CHAPTER TWO

BROWN TIDE MANAGEMENT PLAN

OBJECTIVES

- 1) Determine the chemical, physical and biological factors responsible for producing, sustaining and ending blooms of the Brown Tide organism, *Aureococcus anophagefferens*.
- 2) Determine what management actions can be undertaken to prevent or, if that is not possible, to mitigate the effects of recurrent Brown Tide blooms on the ecosystem and economy of the Peconics.



MEASURABLE GOALS

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, frequency of updating the Brown Tide Workplan and coordinations within the Brown Tide Steering Committee). [See Action B-1]
- 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 Department of Health Services conducts biweekly monitoring at 32 stations in the Peconic Estuary throughout the year, resulting in over 830 samples taken annually. [See Action B-1]

Measurable goals related to natural resources are found in the Habitat and Living Resources Chapter (**Chapter 4**).



INTRODUCTION

Brown Tide is a marine microalgal bloom. Microalgae, or phytoplankton, are microscopic, single-cell plants that are found in all natural freshwater and marine ecosystems. The Brown Tide has appeared in Long Island's Peconic and South Shore Estuaries (see **Figure 2-1**) as well as in Narragansett Bay, Rhode Island, Barnegat Bay, New Jersey, the Delaware Inland Bays, the Maryland Coastal Bays, and in South Africa.

When present in large numbers, the Brown Tide organism literally turns the usually clear blue-green waters of the Peconic Bays a deep brown. At concentrations above 200,000 to 250,000 algal cells per milliliter (ml), water transparency drops to two feet or less. The brown waters are unappealing to swimmers and fishermen, impacting residents, tourists, and the sportfishing industry. An even greater impact of the Brown Tide organism is its impact on natural resources. Although the Brown Tide is not known to be harmful to humans, either through direct contact, ingestion of Brown Tide-filled waters, or through the ingestion of finfish or shellfish harvested from affected waters, the Brown Tide organism has had deadly effects on at least one marine organism, the bay scallop.

The abundant Peconic bay scallop population was virtually eradicated by the onset of the Brown Tide. The reasons for the severe impact of the Brown Tide on the bay scallop are not well understood. The devastating effects on the scallops may be related to toxic, mechanical (*i.e.*, the small size of the Brown Tide organism may interfere with proper ingestion) and/or nutritional (*i.e.*, the Brown Tide organism may not provide required nutrients) parameters, and effects may vary with the growth stage (larval, juvenile, adult) of the scallop.

Other impacts of the Brown Tide potentially include declines in eelgrass coverage and hard clam populations. Eelgrass beds provide important shellfish and finfish spawning and nursery areas.

Impacts to eelgrass may be due in part to reduced light penetration caused by the Brown Tide bloom density. Sharp declines in finfish landings between 1985 and 1988 also may have been due, in part, to the Brown Tide. Finally, harmful algal blooms such as Brown Tide are also believed to be a causal factor for anoxia/hypoxia (no or little dissolved oxygen), and may affect the hatching and survivorship of fish larvae.

The overall economic impacts of the Brown Tide have been severe, for the scallop industry as well as other bay-related businesses dependent on tourism, recreation, fishing, and shellfishing. Scientists are still working to try and understand what causes the Brown Tide blooms, how future blooms can be prevented, and how the impacts of the Brown Tide blooms can be mitigated.

In 1982, the 500,000 pound Peconic Estuary scallop harvest accounted for 28 percent of all U.S. landings and had a dockside value of \$1.8 million. After appearing in the Peconic Estuary in June of 1985, and persisting in high, though decreasing, concentrations for extended periods in 1985, 1986, 1987, and 1988, the Brown Tide bloom virtually eliminated the bay scallop population. By 1987 and 1988, the Brown Tide harvest had dropped to only about 300 pounds per year (see Figure 2-2). As a result of re-seeding efforts and the disappearance of the Brown Tide, bay scallop landings once again reached pre-Brown Tide levels in 1994. Based on NYSDEC data, 266,448 pounds of scallops worth \$1,732,357 were harvested in 1994; however, a Brown Tide bloom in 1995 caused severe scallop mortality. The 1995 scallop harvest dropped to 23,000 pounds, valued at \$180,000. The 1996 scallop landings came in at only 53 pounds, valued at \$400.



