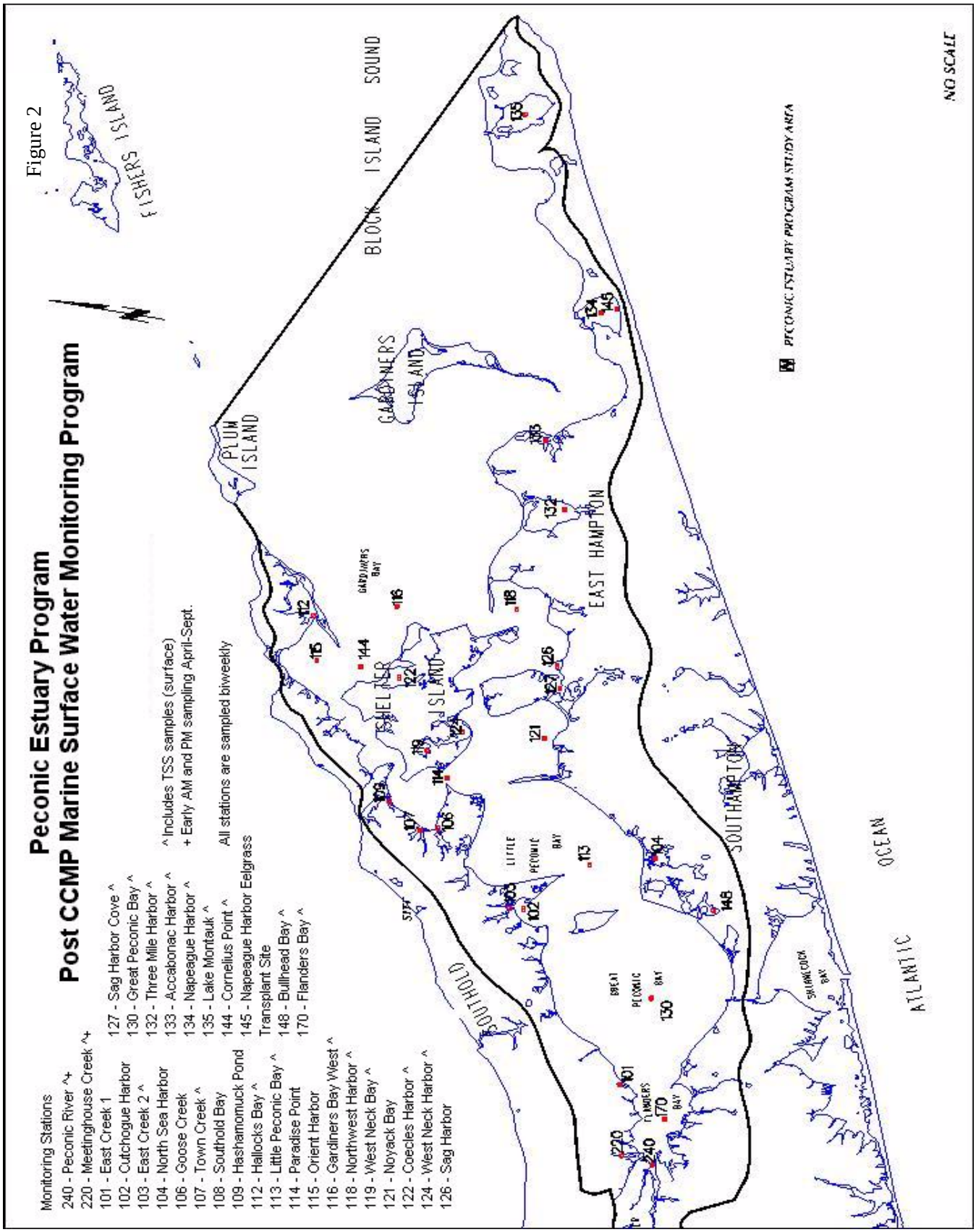


Figure 1. Schematic of Living Resources Research and Monitoring program design. Modified from the Galveston Bay National Estuary Program (1994).

