SoMAS Shinnecock Bay Restoration Program

Overview – 2010

Shinnecock Bay

Over the last decade, the aquatic environment of Shinnecock Bay has been deteriorating. The decline in water quality, habitat conditions and fish and shellfish populations has significant and far ranging implications for other marine animals and seabirds, as well as for people who live or work in this area. Factors responsible for these declines include overfishing, pollution, habitat destruction and nutrient inputs (such as nitrogen from fertilizers and septic systems).

Dramatic headlines have raised public awareness about problems in the bay—dwindling fish populations, red tides, algal blooms—but directed action is needed to slow and ultimately reverse the negative trends plaguing Shinnecock Bay. This concept paper provides the rationale and work outline of a scientific restoration program for Shinnecock Bay. This program is being proposed by the School of Marine and Atmospheric Sciences (SoMAS) at Stony Brook University.

What are the problems in Shinnecock Bay?

Among the many related environmental concerns are:

- **Algal blooms:** The high level of nitrogen in bay waters is stimulating algal blooms in the bay, such as brown and red tides. Shellfish including clams, oysters and scallops formerly filtered large volumes of water and kept algal blooms in check. With the drastic decline of shellfish populations, algal blooms now grow out of control.
- **Red tide—human health risk:** Red tide was first observed in Shinnecock Bay in 2008. The toxins made by the algae that cause red tide can cause respiratory distress and paralytic shellfish poisoning. Consuming shellfish containing this toxin can lead to serious illness and even fatalities.
- **Loss of seagrass beds:** Algal blooms make water turbid, and this in turn blocks sunlight and shades out seagrasses. Seagrass beds have been lost in much of the bay. These beds play an essential role in sustaining fish populations because they serve as crucial nursery habitat for juvenile finfish and shellfish.
- **Decline in fish populations:** Algal blooms and loss of habitat, coupled with overfishing, have led to a dramatic drop in fish populations. Many local species, including winter flounder, that were once common in Shinnecock Bay, are now relatively scarce.
- **Loss of shellfish**: Depleted shellfish populations are the result of decades of overharvesting and chronic harmful algal blooms. Over the past few years, landings of both hard clams and scallops in Shinnecock Bay and other Long Island estuaries have declined by more than 99%.

If the current, alarming trends continue in the direction we have witnessed over the past few years, we risk losing the very attributes that have made this area so desirable and valuable. We can no longer afford to take our local, aquatic environment for granted.

Why is restoration important?

The aquatic environment of Shinnecock Bay--nine thousand acres of open water, salt marshes and intertidal flats--forms a regionally significant habitat for fish and shellfish, migrating and wintering waterfowl, colonial nesting waterbirds, beach-nesting birds, migratory shorebirds, raptors and rare plants. Restoration of the bay is essential to preserve the economic, environmental, aesthetic, and scenic value of the area.

With regard to the bay's economic value, it is important to note that the south shore of Long Island once hosted the largest fishery in New York State. In fact, in the late 20th century, two out of three hard clams consumed in the eastern half of the US came from the south shore of Long Island. During that era, the largest bay scallop fishery on the US east coast was also based on eastern Long Island. Currently, Shinnecock Bay hosts the second most valuable commercial fishing port in New York. Although the fishing fleet based in this port harvests primarily offshore rather than in the bay, the port is ranked among the top 10 ports on the mid-Atlantic coast, and the second most important in New York State in economic value.

It is difficult to quantify the scenic value of Shinnecock Bay; however it is clear that this area has been, and continues to be, a much sought after place for summer and year-round residents.

A plan to restore the bay

In response to the deteriorating situation in Shinnecock Bay, the School of Marine and Atmospheric Sciences at Stony Brook University seeks to restore this ecosystem to health. By conducting a scientific restoration program and engaging with local stakeholders, our long-term goal is to turn this "brown tide bay" back into an estuary of thriving wildlife, productive fisheries, lush seagrass meadows and clear water.

At present, SoMAS is seeking funding to launch this comprehensive research program called the Shinnecock Bay Restoration Program (SHiRP). Our prior research, in addition to work conducted by fellow scientists along the East Coast, suggests that we can restore Shinnecock Bay to a productive, diverse, healthy ecosystem. SoMAS' experienced team of researchers is able to draw upon nearly two decades of research on East End waters and other similar environments in designing the restoration program for Shinnecock Bay. Hundreds of SoMAS undergraduate students will also participate in this research and restoration program, providing robust practical field experience and scientific training for some of the future stewards of our oceans.