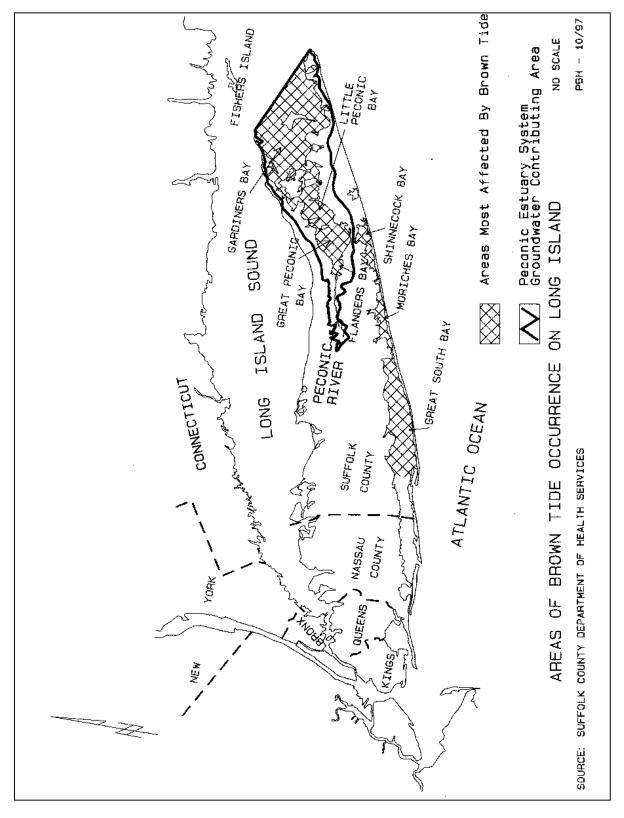


Figure 2-1. Areas of Brown Tide Occurrence on Long Island.

CHAPTER TWO



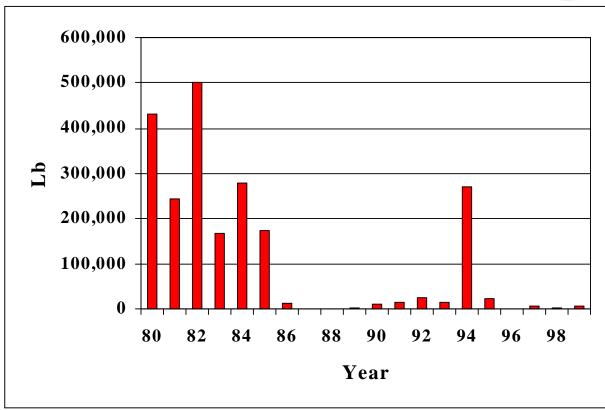


Figure 2-2. Bay Scallop Landings.

The Brown Tide Organism

The Brown Tide was first detected in the Peconic Estuary in June of 1985. Researchers at the University of Rhode Island's Graduate School of Oceanography, using electron microscopy, determined that the Brown Tide is caused by a particularly small and previously unknown phytoplankton species, *Aureococcus anophagefferens* (see **Figure 2-3**). The Brown Tide organism is only problematic when under "bloom" conditions. Phytoplankton communities in temperate coastal waters display a seasonal cycle of abundance and species composition. An algal bloom occurs when accelerated growth of one or a few species is superimposed on this overall community cycle due to a particular concurrence of environmental conditions that strongly favors the growth of a particular species. Most blooms are of relatively limited spatial and temporal extent (McElroy, 1996), but the Brown Tide can persist for unusually long periods of time over large areas (Sieburth *et al.*, 1988). The Brown Tide appears and recedes in the bays of the Peconic Estuary and around Long Island, with no predictable onset, duration, or cessation.



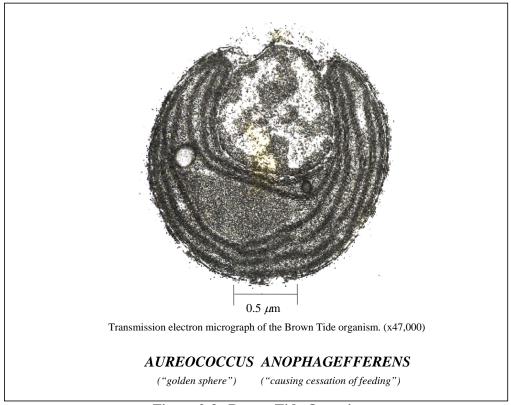


Figure 2-3. Brown Tide Organism.

BROWN TIDE BLOOMS IN THE PECONIC ESTUARY SYSTEM

After its initial discovery in the Peconic Estuary in June of 1985, the Brown Tide bloom persisted in high, though decreasing, concentrations for extended periods in 1985, 1986, 1987, and 1988. Peak Brown Tide cell counts in the Peconics often exceeded one million cells per milliliter of water, as compared with a normal, mixed phytoplankton assemblage concentration which would typically range from 100 to 100,000 cells per milliliter.

