SHINNECOCK INDIAN NATION

CLIMATE CHANGE ADAPTATION PLAN

October 2013

Letter of Commitment from the Shinnecock Indian Nation

Since time immemorial, we have been gifted by the Creator with specific values and responsibilities as Shinnecock people to:

- Teach and promote spirituality, respect, responsibility, integrity, and unity in order to promote and ensure the health, well-being, and safety of individuals, community, and the Nation
- Preserve and promote our sovereignty and freedom of self-determination in order to advance the common good of the people and Nation.
- Restore, maintain, and foster our Shinnecock Culture, values, traditions, and human rights;
- Conserve, manage, and utilize our tribal lands, natural and cultural resources in a sustainably appropriate manner while balancing our economic growth and community needs.
- In all economic development, the Shinnecock Nation will seek to insure that such opportunities are culturally sensitive and protect and preserve the soundness of our environment.

In keeping with our Vision Statement for Shinnecock "Quality of Life," we support the initiation and ongoing development of the Shinnecock Climate Change Adaptation Plan; in order to protect what we value and hold sacred as *The People of the Stony Shore*.

Shinnecock Indian Nation

Council of Trustees

Executive Summary

Planning Process

The Shinnecock Environmental Department and the Natural Resource Committee had begun researching climate change, and particularly the impacts on surface water and ocean acidification, because of tribal shellfish cultivation. The next large concern was the increasing shoreline erosion, which is contributing to the loss of trees. The staff began researching other climate change issues that were impacting the region as well. Climate change is included in the Shinnecock Nation's strategic plan.

Action Recommendations

The Shinnecock Nation plans to:

- Mitigate shoreline erosion by investigating the feasibility of restoring shoreline with native plants and shrubs;
- Further research sea level rise and seek the consultation of local experts for possible ways of increasing our resilience to the flooding that will accompany;
- Decrease ground water contamination by replacement of tribal cesspools with a closed community sewer and waste water treatment facility;
- Reduce tribal carbon footprint through reduced dependency on fossil fuels and increased use of renewable energy programming, and energy audit of all tribal buildings;
- Improve air quality through tribal ordinances pertaining to open burning and idling zones, lessening the number of trees cut down annually, and the planting of new trees;
- Encourage food security and food sovereignty through reestablishment of traditional food systems and community farming; and
- Establish emergency management plan that includes response to extreme weather events.

Implementation of Plan

The Shinnecock Environmental Department will lead the effort to implement the plan. They will actively work with other tribal departments and committees, such as health, land management, education, governance, and emergency management, to review the plan and identify the key areas for which each department/committee is needed for implementation. The plan will be reviewed annually and revised as necessary. Each action item will be reviewed and delegated to the appropriate entity for implementation, including the seeking of outside consultants when deemed necessary. Reasonable timelines and target dates for these efforts are under development.

Key Terms

Adaptation (climate change): actions in response to actual or expected climate change and its effects, that lessen harm or exploit beneficial opportunities. It includes reducing the vulnerability of people, places, and ecosystems to the impacts of climate change.

Adaptive Capacity: the ability of a system to accommodate or respond to the changes in climate with minimum disruption or cost. Generally, systems that have high adaptive capacities are better able to deal with climate change.

Climate: the "average weather" generally over a period of three decades. Measures of climate include temperature, precipitation, and wind.

Climate Change: any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period of time (decades or longer). Climate change may result from natural factors and processes and from human activities that change the atmosphere's composition and land surface.

Global Warming: average increase in the temperature of the atmosphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced.

Greenhouse Gas (GHG): any gas that absorbs infrared radiation in the atmosphere; examples include carbon dioxide, methane, nitrous oxide, ozone, and water vapor.

Mitigation (climate change): actions that reduce the levels of greenhouse gases in the atmosphere; includes reducing emissions of greenhouse gases and enhancing sinks (things that absorb more greenhouse gases than they emit). Examples include switching to renewable energy sources and implementing energy efficiency measures.

Planning Area: this is an area in which the tribal government manages, plans, or makes policy affecting the services and activities associated with built, human, and natural systems. For example, within the sector Utilities, you might have planning areas of Water and Electricity.

Preparedness Actions: actions or activities that the tribe could take to achieve its climate change preparedness goals.

Preparedness Goals: what the tribe wants to accomplish in the priority planning areas through preparedness actions.