What will scientists do to help restore the bay?

- **Evaluate key health indicators for Shinnecock Bay**: We plan to measure and evaluate water temperature, nutrient levels, water clarity, algal densities and blooms, dissolved oxygen and the status of key natural communities such as seagrasses, shellfish, horseshoe crabs, fishes and marine mammals. We will assess the abundance, trends over time, distribution and movements for different life stages of both resident and non-resident organisms.
- **Deploy and maintain scientific instrumentation that monitors bay conditions and tracks the movements of marine wildlife**: Data collected will be transmitted to researchers and will enhance our understanding of factors that have led to degradation of the bay and how these factors influence habitat use by wildlife. This in turn will suggest ways to restore the ecosystem.
- **Enhance natural filtration capacity of the ecosystem with shellfish**: One part of restoration involves restocking multiple species of shellfish (clams, oysters, scallops) in this estuary using a variety of methods--wild plantings, caged plantings, saturation spawning, etc. Filtration by these shellfish will help improve water quality and clarity in Shinnecock Bay.

- **Enhance natural nutrient removal of the ecosystem with seaweeds**: Another part of restoration involves stocking, removing and restocking stands of seaweeds. These aquatic plants have been shown to absorb large amounts of nutrients. By removing nutrients, these plants can have an inhibitory effect on harmful algae, including red tide and brown tide. We will seek to deploy seaweeds in regions of high nutrient loads and to subsequently harvest them to minimize the impacts of nutrient loading on Shinnecock Bay.
- **Expand remaining eelgrass beds:** Another approach of our restoration effort will involve encouraging further growth of existing eelgrass beds. In addition to planting shoots of eelgrass, we will focus on releasing seeds and genotyping eelgrass to ensure that specific strains of eelgrass are properly matched with the prevailing conditions in Shinnecock Bay.
- **Evaluate efficacy of our restoration efforts:** Ongoing research and monitoring will show scientists how the ecosystem responds to restoration efforts and, over time, will indicate which interventions are the most effective. Scientists will monitor population trends and movements of several species of fish, marine mammals and seabirds during the course of restoration. This will enhance our capacity to plan further efforts and predict likely results.
- **Work with stakeholders:** Communicate with key groups and involve them in the restoration program. This will include meeting with local municipal officials and environmental groups, and developing a website to display program information in real time.

What is the plan for restoration?

The restoration program is in its beginning stage but draws upon years of experience from an exceptional team of investigators who have worked in Shinnecock Bay for nearly two decades. We are confident that we can achieve measureable results based on prior research and successes. Restoration efforts will be executed by the faculty, staff and students of Stony Brook University's School of Marine and Atmospheric Sciences based at both the Stony Brook and Southampton campuses.

Phase One

Planning, Pilot Projects and Initial Design (Summer 2010 through Fall 2011): Once funding is in place, the project will commence with a program to design and model the approaches best suited for restoration within the diverse environments across Shinnecock Bay. The pilot phase of the program will commence with four major efforts.

1) establish annual water quality monitoring and biological surveys of fish, shellfish and eelgrass.
2) establish remote data logging with water quality probes across Shinnecock Bay linked to a website for public viewing. This data logging component compliments and supports our biological survey work.
3) experimental deployment of multiple bivalve, eelgrass, and seaweed species across varying locations of Shinnecock Bay. By monitoring their growth and survival across the full growing season (spring through fall), decisions can be made regarding the purposeful deployment of these organisms during phase two for ecosystem restoration.
4) track the movements of key fish species in relation to water quality and eelgrass, so that we may predict the effect of restoration efforts on fish distribution and abundance in the bay.

(See Attachment A for a more detailed description of pilot studies to be conducted.)