Brown Tide blooms were not evident during 1989. In July of 1990, however, elevated Brown Tide cell counts were observed in West Neck Bay, an enclosed embayment off Shelter Island. Another intense bloom of Brown Tide began in the Peconic Estuary System in May 1991 and persisted in high concentrations through July 1991. In the summer of 1992, Brown Tide reappeared in high concentrations in West Neck Bay and Coecles Harbor, subsiding in the fall of 1992. The Brown Tide did not appear again in the Peconic Estuary until May of 1995, when an intense bloom lasted through June and July, declined in August, became more intense, and then again subsided in September. In 1996, the Peconic Estuary was free of Brown Tide blooms, although a bloom occurred in the South Shore Estuary. Only one localized and short-term Brown Tide bloom occurred in the Peconic Estuary in 1997, in West Neck Bay, but a more widespread bloom occurred in Great South Bay in the South Shore Estuary Reserve System that year. In 1998, there was a summer bloom in West Neck Bay and Great South Bay, with no major Peconic Estuary blooms. In 1999, a major late fall/early winter



bloom took place in Great South Bay, and an early summer bloom occurred in Quantuck Bay, with no major blooms anywhere in the Peconics. The Great South Bay bloom continued into the summer of 2000, while the Peconics remained free of Brown Tide in 2000.

The dynamics of the Brown Tide bloom (*i.e.*, concentration and timing of onset, persistence, and subsidence) in the main Peconic Estuary System have often radically differed from those in West Neck Bay and the South Shore Estuary Reserve System. In general, bloom conditions have been consistently most severe in Flanders and West Neck Bays. Peak Flanders Bay Brown Tide cell counts are shown in **Figure 2-4**.

The Brown Tide organism has been observed in small numbers (non-bloom conditions) from Massachusetts to New Jersey. Outside of Long Island, Brown Tide blooms have been observed in Narragansett Bay, Rhode Island, Barnegat Bay, New Jersey, the Delaware Inland Bays, the Maryland Coastal Bays, and in South Africa.

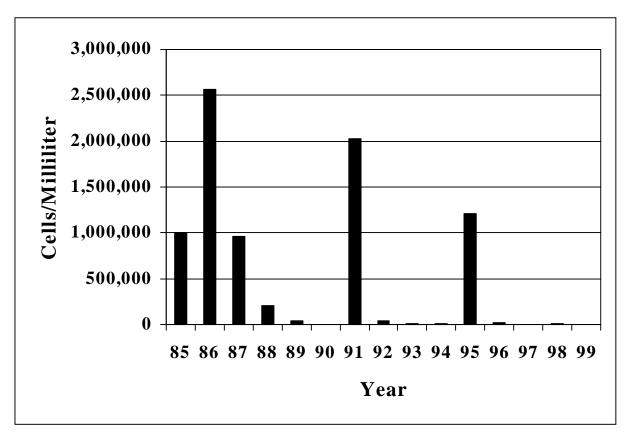


Figure 2-4. Flanders Bay Peak Brown Tide Cell Counts.



Contributing Factors

Although advances have been made regarding the identification and characterization of the Brown Tide organism and its growth needs, the causes of Brown Tide are not known. The input of conventional inorganic macronutrients such as nitrogen and phosphorus apparently do not trigger the onset of the Brown Tide blooms, although organic nitrogen may play a role (discussed below). This conclusion is based on laboratory research, comparative monitoring data (historical trends within Peconic Estuary, as well as a comparison of Peconic Estuary to other estuaries), and statistical analysis. More recent analysis of the long-term data set collected by the Suffolk County Department of Health Services (SCDHS) suggests that groundwater inputs (related to rainfall patterns) affect the relative amounts of dissolved inorganic and organic nitrogen in the waters of the Peconic Estuary, and that this may be an important factor in the onset of Brown Tide blooms. Various constituents and situations believed to play a role in Brown Tide blooms are discussed below.

Chemicals and Trace Metals

Chemicals implicated by prior research as potential contributors to the Brown Tide's pervasiveness include chelators (molecules or ions that are able to form bonds with metals) such as citric acid and trace metals such as iron, selenium, vanadate, arsenate and boron. A correlation has been noted between the Brown Tide bloom and elevated concentrations of dimethyl sulfide (DMS) in the Peconic Estuary. Because acrylic acid is part of the compound, which forms DMS, it is postulated that acrylic acid also is directly related to the Brown Tide. These, or perhaps some other as yet unidentified chemicals, may be toxic to potential grazers that might otherwise control phytoplankton blooms.

Meteorological and Climatological Factors

Water circulation in certain areas of the estuary is strongly influenced by winds. It has been postulated that reduced flushing in the Peconics due to a reduction or change in wind patterns results in a retention of land-derived nutrients that may stimulate Brown Tide blooms.