Priority planning areas: planning areas of particular importance to the tribal government or community which are vulnerable to climate change impacts.

Resilience: ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to absorb stress and change.

Risk: Risk= Consequence of an impact X Probability or likelihood that the impact will happen.

Sector: general grouping used to describe any resource, ecological system, species, management area, etc. that may be affected by climate change. For example, Transportation, Utilities, Water Resources, Forest Resources, Human Health, or Cultural Resources and Traditions.

Sensitivity: how much a system is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., sea level rise, increased water temperature). If a system is likely to be affected as a result of projected climate change, it should be considered sensitive to climate change.

Vulnerability: the susceptibility of a system to harm from climate change impacts. It's a function of how sensitive the system is to climate and the adaptive capacity of the system to respond to such changes. Generally, systems that are sensitive to climate and less able to adapt to changes are considered to be vulnerable to climate change impacts.

1 Introduction

1.1 General Characteristics and History of the Shinnecock Indian Nation

Location

The Shinnecock Indian Nation territory is 800 acres of ancestral land, located on the East End of Long Island adjacent to Southampton, New York. Approximately 500 tribal members live on this peninsula, referred to as "the neck." Additional land known as "Westwoods," is located in Hampton Bays, NY, and remains a tribal gathering place for spiritual and recreational purposes. The Nation is aware of the effects that ocean storm surge can have on its lands, especially because the "neck" is bordered by Heady Creek, Shinnecock Bay, and Old Fort Pond (Figure 1). The Shinnecock Reservation is at sea level, with portions of it rising to 33 ft. above sea level. The majority of the Shinnecock Indian Reservation resides in a low-lying, south-facing peninsula on Shinnecock Bay (Figure 2). Although landward of a barrier beach formation, which was breached as a result of Hurricane Sandy, this area is still particularly vulnerable to major storms and associated flooding.

An Ancient History and Culture

The Shinnecock Indian Nation is located on what remains of ancestral homelands, on the East End of Long Island adjacent to the Town of Southampton. Federal recognition was achieved October 1, 2010.

Since the beginning, the daily lives of the Shinnecock revolved around the land and the waters surrounding it. The Shinnecock people moved accordingly with the seasons, during spring and summer living closer to the water and in the fall and winter seasons living in the woodland areas. The earliest history was oral, passed down by word of mouth from generation to generation, and as far back as the collective memory can reach, the Shinnecock are an Algonquian people who have forever lived along the shores of Eastern Long Island.

As coastal dwellers, the Shinnecock continue to prize the bounty of the sea, the shellfish, the scaly fish, which for thousands of years provided the bulk of our diet. Changes in water quality related to climate change, such as temperature, salinity, and acidification, will impact what is still readily available in the waters.

Hurricane Sandy

In the wake of Hurricane Sandy, the Shinnecock Indian Nation declared a state of emergency, and chose to evacuate elders and children due to the loss of power and heat following the storm on October 28, 2012. The Shinnecock Nation was grateful that damage was minimal and the people were safe; however, Hurricane Sandy reinforced for tribal members the threat of increased storm activity and increased intensity in the future.

The United South and Eastern Tribes (USET) set up a donation center to collect aid for the Shinnecock Indian Reservation, after a storm surge eroded away the bluffs at the West Woods Tribal Reservation

and caused flooding to Shinnecock Nation lands, including flooding of burial grounds, damage to homes and government buildings, debris, and wide-spread power outages (FDEM, 2012).

Following the storm, through a contract to provide support for climate change adaptation to the St. Regis Mohawks and other tribes, Industrial Economics and Woods Hole Group, Inc. visited the site to assess potential coastal flooding vulnerabilities and coastal engineering adaptations that could be considered in planning for future sea level rise and storm events.