Upon completion of these major objectives, we will have the data to answer the following critical questions regarding the restoration of Shinnecock Bay:

- What are the densities of shellfish, eelgrass, and seaweeds across the bay?
- What parts of the bay are at greatest risk due to poor water quality (e.g. brown tide, red tide, turbidity)?
- Where do different species of shellfish, eelgrass, and seaweeds grow most rapidly?
- Where do different species of shellfish and seaweeds remove algae and nutrients, respectively, at the greatest rates in the bay?
- Which fish species are most prevalent in which parts of the bay?
- How do these fish populations relate to water quality and nursery habitat in different parts of the bay?
- Which types of fishing gear are best suited to continued monitoring of fish populations?
- How does physical circulation of the bay compare to the biological turnover of the bay via shellfish filtration and seaweed production?
- What improvements in water quality are needed to expand eelgrass and shellfish populations across the bay?
- What species of shellfish and seaweeds should be targeted for restoration in which parts of the bay to improve overall water quality?

The answers to these questions will provide the data required to move forward with the restoration of Shinnecock Bay. Initial assessments will also inform and shape subsequent pilot projects and will further define the comprehensive ecosystem level project to be launched during the summer of 2012. After the pilot projects are launched, we will begin modeling based on initial data collected from these studies. The modeling will help us determine which species to target for restoration in specific areas at certain times of the year. With modeling results in hand, we will then develop the details of a long term monitoring and restoration program design for the bay.

Depending on funding levels, it may not be possible to sample and examine all elements of the ecosystem with the same intensity during the first summer. At a minimum, we will establish the extent of seagrass, seaweeds, and shellfish in key sections of the bay. We will also obtain an initial assessment of water quality, current fish diversity and population abundance. With enough financial support, all elements will be sampled through Shinnecock Bay and all initial pilot studies will be conducted. These studies will indicate the best areas to target for improving bay filtration.

A significant benefit of this project will be its rich contribution to undergraduate education. SoMAS undergraduate students will participate in research and restoration activities throughout all phases of the project. For example, several marine science classes taught at our Southampton campus will incorporate regular project monitoring activities (e.g., water quality, bottom composition, fish abundance) into the curriculum, helping us to maintain a time series of bay health. Our students will be trained in advanced scientific techniques while getting a vivid lesson in how science can be applied to solve real-world problems. These lessons will equip our students to be leaders when it comes to the future stewardship of this and other coastal habitats.

In addition, significant efforts will be made to establish relationships and coalitions with local municipalities and environmental groups, as well as environmental management agencies. Principals of the restoration plan will meet regularly with key stakeholder groups including the Southampton Town Trustees who are the primary governing body responsible for management of Shinnecock Bay, as well as the NYS Departmental of Environmental Conservation, Suffolk County, environmental groups including the Peconic Baykeeper, Nature Conservancy, and

Shinnecock Nation among others. All necessary permits for restoration efforts will be obtained. In conjunction with our own sampling in the bay, we will also reach out to the local fishing community for their data regarding distribution and seasonal trends of different marine species.

Phase One Timeline
Our optimal plan, contingent on funding, is to complete these objectives by Fall 2011.

- Hire project manager as early as possible to begin meetings with local stakeholders, environmental organizations and government planning agencies. The project manager will also begin forming coalitions with advocacy groups, apply for permits, help prepare pilot studies, and coordinate the work of graduate and undergraduate students under the direction of the principal investigators.
- Launch bay-wide assessments, sampling, monitoring program, May 1, 2010.
- Launch pilot studies, May 1, 2011.
- Assess progress of monitoring and pilot studies through November, 2011.
- By end of summer, (September 2011) analyze growth and filtration rates, water quality (brown tide, red tide, turbidity, GIS maps of bathymetry (water depth), graphical and statistical analyses and models.
- Finalize Shinnecock Bay Restoration Program and Long term monitoring effort, September 2011 – May 2012.
- Establish website for the program that collects data from scientists and citizens and displays real-time restoration progress. In following years, expand and adapt the website to meet program needs.