Dissolved Inorganic and Organic Nitrogen

In terms of using actual field data, perhaps the most plausible hypothesis set forth to date has been produced by Brookhaven National Laboratory (BNL), using SCDHS data. BNL hypothesizes that Brown Tide bloom onset conditions may be optimized by elevated ratios of available dissolved organic nitrogen (high "DON") in surface waters, with respect to the supply of dissolved inorganic nitrogen (low "DIN"). These nitrogen constituents may, in turn, be related to groundwater inputs and weather patterns. Thus, the hypothesis is that Brown Tide bloom onset conditions could be optimized in a dry year (low DIN supply from groundwater), particularly when the dry year is preceded by a wet year (which results in conversion of prior groundwater DIN inputs to current DON supply). A long-term management implication of the BNL hypothesis, should it be validated, is to reduce nitrogen loadings (septic systems, fertilizers, etc.; see **Chapter 3**) to dampen the effect of groundwater nitrogen inputs.

In an independent analysis, the U.S. Geological Survey (USGS) lent further credibility to the hypothesis in a study of relative water table altitudes. The USGS found that, between 1985 and 1995, Brown Tide blooms coincided with below-average water table altitudes in the Peconic Estuary study area. During four years with nearly average or above-average water table altitudes, there were no widespread Brown Tide blooms.



Other Factors

Monitoring data collected by Suffolk County since 1985 suggest physio-chemical limits for Brown Tide bloom events. It appears that salinities in excess of 26 parts per thousand (ppt) and temperatures between 20-25 degrees Centigrade are factors associated with the occurrence of major bloom events.

These limits are consistent with the findings for optimal growth of *A. anophagefferens* in laboratory cultures, but are not believed to be sufficient causal mechanisms in and of themselves. Finally, a virus, which has been shown to be associated with the Brown Tide organism, is suspected to be important in ending blooms.

The CCMP discussion about Brown Tide represents a sketch of various historical theories and investigations. The state of knowledge about Brown Tide is advancing at a rapid rate, and would be impossible to fully capture in a document such as this CCMP. Therefore, persons interested in obtaining updates about Brown Tide research are encouraged to contact New York Sea Grant to obtain bulletins summarizing

Ongoing Brown Tide research is being funded with an initial \$1.5 million commitment from NOAA (over three years), \$100,000 in BNL services, and \$100,000 in Suffolk County funds to be used in conjunction with the BNL funds. Suffolk County appropriated an additional \$450,000 (over three years) in Brown Tide research capital funds, and is considering additional appropriations. Historic Brown Tide research has been funded primarily by Suffolk County and the New York Sea Grant Institute. An additional \$1.5M over three years for Brown Tide research recently has been committed by NOAA. Appendix E contains a summary of funded projects.

the most current results of Brown Tide Research Initiative investigations (discussed below). Also, the Suffolk County Department of Health Services may be contacted to obtain copies of the latest summaries and status reports of Suffolk County-funded Brown Tide research.

Public Comments

Questions have been raised about the possible relationship between radionuclides, toxics, and Brown Tide. The issue of radionuclide and toxic contamination, and Brookhaven National Laboratory, is dealt with in detail in **Chapter 6**. With respect to Brown Tide, to the knowledge of the PEP, the scientific community has, to date, not produced a credible theory that links Brookhaven National Lab's radionuclide contamination and Brown Tide. This is based on several factors, including the appearance of the Brown Tide in several locations (not just the Peconic Estuary) dating back to 1985. Also, there has been a recent global increase in harmful algal blooms. Moreover, there does not appear to be a hypothesis, which offers a mechanism by which relatively low-level radioactive contamination can result in onset or persistence of Brown Tide.

More important than the specific issue, however, is the PEP approach to dealing with the matter. With the assistance of the New York Sea Grant, the PEP has submitted queries to Brown Tide Research Initiative researchers about whether the onset and/or persistence of the Brown Tide may be related to, or caused by, radioactive and/or toxic chemical contamination associated with BNL. The researchers, who are closest to the latest findings about Brown Tide, were asked to offer commentary on the viability of this hypothesis, citing the nature of the basis of their response (personal knowledge of relevant studies, personal expert opinion based on well-established scientific principles, discussions with third parties, etc.). Also, they were asked to provide guidance on elements of a recommended research and/or monitoring program to test it. They were also asked similar questions about other issues posed by the public, including a theory that a relatively low supply of dissolved inorganic nitrogen may be causing the Brown Tide; the corollary to that hypothesis is that human DIN enrichment of surface waters (*e.g.*, direct applications of nitrogen) could prevent or minimize Brown Tides. This issue is discussed in greater detail in **Chapter 3**.



Other external experts were also identified to respond to the questions about radionuclides. Via this active process of soliciting input from experts, coupled with periodic updates to the Brown Tide Workplan by the Brown Tide Steering Committee (discussed below), the PEP is able to actively respond to public concerns on a continuing basis.

RESEARCH EFFORTS

Since the first appearance of the Brown Tide in 1985, significant effort has gone into researching the causal mechanisms behind the appearance and persistence of the Brown Tide. Numerous agencies and organizations from New York, as well as Rhode Island and New Jersey, have become involved in Brown Tide research.