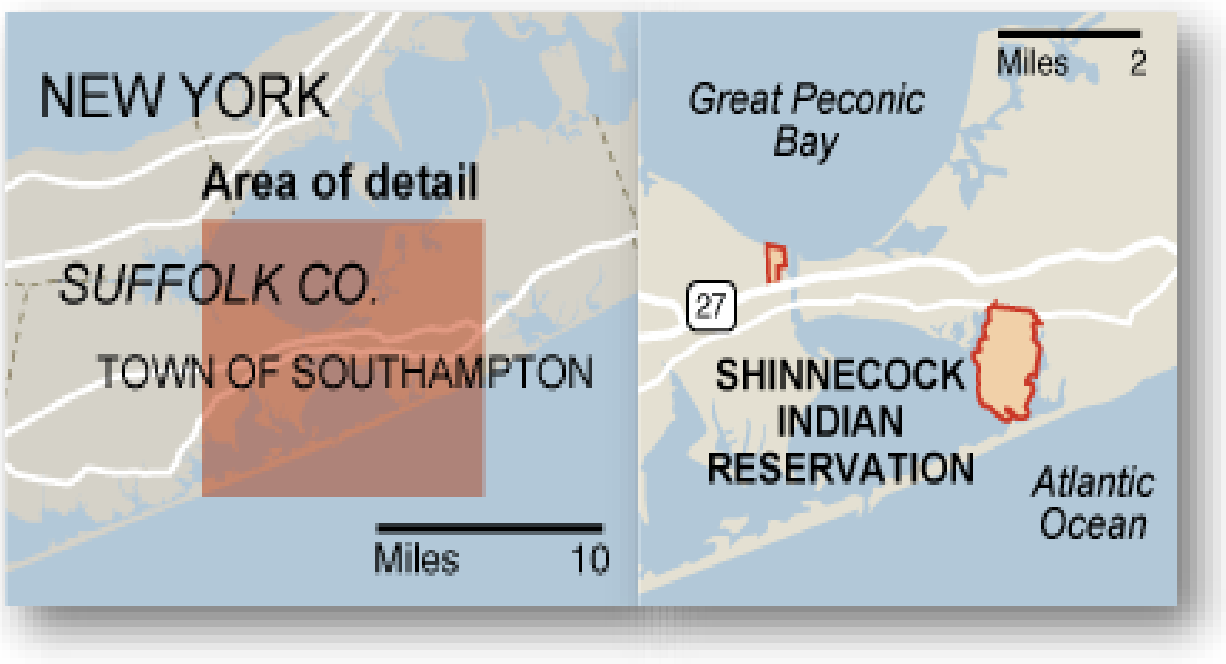

Figure 1. Map of Shinnecock Nation lands in Suffolk County, New York (HREB 2009).

Figure 2. Aerial photo showing the main peninsula of the Shinnecock Indian Reservation in Suffolk County, NY.

1.2 Why Shinnecock Indian Nation is Planning for Climate Change

Because the majority of its lands are located on a peninsula, the Nation is already aware of the effects that ocean storm surge can have on its lands. The tribal lands are as valued as the waters to the Shinnecock people. From the lands come food, medicine, and other useful materials. The threat of shoreline erosion, sea level rise, and salt water intrusion are concerns that are clearly expressed by tribal members. Along the shoreline there is a noticeable loss in trees, as salt water moves higher up (Figure 3). The Shinnecock people have lived on the "neck" for innumerable generations and mass relocation is not a realistic option. The people are inherently tied to the land, and only this place could be called Shinnecock. The Shinnecock Indian Nation is planning for adaption, in an effort to be proactive rather than reactive. The future is unknown to any mortal, but planning can potentially mitigate the extent of loss and damage.

Threats Posed by Climate Change

Members of the Shinnecock Nation have identified several concerns already raised by members of the community. These included the following:

- **Erosion and flooding**: A primary concern is the loss of lands to erosion and flooding as sea levels rise. Hurricane Sandy washed away the bluffs along the Nation's shores in the Great Peconic Bay area. This is a beach that was used by ancestors and is still being used by the Nation. A few tribal buildings and residential homes roofs were ripped off, and homes had flooded basements.

- **Insect pests**: The change in winter temperatures may increase the prevalence of biting and stinging insects on Nation lands, particularly wasps, flies, and mosquitoes.

- **Diseases**, including lyme disease, insect-borne diseases are on the rise. Tidal marshes on Nation lands are typically filled with stagnant water and are unable to flush due to damaged culverts. The stagnant water has become a breeding ground for mosquitos. There is a fear of the possibility of West Nile Virus which is transmitted by mosquitos.

- **Rodents**, as with insects, may thrive better in warmer temperatures.

- **Shellfish Harvests:** There is some concern that increases in bacterial presence could affect the survival of shellfish traditionally harvested in tribal waters. Increased ocean acidification poses a threat to the ability of shellfish to produce a hard shell, which is vital to its survival. In addition to naturally spawning shellfish, the tribe has an aquaculture business that cultivates oysters off shore. Water quality is key to the success of the project, as well access to equipment to oyster beds, which is dependent on the fluctuating tides.