Phase Two (2012): Restoration efforts initiated

Executing ecosystem restoration of Shinnecock Bay and establishing the SHiRP long term monitoring program: The SHiRP's annual water quality monitoring and biological surveys of fish, shellfish and eelgrass will be refined and finalized for phase two. Based on information obtained in phase one, the frequency, spatial extent, and list of parameters and species monitored will be refined to complement our phase two ecosystem restoration efforts. Our efforts will specifically involve:

1. Enhancing natural filtration capacity of the ecosystem with shellfish: Multiple species of shellfish (clams, oysters, scallops, mussels) will be restocked in this estuary using a variety of methods--wild plantings, caged plantings, saturation spawning, etc. Areas and species chosen for shellfish stocking will be determined by the results of our phase one monitoring and pilot studies. Filtration by these shellfish will help improve water quality and clarity in Shinnecock Bay. Moreover, spawning of these individuals will enhance wild stocks of shellfish in the estuary and further promote ecosystem filtration by shellfish.

2. Enhancing the natural nutrient removal of the ecosystem with seaweeds: Another part of restoration involves stocking, removing, and restocking stands of seaweeds. These aquatic plants absorb large amounts of nutrients. By removing nutrients, these plants can have an inhibitory effect on harmful algae, including red tide and brown tide. We will seek to deploy seaweeds in regions of high nutrient loads and to subsequently harvest them to minimize the impacts of nutrient loading on Shinnecock Bay. Harvested seaweeds can even be used as fertilizer. The precise regions and species chosen for seaweed stocking will be determined by the results of our phase one monitoring and pilot studies.

3. Expand remaining eelgrass beds: Another approach of our restoration effort will involve encouraging further growth of existing eelgrass beds. In addition to planting shoots of eelgrass, we will focus on releasing seeds and genotyping eelgrass to ensure that specific strains of eelgrass are properly matched with the prevailing water quality conditions in Shinnecock Bay. The precise approach utilized and the regions of the bay in which we make these efforts will be determined by our phase one monitoring and pilot studies.

4. Implement our long term monitoring effort for Shinnecock Bay: To quantify the success of our ecosystem restoration efforts and to account for long term trends and interannual variability, it will be crucial that monitoring of Shinnecock Bay be refined and continued throughout the restoration effort. Based on our findings during phase one monitoring and pilot studies and the specific restoration efforts undertaken, the precise frequency, spatial extent, and list of parameters and species monitored will be established. This monitoring will include remote water quality monitoring.

5. Undergraduate education program: During phase two we will work with SoMAS faculty who are teaching undergraduate marine science courses to integrate their students into our monitoring activities. In some cases, these courses will include at least one full-day field trip, in which the class will join research and restoration activities described in points one through four above. The students will be trained to use our sampling equipment, learn about the local ecosystem and the biology of its flora and fauna. They will also be exposed to cutting edge restoration and research methods. We will also involve many of these students more deeply by including them as volunteers to regularly assist our scientists in the field. As the program progresses, we envision that the bay will become our largest and most engaging classroom at SoMAS. We will keep our students informed as the restoration blossoms, so as to instill in them a sense of achievement and provide an especially meaningful lesson of how they can use their scientific training to benefit society.

6. Public outreach program: Phase two will also include a robust public outreach component. Public meetings and seminars will be held informing the public and stakeholder groups regarding the status and progress of our restoration efforts. Opportunities will be made for citizens and school groups to be involved in our restoration efforts.

As our restoration efforts proceed and are evaluated, practices undertaken will be refined to maximize the efficacy of our programs. Approaches which yield ideal results will be expanded. Approaches which are less effective will be altered and refined. Similarly, our monitoring program may be refined to best evaluate emerging temporal and spatial trends in water quality or species abundances. Ongoing research and monitoring will show scientists how the ecosystem responds to restoration efforts and, over time, will indicate which interventions are the most effective. Scientists will continue to monitor population trends and movements of several key species. This will enhance our capacity to plan further efforts and predict likely results.

Annual Timeline for Restoration Program:

- Host launch of Shinnecock Bay Ecosystem Restoration to unveil our plans to the public. In subsequent years, an annual event to update the public on our progress will also be hosted: Spring 2012.
- Launch long term Shinnecock Bay monitoring program: Spring 2012.
- Commence initial stocking of shellfish, seaweeds, and eelgrass: Spring 2012. In subsequent years, adjust stocking of shellfish, seaweeds and eelgrass during the spring.

- Monitor progress of stocking efforts: Summer 2012. In following summers, continue to monitor progress.
- Assess year one growth and survival of stocked shellfish, seaweeds, and eelgrass: Fall 2012. In subsequent years, assess growth and survival each fall.
- Host Annual Shinnecock Bay Ecosystem Restoration clambake.