To refine the research agenda, the PEP, in cooperation with the New York Sea Grant Institute and the State University of New York at Stony Brook's Marine Sciences Research Center, hosted a Brown Tide Summit in October 1995, with local, national, and international experts meeting to develop a comprehensive research agenda. The Summit resulted in both recommendations for the direction of future research and commitments for funding. BNL and Suffolk County announced the formation of the Brown Tide Monitoring Network, funded with \$100,000 in Suffolk County funds with a matching amount from BNL. NOAA announced that \$1.5 million, over three years, would be used for funding the Brown Tide Research Initiative (BTRI). Finally, a Brown Tide Steering Committee was proposed by various Federal, State, and local representatives to more broadly coordinate and guide Brown Tide research and monitoring efforts. The proceedings of the Summit were published in January 1996 as a New York Sea Grant publication (No. NYSGI-W-95-001). An additional \$1.5 million over three years has been committed by NOAA to pursue the most promising avenues of Brown Tide research and management.

Brown Tide Monitoring Network

The Brown Tide Monitoring Network is a research effort funded jointly by BNL and Suffolk County. The primary objectives of this research effort are to:

- Determine the basic photosynthetic physiology of *Aureococcus* in the field;
- Deploy three real-time monitoring buoys in the Peconic Bays system to measure the abundance of chlorophyll, temperature, salinity, dissolved oxygen and tidal information, and use this information to develop and test models for bloom dynamics; and
- Develop and maintain a Brown Tide "home page" on the World Wide Web containing real-time data from the buoys.



BNL is also funding an in-house research effort that will investigate the photosynthetic and nutrient uptake physiology of Brown Tide, including conducting nutrient addition experiments with natural seawater samples from Peconic Bay that contain Brown Tide. The final part of the study, a retrospective analysis of the oceanographic, meteorological, and biological conditions that are associated with Brown Tide blooms in the Peconic Estuary, has already resulted in the formulation of

the hypothesis previously noted on the roles of dissolved inorganic and organic nitrogen and groundwater levels and rainfall patterns in the onset of blooms. Work by BNL researchers (now at the University of Kiel) has also produced the first axenic (bacteria-free) culture of Brown Tide, a major breakthrough.

Other Suffolk County Capital Programs

Between 1997 and 1999, Suffolk County appropriated \$450,000 to support Brown Tide monitoring and investigation efforts (above and beyond historic appropriations of \$400,000). The general criteria used to select Suffolk County-funded projects included:

- Consistency with the Brown Tide Workplan;
- Linkages with potential physical management applications (e.g., nutrient reductions, structural changes to the Shinnecock Canal locks, etc.);
- Focus on collection and application of actual field data (typically with the assistance of the SCDHS marine monitoring crew);
- Development of data and products useful to the broader research and management community; and
- Cost-effectiveness of proposals.

Historic Research Efforts and Findings

Between 1986 and 1997, Suffolk County funded Brown Tide research projects totaling approximately \$400,000. The New York Sea Grant Institute funded \$700,000 in Brown Tide research projects from 1991-1996 and \$57,000 in projects for 1996-1997.

The following achievements are a result of the SCDHS and Sea Grant research projects.

- An immunofluorescent Brown Tide identification procedure which allows accurate, reliable, and expeditious analysis of Brown Tide cell concentrations;
- The production of a laboratory culture of the Brown Tide organism which could be used for investigating the organism's chemical and physical requirements;
- Laboratory results bolstering the indication from monitoring data that conventional inorganic macronutrients, such as nitrogen and phosphorus, do not appear to trigger Brown Tide blooms;
- The laboratory indication that micronutrients, such as iron and selenium, may be important in bloom formation;
- Mathematical modeling indicating that Brown Tide blooms do not seem to be directly related to the concentrations of conventional nutrients;
- Studies which indicate that Brown Tide may be stimulated by a relatively high ratio of available dissolved organic nitrogen, with respect to supply of dissolved inorganic nitrogen;
- Field verification of the decimation of eelgrass populations, possibly due, in part, to the light shading effects of Brown Tide; and
- Microzooplankton grazing experiments that strongly suggest that microzooplankton consume alternative phytoplankton and avoid Brown Tide cells.

Five projects have been funded with this \$450,000, including the Brown Tide Monitoring Network (discussed above). The Suffolk County Capital Program moneys also support an investigation of the various constituents of dissolved organic nitrogen in Long Island waters (BNL/Woods Hole Oceanographic Institute; LaRoche, Repeta, *et al.*), with the goal of eventual linkages to Brown Tide and other phytoplankton dynamics. Also prominent is a forthcoming study of the influence of various groundwater constituents on Brown Tide (Taylor *et al.*, SUNY MSRC). In addition, Suffolk County



field staff are assisting in the collection of samples for a Differential Phytoplankton Analysis project (Lonsdale *et al.*, SUNY MSRC). Finally, Tetra-Tech, Inc. will be calibrating and verifying a Shinnecock Bay model (coupled with the Peconic Estuary model), to test the hypothesis that reversal of the locks at the Shinnecock Canal will greatly improve Peconic Estuary flushing, potentially mitigating or preventing Brown Tide blooms. An additional \$133,000 was appropriated for Brown Tide research by Suffolk County in 2000, and \$150,000 per year has been authorized by Suffolk County for 2001 and following years.