Figure 2


Peconic Estuary Program
Post CCMP Marine Surface Water Monitoring Program
Monitoring Stations
240 - Peconic River ^+
220 - Meetinghouse Creek ^+
101 - East Creek 1
102 - Cutchogue Harbor
103 - East Creek 2 ^
104 - North Sea Harbor
106 - Goose Creek
107 - Town Creek ^
108 - Southold Bay
109 - Hashamomuck Pond
112 - Hallocks Bay ^
113 - Little Peconic Bay ^
114 - Paradise Point
115 - Orient Harbor
116 - Gardiners Bay West ^
118 - Northwest Harbor ^
119 - West Neck Bay ^
121 - Noyack Bay
122 - Coecles Harbor ^
124 - West Neck Harbor ^
126 - Sag Harbor
127 - Sag Harbor Cove ^
130 - Great Peconic Bay ^
132 - Three Mile Harbor ^
133 - Accabonac Harbor ^
134 - Napeague Harbor ^
135 - Lake Montauk ^
144 - Cornelius Point ^
145 - Napeague Harbor Eelgrass Transplant Site
148 - Bullhead Bay ^
170 - Flanders Bay ^
^ Includes TSS samples (surface)
+ Early AM and PM sampling April-Sept.
All stations are sampled biweekly
PLUM ISLAND
GARDINERS ISLAND
FISHERS ISLAND
BLOCK ISLAND SOUND
EAST HAMPTON
SOUTHAMPTON
SOUTHOLD
ATLANTIC OCEAN
PECONIC ESTUARY PROGRAM STUDY AREA
NO SCALE