Phase Two (2013-2016): Restoration efforts refined, long term monitoring continued:

After the first two years, the details of restoration efforts will be much better understood and the costs better known. We anticipate that the restoration program will take approximately five years and, at present, we are estimating annual costs for deployment. The attached budget document outlines the funding necessary to launch phase one.

Beyond Phase Two: Sustaining the success once achieved

As restoration efforts proceed, we believe a tipping point can be achieved whereby the restorations efforts of phase two and beyond will take hold in Shinnecock Bay. Natural populations of shellfish will begin to recover in the bay. Eelgrass beds will expand within the bay. Once these populations have expanded to sufficient densities, they will begin to self promote and expand. Our continued long term monitoring will be ongoing and designed to be practical to maintain over a long period of time (ie. low budget, activities built into existing SoMAS courses and teaching assistant responsibilities, etc.)

If we are successful in restoring the bay to a stable state and in re-establishing healthy populations, then we will need to remain involved and work with area stakeholders to safeguard and maintain this balance. Long-term monitoring of the bay will be essential. As the restoration project proceeds, we will need to incorporate an advocacy effort and/or partner with other organizations to address protecting the bay. Regulations on fishing and nutrient input will need to be established as well as specific protected areas. We expect that the project manager’s role will be to establish these advocacy coalitions early on and continue to strengthen them throughout the restoration program.

How can local residents and concerned citizens help?

Funding is needed to make the Shinnecock Bay Restoration Project a reality. Please contact us about the following opportunities and other ways in which you can help.

- **Provide a planning grant for phase one of the restoration program**
  See attached budget for details.
- **Contribute to the cost of equipment and travel needed for research and monitoring**
  These items include fish tracking tags, cages and restocking costs; time on research vessels; and lab equipment. A description of these costs is included in *Attachment B*.
- **Support Student Scholarship**
  Funding is needed to support the work of undergraduate and graduate students involved in the restoration program. A $5,400 contribution will fund a summer stipend for one undergraduate student and $32,250 will fund a yearly stipend for one graduate student.
- **New Marine Sciences Building at Stony Brook Southampton campus**
  Funding is needed to equip, furnish and support personnel associated with the new marine sciences building planned for the Stony Brook Southampton campus. This building will be central to this project as the majority of laboratory-based research, monitoring and restoration efforts of the Shinnecock Bay Restoration Program will occur there. A full schedule of naming opportunities will be available shortly.

- **Citizen Scientists**
  The restoration program will be designed in such a way that ordinary citizens will be able to collect data and participate in the overall program. Data will be reported directly to the restoration program's website and used to inform our restoration efforts. Educational cruises on Shinnecock Bay for Citizen Scientists will also be included as part of the program.

Early gifts will encourage other support from foundations and agencies and will also help build curriculum for Stony Brook Southampton in the following areas:

- Ichthyology
- Experimental marine biology
- Marine mammals
- Marine Conservation
- Biological Oceanography

SoMAS faculty, students, class and lab time will all support the ongoing restoration project. SoMAS students will be conducting specific program studies, under faculty supervision, as part of their course requirements.

Please help us restore and safeguard Shinnecock Bay. The decisions we make and the actions we take now will determine whether we are able to continue to enjoy our unique marine "backyard" in the future.

For more information please contact:

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SoMAS Shinnecock Bay Restoration Program

Phase One Budget

Full annual budget: $498,790. Supports all experiments detailed in *Attachment A*, *SoMAS Shinnecock Bay Restoration Program Pilot Studies*.

This includes all program activities such as fisheries assessment, funding for four graduate students and four undergraduates, all pilot studies, and comprehensive monitoring of the water quality and benthic ecology of Shinnecock Bay.

This monitoring will be conducted via robust surveys and remote water quality probes which transmit data to the SHiRP website. This budget also includes a small percentage of salary for principal investigators and funds for other SoMAS faculty participation.