- **Water supplies**: There is a small subset of Nation homes that are dependent on untreated ground water to meet their needs. While saltwater intrusion is a real possibility in the future, this threat is not thought to be as immediate as some of the others, and is less widespread. The tribe is investigating the feasibility of closed sewer systems to decrease the degradation of ground and surface waters.

- **Agriculture** is thought to be a minor concern as most plots are small personal plots. Forest resources are similarly thought to be very small scale.

- **Surface Water quality** is of growing interest to the Nation. The western side of Shinnecock Bay has experienced high incidences of algal blooms and poor shellfish survival rates. The eastern side, which borders Shinnecock, has optimal conditions, and the tribe wishes to maintain that as much as possible. A grant proposal for such monitoring has been submitted.

Tribe's Commitment to Planning

In an effort to educate staff and the tribal citizens on current climate change issues, the Shinnecock Environmental Department has researched the issues and participated in workshops and conferences, including the 1st Coastal Tribes Climate Change Symposium in 2012. The tribe's Natural Resource Committee has committed to working closely with staff to develop strategic plans and policies that will lessen the tribe's environmental impact. The future environmental policy of the Shinnecock Indian

Nation will call for all department heads and committees to identify how their individual area will be impacted by climate and how plans to adapt and respond can be drafted.

The Nation hosted a meeting with Industrial Economics (IEc), Woods Hole Group (WHG), and members from the Saint Regis Mohawk Tribe (SRMT) to discuss climate change adaptation planning, and to conduct an initial review of flood vulnerabilities. Following this meeting, the Nation held a community workshop on climate change adaptation. The Nation has expressed interest in:

- Continuing to evaluate the ongoing changes occurring due to climate change.
- Assess and recommend solutions to the erosion along the shoreline and the sea level rise issue.
- Assess and recommend solutions to the shellfish and sandbar changes, as well as the possibility of bacterial contamination to shellfish.
- Resolve flooded basements issue. Mitigation needs to be put in place to prevent homes and the Nation's burial ground from flooding.

Figure 3. A dead tree on the coast of the Shinnecock Indian Reservation.

Reason for Planning

The Shinnecock Nation has initiated Climate Change Adaptation Planning, with the assistance of the St. Regis Mohawk Environmental Division. The Shinnecock Nation is restructuring its government, strategically planning for current departments, and future planning; so climate change adaptation planning was the logical step. The impacts of the changes in weather patterns and storm intensity have already been witnessed on Shinnecock territories. The tribe faces the same concerns as the rest of the Northeast Region, particularly coastal impacts. It is vital that the tribe be proactive in decreasing its vulnerability and increasing resilience. The peninsula on which the tribe resides is losing land quicker than might have been initially realized. Preservation of the land base and prevention of water degradation is vital to future generations.

1.3 Planning in a Regional Context

The federal government has established regional Climate Change Science Centers. The northeast region center is located in Massachusetts, and has identified the following as areas of concern: agriculture/growing seasons, fish and wildlife disease, invasive species, habitat fragmentation, and coastal resilience, to name a few.

Locally, the Coastal Resilience Long Island project has explored flooding scenarios resulting from sea level rise and storm surge for the south shore of Long Island, New York, to help communities understand and incorporate responses to these stressors in their decision-making. Long Island's combination of highly developed lands, valuable coastal and marine resources, and large areas of low lying land has resulted in increasing costs of coastal hazards over the years, as these effects are being increasingly felt.

There have already been requests for water quality monitoring on Nation Lands and, under separate effort, a grant proposal for such monitoring has been submitted. Shinnecock Indian Nation and the Peconic Estuary Program have formed a partnership to assess their vulnerabilities to natural hazards due to climate change, and have taken the first step towards climate adaptation by evaluating their environmental risks and conducting a climate vulnerability assessment. Because climate change predictions are done at a regional scale, their geographic proximity makes the Peconic Estuary Program and the Shinnecock Indian Nation natural partners in this study; working together will allow the two entities to share resources, data, and information learned about performing a climate vulnerability assessment. This partnership has also requested funding (approximately $30,000) from the Climate Ready Estuaries Program to perform a collaborative vulnerability assessment. This represents a solid start to understanding the vulnerabilities associated with climate change and developing potential adaptations.