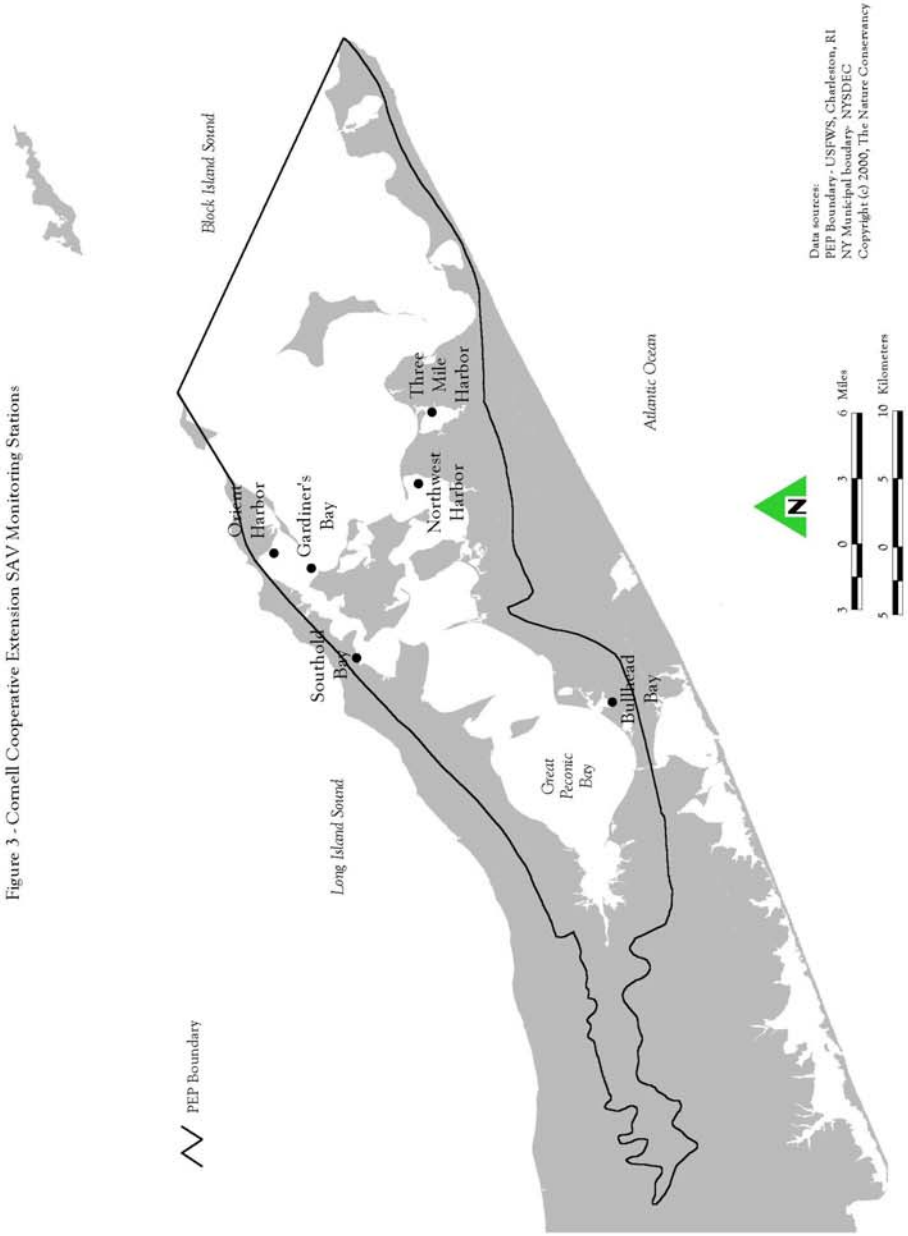


Figure 3 - Cornell Cooperative Extension SAV Monitoring Stations

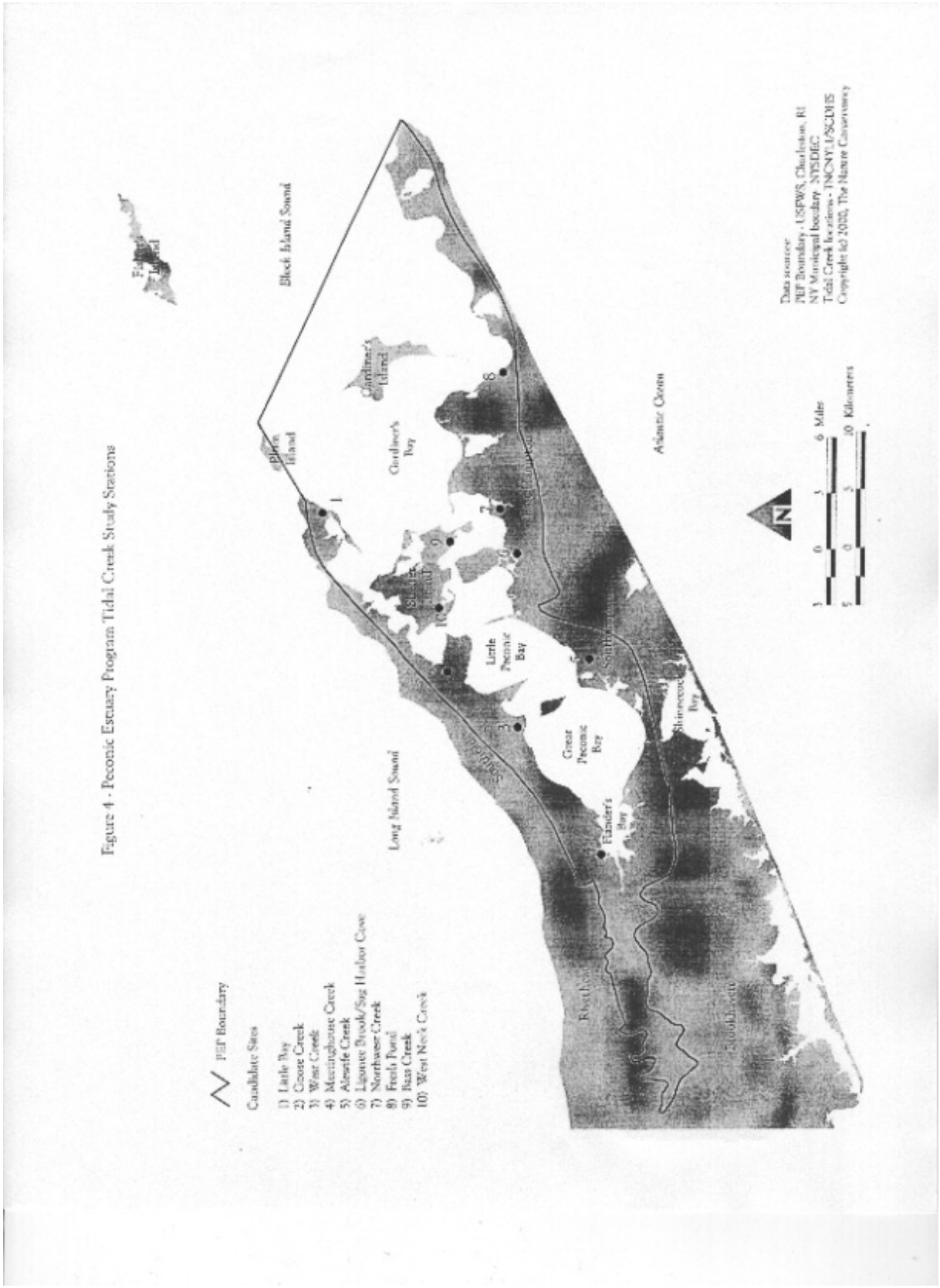