Brown Tide Research Initiative

NOAA, through its Coastal Oceans Program (COP), is providing Brown Tide research funding totaling \$3.0 million over six years. A Brown Tide Research Initiative (BTRI) committee, chaired by New York Sea Grant, was formed by the COP in consultation with the PEP to manage the research funding process. The BTRI committee includes representatives from the PEP, COP, South Shore Estuary Reserve, Suffolk County, citizens groups, and local government. The primary objectives of the BTRI are to:

- ! Develop additional isolates and axenic cultures of the Brown Tide organism and methods for culture maintenance;
- ! Identify the physical, chemical, and biological factors that initiate and sustain Brown Tide blooms; and
- ! Identify factors leading to the cessation of Brown Tide blooms.

A full list of the Brown Tide research projects being funded by NOAA can be found in **Appendix E**.

Brown Tide Steering Committee and Workplan

The Brown Tide Steering Committee (BTSC) was formed to broadly coordinate Brown Tide research efforts both inside and outside of New York through the development of a comprehensive Brown Tide research and management plan or Brown Tide Workplan. The BTSC includes representatives from various agencies and environmental groups as well as elected officials, commercial fishermen, and other interested parties. The BTSC is coordinated by Suffolk County. The Brown Tide Workplan will be implemented by the BTSC through the PEP, NOAA, and Sea Grant and in coordination with the Barnegat Bay National Estuary Program, the Narragansett Bay National Estuary Program, the South Shore Estuary Reserve Program, the Delaware Inland and Maryland Coastal Bays Programs (to be included on committee) and other participants.

The Brown Tide Workplan recommends Brown Tide research priorities for the next three years. Research priorities are based on a review of past and current research efforts as well as recommendations for research from the Brown Tide Summit. The *Brown Tide Interim Workplan* (BTSC, 1998) estimates that, over the next three years, \$2.1 to \$2.8 million will be necessary to conduct the high priority research efforts identified by the BTSC. The Interim Workplan has been approved by the BTSC and the PEP Management Committee and will be refined and updated periodically. A copy of the Interim Workplan can be found in **Appendix F**.



MANAGEMENT ACTIONS

The Peconic Estuary Program recognizes the need to continue to better coordinate, focus, and expand Brown Tide research efforts. To this end, the PEP has worked to coordinate Brown Tide research and has prepared a comprehensive, regional Brown Tide research workplan. Further, the PEP recommended a commitment of significant additional funding to extend promising avenues of research and management. This funding is in addition to the funds allocated for the preparation/implementation of the PEP CCMP. Thus, comprehensive, regional Brown Tide research can take place on a separate, parallel course with the current Management Conference direction, which deals with conventional water quality and natural resource issues.

The Brown Tide management action contained in this chapter reinforces the need for continued research and monitoring as well as the need for continued coordination of research efforts and information sharing. The Brown Tide management action, shown in the accompanying text box, is detailed below. The Brown Tide Management Action Summary Table (**Table 2-1**) includes information on the costs, status, and timeframe associated with the action. The table is located at the end of this chapter.

Within the CCMP, some steps within the actions have been identified as priorities, as indicated under the step number. The PEP will seek to implement priority actions in the near term. Priorities may be either new or ongoing, commitments or recommendations. Completing some priority actions does not require any new or additional resources, because they are being undertaken through "base programs" or with funding that has been committed. In other cases, in order to complete the priority actions, new or additional resources need to be secured by some or all of the responsible entities.

In addition to Brown Tide research initiatives, the PEP has been involved in restoring those natural resources believed to be most impacted by Brown Tide: bay scallops and eelgrass. Many of these efforts have been funded by the PEP, the State, Suffolk County, and local towns. These initiatives and the associated management actions are found in the Habitat and Living Resources section of this CCMP (see **Chapter 4**).

BROWN TIDE MANAGEMENT ACTION

B-1. Ensure Continued Brown Tide Monitoring, Research, Coordination, and Information Sharing.



B-1. Ensure Continued Brown Tide Monitoring, Research, Coordination, and Information Sharing.

Addresses Brown Tide Management Objectives 1 and 2.