2. Climate Impacts

2.1 Climate Change Impacts in the Northeast

The northeastern portion of the continental United States consists of eleven eastern states that stretch from the most northeastern state of Maine and south to Maryland, from Pennsylvania and east to the

Atlantic Ocean, and is home to 18 federally recognized tribes. This area of the country is the most densely populated area in the United States and is known for its extreme climatic variability. According to the U.S. Fish and Wildlife Service, this area houses several key habitats and ecosystems from Atlantic northern forest and Appalachian Mountains to freshwater and salt marshes to coastal islands.

Climate change caused from greenhouse gas emissions is having an impact on a global to local scale. The Northeast is beginning to witness changes that are impacting all environments, and consequently all living organisms.

The Northeast has already observed climate-related changes on a broad spectrum. In general, the temperature in this region has increased by 2°F since 1970, with winter months having seen a even greater increase in temperatures (Karl *et al.,* 2009). Temperature changes are having an effect on all aspects of life in the Northeast, and sea-surface temperatures and sea level are rising. According to Frumhoff *et al.* (2007), summer variability is beginning to include more frequent days with temperatures above 90°F, and the growing season is lengthening. Winter changes include less precipitation falling as snow and more as rain, a reduced snowpack, and increased snow density. Spring is seeing an earlier breakup of winter ice on lakes and rivers and an earlier spring snowmelt that is ultimately resulting in earlier peak river flows. Living organisms in the Northeast are beginning to adjust to these changes. It has been observed that plants are experiencing earlier first-leaf and first-bloom dates, while the migration dates for Atlantic salmon and the mating season for frogs are shifting (Frumhoff *et al., 2007).*

Continued future warming in this region is inevitable, even if all greenhouse gas emissions were halted today. According to Karl *et al.* (2009), temperatures are projected to rise anywhere between 2.5°F to 4°F in winter and 1.5°F to 3.5°F in the summer. Further projected changes include shorter winters with fewer cold days and more precipitation, a shorter snow season, more summer days with temperatures above 100°F, short-term drought in the Catskill and Adirondack Mountains as well as in the New England states, extended hot summer conditions (arriving earlier in the spring and lasting later into the fall), and sea level rise.

The significant temperature increase that has already occurred in the Northeast, and that will continue to occur, has the potential to alter the landscape considerably and may have immeasurable implications not only for the economy, but also for many plants, animals and people in the Northeast.

2.2 Sea Level Rise

Coastlines have always been dynamic locations, but with the increase in storm intensity, as well as the sea level rise forecasted by climate change predictions, coastal communities are at a greater risk than ever. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) predicted that global average sea level would rise by 7.2 to 23.6 inches during this century (IPCC, 2007). However, the IPCC did not consider contributions from dynamic melting of the Greenland and Antarctica ice sheets, a potentially major source of melt water that has recently been shown to be an important contributor to historic sea level rise, and a likely major influence on future sea level rise.

As a result, the recently released draft National Climate Assessment, and more specifically the technical support document on sea level rise projections prepared for that effort, proposed four global sea level rise scenarios that characterize a range of potential outcomes, three of which include less conservative assumptions about glacial ice melt. The range of potential sea level rise in these scenarios range from 0.7 feet to 6.6 feet of projected global sea level rise by 2100 (Parris et al., 2012).

Climate impacts, however, are expected to vary by region. For example, the New York City Panel on Climate Change (NPCC) specifically looked at additional local climate change impacts and found that by the end of the century, New York City's mean annual temperatures are projected to increase by 4 to 7.5 degrees Fahrenheit, with a projected increase in annual precipitation by 5 to 10 percent (NPCC, 2009). Relative impacts of sea level rise will also vary based on location-specific factors such as land uplift and subsidence.

2.3 Climate Change Impacts on Shinnecock Nation

Anticipated Sea Level Rise Impacts on Shinnecock Nation

To estimate sea level rise on the Shinnecock Nation lands, we use data on local land movement, as measured by nearby tide gauges at Montauk and Port Jefferson, NY, and Sandy Hook, NJ, and global sea level rise projections from the two central National Climate Assessment scenarios, known as “Intermediate-Low” and “Intermediate-High” (Parris et al., 2012). The results of this adjustment, presented in Figure 4, suggest relative sea level rise on the Shinnecock Nation lands of 2.1 to 4.4 feet by 2100.