Category	**Amount**
Equipment *(see attachment B)*	$50,000
Travel *(see attachment B)*	50,000
Materials and Supplies *(see attachment B)*	42,000
Graduate Students (four, full time)	129,000
Undergraduate Students (four, summer)	21,600
Program coordinator	69,150
Principal Investigators	107,500
University grant management	29,540
Total Costs	**$498,790**

Total estimated project costs: $3,000,000

SoMAS Shinnecock Bay Restoration Program Pilot Studies

Attachment A

One of the major goals of the Shinnecock Bay Restoration Program is to enhance the natural filtration and nutrient removal capacity of the bay using shellfish and seaweeds, while also working to expand eelgrass beds. These actions should also help enhance populations of other types of aquatic wildlife, including fish, and marine mammals. However, scientists need to assess the suitability of various habitats within Shinnecock Bay for shellfish, eelgrasses, and seaweeds before an effective restoration plan can be implemented. Researchers also need to gather baseline information on the current extent of these natural populations, as well as other species that will likely benefit from their restoration. Effective restoration plans can be developed based on this essential information.

Monitoring and mapping the current extent of estuarine resources in Shinnecock Bay. We will conduct surveys to rapidly and accurately estimate shellfish, seaweed, and eelgrass abundances in Shinnecock Bay. By surveying in regions which progress from well-flushed to poorly flushed, we can establish population densities relative to ocean exchange. Surveys will be made using one square meter sampling gridpoints, and will consist of approximately 150 sites throughout Shinnecock Bay. We will obtain shellfish counts within each transect via raking. The size of the shellfish will also be established to help us develop estimates of population structure. Surveys of seagrass and seaweed communities will be conducted using a modified qualitative scoring technique. To interpret observed gradients in shellfish and eelgrass densities along our transects, we will generate a robust ancillary data set to characterize the water and sediment conditions along transects. At each site, changes in temperature, salinity, and dissolved oxygen with depth will be measured. Light measurements will also help us assess the suitability of each site for growing seagrasses and/or seaweeds. Sediment grab samples will be obtained to characterize sediment composition.

Water quality and phytoplankton populations in Shinnecock Bay vary seasonally and will influence shellfish and eelgrass growth. Using standard techniques, we will monitor phytoplankton species abundance and composition along transects that match our sediment survey (as described above) through one seasonal growth cycle (March through November). Special emphasis will be placed on monitoring brown and red tide species which may be harmful to shellfish, eelgrass, and/or humans. To help facilitate water quality monitoring, we will deploy water quality probes within selected regions of Shinnecock Bay. Once our field surveys have been completed, point data generated on water quality, phytoplankton community structure, sediment characteristics, densities of seagrasses, shellfish and wildlife populations (see below) will be used to produce continuous maps of these parameters across Shinnecock Bay using geographic information systems (GIS).

We expect that restored water quality and eelgrass cover will increase habitat and enhance populations of fish in the bay. For that reason, we will map the distribution and monitor the abundance of these animals before, during and after the restoration. The pilot study will include standard trawl and longline surveys of fish populations in multiple sites throughout the bay.

These efforts will establish quantitative measures of abundance for these animals, which can be tracked over time. We will also be able to map their distribution in relation to water quality and eelgrass cover (see above), which will allow us to determine if these animals are likely to move into restored parts of the bay. As the project unfolds, we will continue to monitor their distribution and movement. Lastly, several fish species will be fitted with ultrasonic transmitters that will allow us to remotely track their movements in the bay. This will provide finer-scale information on their distribution and habitat requirements, which will further enhance our ability to restore the bay so that these species can flourish. To this end, we will establish a network of remote acoustic tracking receivers in the bay that will monitor the movements of tagged fish throughout the year.

Examining the growth, filtration, and nutrient removal of shellfish and seaweeds in Shinnecock Bay

We will conduct experiments to provide the background information required to construct successful restoration plans. Since our restoration goals include enhancing the natural filtration and nutrient removal capacity of the bay, while working to expand eelgrass beds, we will field deploy juvenile and adult hard clams, bay scallops, and oysters, as well as eelgrass, and macroalgae (seaweeds) at multiple locations along east-west and north-south gradients in Shinnecock Bay. Juvenile shellfish will be ~ 10mm in size and will be obtained from the East Hampton Shellfish Hatchery while adult shellfish will come from local harvesters. All shellfish will be placed in vessels held in experimental, off-bottom cages. Shoots of eelgrass in enclosed 'planters' will be secured to the top of each shellfish rack and the macroalgae *Ulva lactuca* will also be deployed in separate cages. At each location we will measure the growth of the eelgrass and *Ulva* and consider how this growth is affected by water quality.