Figure 4 - Peconic Estuary Program Tidal Creek Study Stations

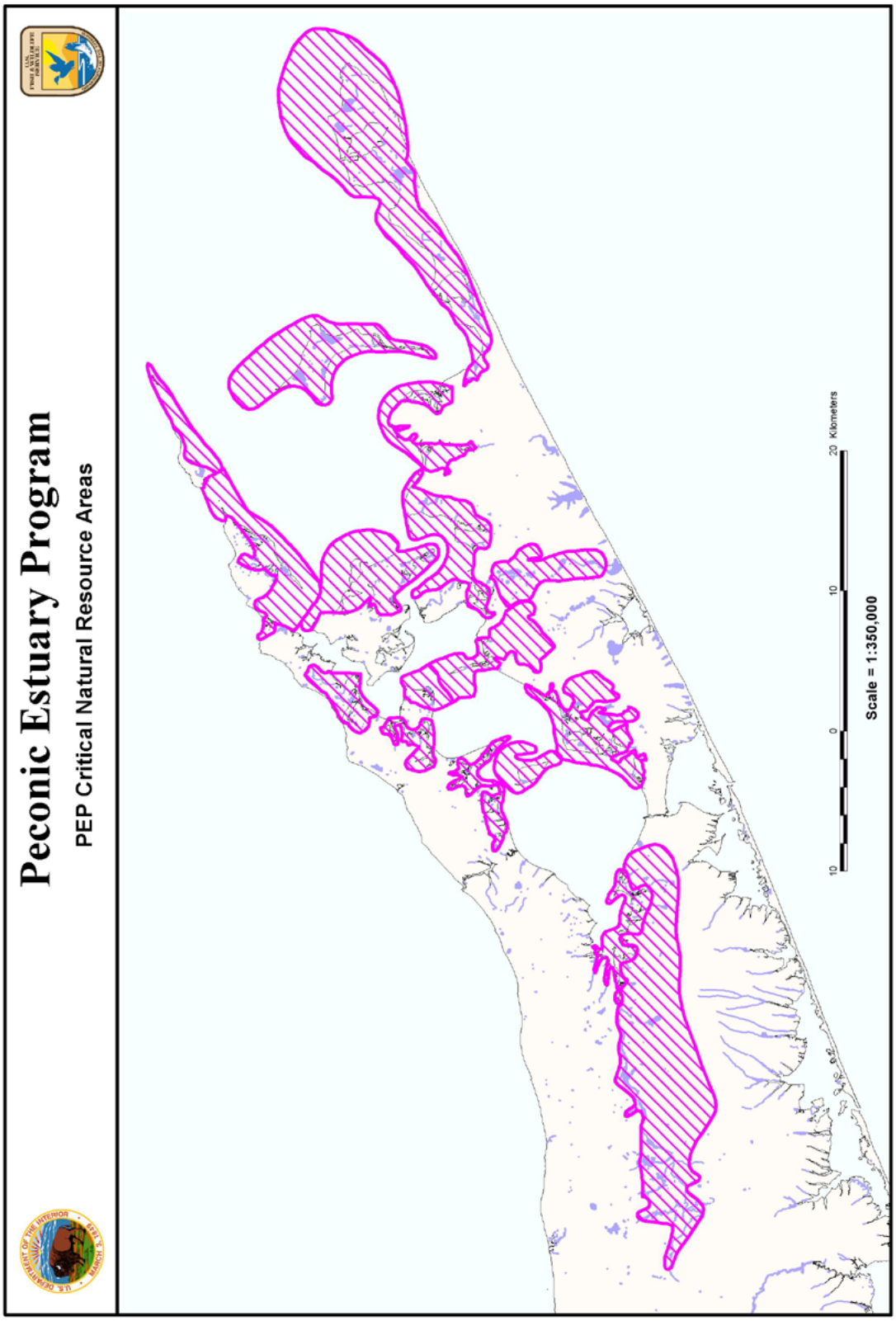


Figure 5. PEP Critical Natural Resource Areas