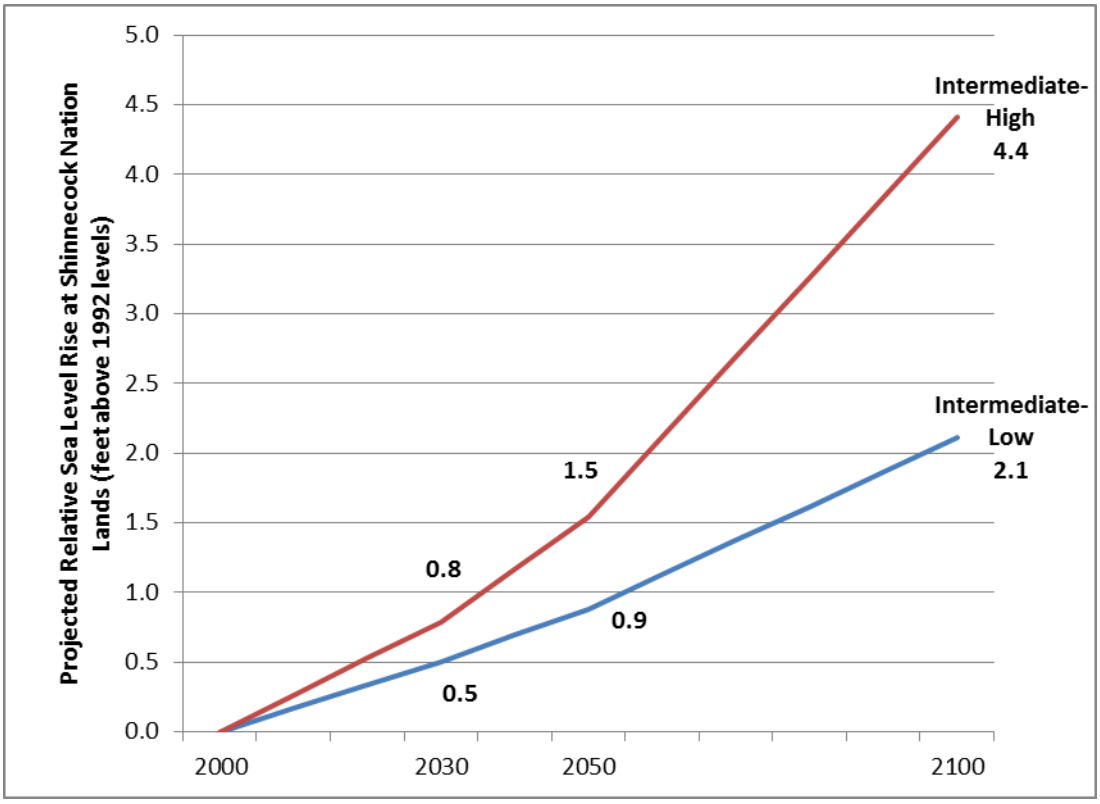

Figure 4. Potential Relative Sea Level Rise on Shinnecock Nation Lands Using Intermediate National Climate Assessment Scenarios.

Sources: Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss. 2012. Global Sea Level Rise Scenarios for the U.S. National Climate Assessment. NOAA Tech Memo OAR CPO-1. 37 pp.

NOAA Tides & Currents. Sea Level Trends. Accessed at: http://tidesandcurrents.noaa.gov/sltrends/index.shtml.

Figure 5 presents the water surface elevation associated with the projected MHW in 2050 within the Shinnecock Nation peninsula, assuming a sea level rise of 1.5 feet, which represents the "Intermediate-High" National Climate Assessment global sea level rise scenario after adjustment for localized rates of land subsidence. The dark blue color shows the current MHW levels, while the lighter blue color shows the projected MHW elevation in 2050. Even in the absence of a storm, there are a number of areas within the region that will likely be susceptible to flooding with each high tide by 2050.

Additionally, Figure 6 shows areas that are impacted during a 100-year storm both for current conditions (Figure 6a), and during a 100-year storm in 2050, assuming a sea level rise of 1.5 feet (Figure 6b). Under these assumptions, the areas that will likely be inundated during a 100-year storm in 2050 will encompass almost half the Shinnecock Nation peninsula.

Figure 5. Areas of predicted inundation during mean high water by 2050, assuming that sea level rises 1.5 feet above current levels, consistent with the adjusted "Intermediate-High" NCA global sea level rise scenario.