All plants and animals will be deployed in spring and will remain through the fall. Every two weeks, researchers will track changes in lengths to determine the growth rate of juvenile shellfish, eelgrass, and macroalgae. The rate at which adult shellfish are filtering the water within each site will also be determined using laboratory-based water filtration experiments. Measuring the filtration of phytoplankton as well as carbon, nitrogen, and phosphorus will help us determine the rate at which these elements are being removed from Shinnecock Bay. Seagrass productivity will be assessed using a modified leaf marking technique. Macroalgae growth, based on changes in area and weight and measurements of carbon, nitrogen, and phosphorus, will assess the rate at which these elements are being removed from the bay.

By the end of these experiments, we will know:
1) Which species of shellfish grow most rapidly in which parts of the bay.
2) Which species of shellfish filter most quickly in which parts of the bay.
3) Which parts of the bay are most suitable for eelgrass growth.
4) In which parts of the bay macroalgae/seaweeds remove nutrients most effectively.
5) The baseline abundance, distribution and, in some cases, movements of fish, that we expect will benefit from our restoration efforts.

SoMAS Shinnecock Bay Restoration Program

Attachment B

Travel: Fish surveys will require using the largest research vessels at Stony Brook Southampton's marine station. The usage fees for these boats are $1,000 per day—we anticipate needing 30 days of vessel time. Benthic and pelagic sampling will utilize small boats, which cost $250 daily. Additional costs will include van use to travel to sites around Shinnecock Bay and for students to present their results at scientific conferences.

Materials and supplies: This will include all material required for experiments including experimental cages, experimental grow-out bags for shellfish, experimental grow-out bags for seaweeds, floating racks, floating devices, experimental animals, etc.

Supplies for experiments will include juvenile fish, scallops, oysters, clams, aquarium pumps, bubblers, light-temperature loggers, supplies for the construction of mini-cages for shellfish, juvenile cages for fish, supplies to construct seagrass planters, calipers, etc.

Additional supplies for cage grow-out experiments include shellfish bags, juvenile scallops, oysters, clams, light-temperature loggers, collection bottles, carboys.

The analyses (nutrients, elemental, phytoplankton) associated with this project also require extensive supplies including reagents, filters, vials, jars, test tubes, filter capsules, collection bottles, carboys, tubing, pipettes, pipette tips, gloves, settling chambers, repipettemen, microscope bulbs, slides, cover slips, columns, tins, weigh tins, elemental analyzer expendable supplies, graduated cylinders, and general lab maintenance supplies.

Analyses of microalgae often need to be precise with regard to brown tide and red tide species and thus require highly sensitive molecular testing. For example, we will quantify *Alexandrium* cell densities, a highly sensitive molecular technique, which requires the purchase of oligonucleotide probes NA1 for the North American ribotype *Alexandrium fundyense/catenella/tamarense* with Nu-light ™ dye conjugated to the 5' end, hybridization buffer, SET, and filters for Cy3™ dye.

Additionally, saxitoxin analysis will be performed using competitive enzyme linked immunosorbent assays (Abraxis®). Primulin stain will be required for cyst enumeration. Molecular analysis and detection of harmful algae will also require 0.2 mm pore-size polycarbonate and GF/F filters, DNA purification kits, ultracentrifugation reagents and supplies, and reagents for PCR, TRFLP, and cloning/sequencing.

For RNA extraction, supplies required will include CTAB, PVP, buffers and salts (NaCl, EDTA, Tris), Chloroform, Alcohols, DNase. For cDNA construction we will purchase a Superscript III RTPCR kit from Invitrogen, filter tips, Rnase free water. TaqMan probes will be required to quantify genes.

Additional costs will include general laboratory chemicals and glassware and plasticware required for nutrient, pigment, and flow cytometric analysis. Fortunately, multiple larger equipment items required for this project including peristaltic pumps, shellfish cages, hand held CTDs, hand held light meters, vacuum filtration pumps, manifolds, an elemental analyzer, a spectrophotometer plate reader, microscopy imaging system, and mesocosm tanks have previously been purchased.