Since 1985, the Suffolk County Department of Health Services (SCDHS) Office of Ecology has maintained a monitoring program, which has included the analysis of thousands of water samples for Brown Tide levels and for the chemical and physical characterization of the estuary. This program has been important for a number of reasons, including the determination of the timing and spatial extent of Brown Tide blooms; the determination of physical and chemical parameters associated with the blooms; and the generation of data supporting numerous research and management efforts. The joint SCDHS/BNL project (the Brown Tide Monitoring Network) also contains a much-needed Brown Tide monitoring component.

Continued research on Brown Tide depends on continued funding. Historically, most of the Brown Tide research was funded by NY Sea Grant and Suffolk County. In 1995, several additional avenues of Brown Tide research were opened through the NOAA funding initiative. Additional research continues to be funded by the PEP, Suffolk County, NOAA, and Sea Grant.

Steps

- B-1.1 Ensure that the SCDHS water quality monitoring program continues to provide information needed for analysis and research related to Brown Tide.
- B-1.2 Include Brown Tide monitoring as a component of the long-term monitoring program of the PEP.
- B-1.3 Continue research efforts by BNL and Suffolk County under the Brown Tide Monitoring Network and BNL hind-casting and autoecological investigations, as well as other monitoring and investigation projects funded by the Suffolk County Capital Program.
- B-1.4 Support continued funding for NOAA-funded Brown Tide research and management **Priority** projects, cooperation among researchers, and dissemination of information on progress and results under the Brown Tide Research Initiative.
- B-1.5 Identify potential funding sources to implement the Brown Tide Workplan and secure **Priority** funding for Workplan priorities.
- B-1.6 Assign agency staff members to coordinate Brown Tide research.
- B-1.7 Coordinate Brown Tide Steering Committee activities to periodically update the Brown **Priority** Tide Workplan with necessary research and management projects.



Responsible Entities

- B-1.1 Suffolk County Department of Health Services (lead), PEP
- B-1.2 Suffolk County Department of Health Services (lead), PEP
- B-1.3 BNL and Suffolk County (co-leads)
- B-1.4 NY Sea Grant (lead), NOAA, BTRI Steering Committee, PEP
- B-1.5 Suffolk County (lead), Brown Tide Steering Committee, and various agencies funding Brown Tide research
- B-1.6 PEP (lead)
- B-1.7 Suffolk County (coordination), PEP, EPA, NOAA, Sea Grant, SUNY Marine Sciences Research Center, local government, New York State, and other estuary programs (Buzzards, Narragansett, Barnegat Bays, and South Shore Estuary Reserve Program)

BENEFITS OF THE BROWN TIDE MANAGEMENT ACTIONS

Successful management actions, which prevent Brown Tide blooms, lessen their severity, cause blooms to subside, or otherwise mitigate impacts, are vital to the restoration and protection of the once economically important Peconic bay scallop industry. Other important shellfish that will benefit from successful Brown Tide management include blue mussels, hard clams, and oysters. The reduction or control of Brown Tide will be helpful in protecting eelgrass, which serves as an important habitat for finfish as well as shellfish. There is also evidence that the Peconic Estuary is important as a nursery and spawning ground for a variety of marine organisms, including weakfish and other commercially valuable finfish. Although the dockside value of commercial fishery landings is significant, it is much smaller than actual revenues generated by other water-related activities, including marinas, restaurants, and other businesses and institutions which cater to sports fishermen, boaters, bathers, and tourists who utilize the Peconic system. An economic assessment conducted by the PEP has shown that there are over one thousand business establishments that are estuarine-dependent (21 percent of the total businesses in the Peconic Estuary study area). Gross revenues for these establishments total \$442 million/year, and they employ over 7,000 individuals.

COSTS OF THE BROWN TIDE MANAGEMENT ACTIONS

At this time, the long-term costs of identifying the causes of the onset and persistence of Brown Tide blooms, and of developing measures to control and minimize those blooms, are unknown. As of 1997, Brown Tide-specific and related research totaled approximately \$1.2 million (excluding NOAA funds). As mentioned previously, NOAA has committed \$3 million over six years to conduct Brown Tide research, beginning in 1996, and BNL and Suffolk County have committed a combined total of \$200,000 in equipment and services for Brown Tide research.

The County will continue to monitor the waters of the Peconic Estuary for Brown Tide and other constituents of concern. Between 1997 and 2000, Suffolk County appropriated \$583,000 of Capital Program funds for Brown Tide research. Suffolk County has also authorized \$150,000 each year for



the next three years (2001-2003) from the Capital Budget. Suffolk County also has requested that \$1 million in NY Clear Water/Clean Air Bond Act funds be dedicated to Brown Tide investigations.

The Brown Tide Steering Committee has identified short-term Brown Tide research and management needs in the form of a workplan. These needs are currently estimated to be \$2.1 to 2.8 million over the next two to three years. Additional funding may be needed to extend promising new avenues of research, and may be requested in the future, based on the recommendations of the Committee.

The total cost of all actions proposed for Brown Tide management is \$3.25 million in new one-time costs. (See "Action Costs" in **Chapter 1** for an explanation of how these costs were determined.)

BROWN TIDE ACTIONS SUMMARY TABLE

Table 2-1 provides the following summary information about each of the actions presented in this chapter.

Status

An action's status is designated in the table by either an "R" for "Recommendation" or a "C" for "Commitment." Actions that are commitments are being implemented because resources or funding and organizational support is available to carry them out. Actions that are "recommendations" require new or additional resources by some or all of the responsible entities. "O" refers to ongoing activities; "N" indicates new actions.

Timeframe

This category refers to the general timeframe for action implementation. Some actions are ongoing or nearing completion; implementation of other actions is not anticipated until some time in the future.

Cost

Information in the cost column represents the PEP's best estimate of the costs associated with action implementation. "Base Program" means that no new or additional funds will be needed outside of the responsible entity's operating budget to implement the action. Where additional funding is needed, resources to implement an action may be expressed in dollar amounts or work years or both. One full time equivalent employee or "FTE" is estimated as costing \$75,000 per year, which includes salary, fringe benefits and indirect costs. The "Action Costs" description in both **Chapter 1** and **Chapter 9** provides an expanded explanation of base programs and action costs.

Table 21. Brown Tide Management Actions.

Action		Responsible Entity	Timeframe	Cost	Status		
B-1	Ensure Continued Brown Tide Monitoring, Research, Coordination, and Information Sharing. (Objectives 1 and 2)						
B-1.1	Ensure that the SCDHS water quality monitoring program continues to provide information needed for analysis and research related to Brown Tide.	SCDHS (lead), PEP	Ongoing	Minimum grant commitment of \$120,000/yr to satisfy EPA local match requirements. As with prior years, costs likely to be substantially higher than EPA grants. (See Environmental Monitoring Plan)	C/O		
B-1.2	Include Brown Tide monitoring as a component of the long-term monitoring program of the PEP.	SCDHS (lead), PEP	Ongoing	Included in Action B-1.1	C/O		
B-1.3	Continue research efforts by BNL and Suffolk County under the Brown Tide Monitoring Network and BNL hind-casting and autoecological investigations; as well as other monitoring and investigation projects funded by the Suffolk County Capital Program.	BNL, Suffolk County (co-leads)	Ongoing	(Between 1997 and 2000, \$583,000 Suffolk County Capital Program funds. Suffolk County has authorized \$150,000 each year for the next three years (2001-2003) from the Capital Budget.)	C/O		
B-1.4	Support continued funding for NOAA-funded Brown Tide	NY Sea Grant (lead), NOAA, BTRI Steering	1996-2001	\$3,000,000	C/O		
Priority	research and management projects, cooperation among researchers, and dissemination of information on progress and results under the Brown Tide Research Initiative.	Committee, PEP					

Table continued on next page



Table 2-1. Brown Tide Management Actions. (continued)

	Action	Responsible Entity	Timeframe	Cost	Status
Action		Responsible Entity	1 iiiicii aiiic	Cost	Status
B-1.5 Priority	Identify potential funding sources to implement the Brown Tide	Suffolk County (lead), Brown Tide Steering	Ongoing	Identify funding:	C/O
	Workplan and secure funding for Workplan priorities.	Committee, and various agencies funding Brown		Secure funding:	R
		Tide research		The necessary workplan research is estimated to require an additional	
				\$2.1–2.8 million over 2 to 3 years.	
				Funds obligated: None. Potential	
				sources: NYS Environmental	
				Protection Fund or Clean	
				Water/Clean Air Bond (\$1 million	
				requested); Suffolk County Capital funds (\$450,000 requested)	
B-1.6	Assign agency staff members to	PEP (lead)	Ongoing	EPA – 0.1 FTE/yr	C/O
D -1.0	coordinate Brown Tide research.	TEI (lead)	Oligonig	NYSDEC – 0.05 FTE/yr	C/O
	ecoramace Brown Trae research.			SCDHS – 0.1 FTE/yr	
B-1.7	Coordinate Brown Tide Steering	Suffolk County	Ongoing; Interim	SCDHS – 0.2 FTE/yr	C/O
Priority	Committee activities to	(coordination), PEP, EPA,	Workplan last	-	
	periodically update the Brown Tide	NOAA, Sea Grant, SUNY	updated in Feb.		
	Workplan with necessary research	Marine Sciences Research	1998; workplan		
	and management projects.	Center, local government, New York State, and other	to be updated		
		estuary programs (Buzzards,	annually as necessary		
		Narragansett, Barnegat,	necessary		
		Delaware Inland, and			
		Maryland Coastal Bays, and			
		South Shore Estuary			
		Reserve Program)			