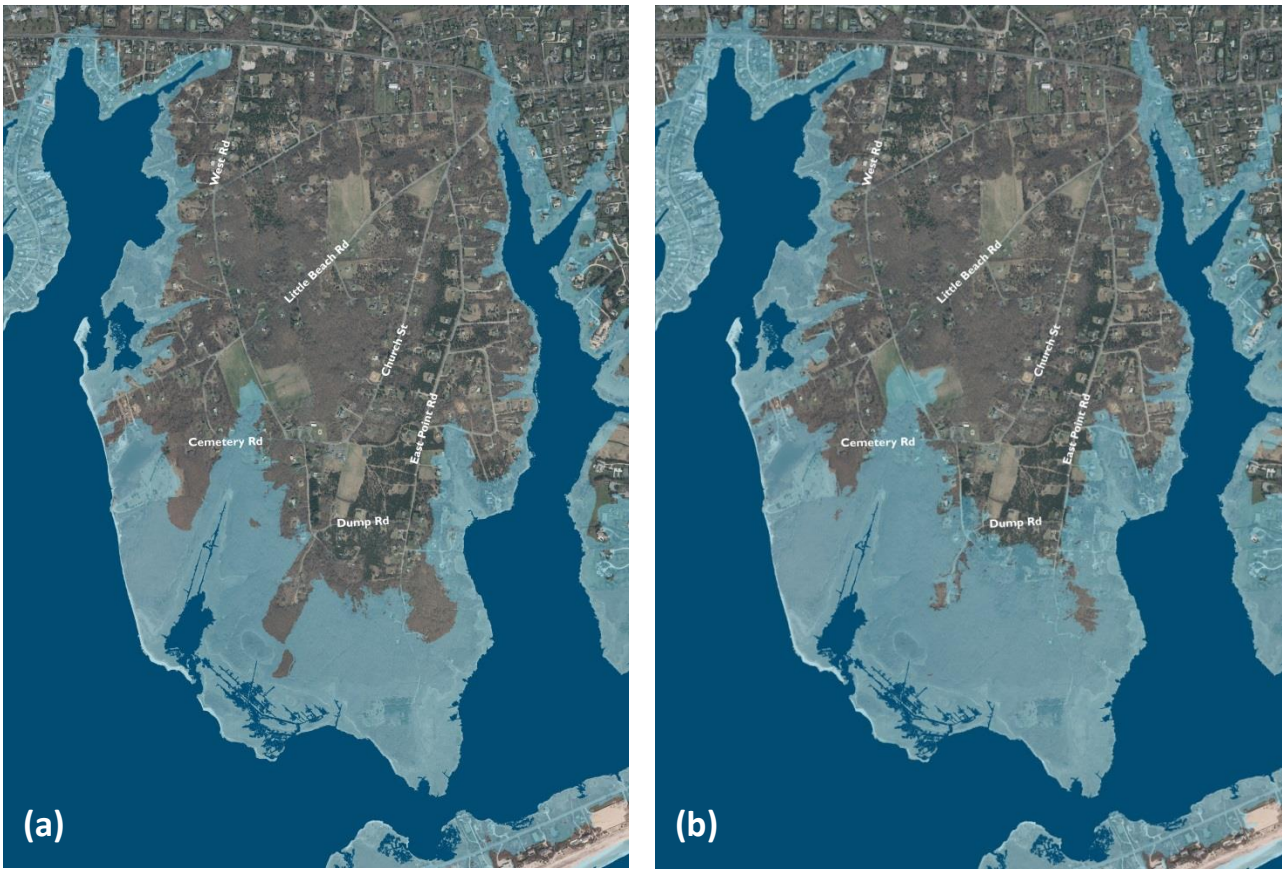

Figure 6. Areas of predicted inundation during a 100-year storm presently (a) and in 2050 after a sea level rise of 1.5 feet (b), consistent with the adjusted "Intermediate-High" NCA global sea level rise scenario).

Current Trends and Recent Observations

Recently, the Shinnecock Nation members have observed impacts of a changing climate. These include the following:

- Loss of electricity which during that time of the year when temperatures were dropping, was needed for heating homes and offices. There was a need for generators to heat homes.
- Tribal burial grounds were flooded halfway.
- The storm surge ate away a significant amount of bluffs at the West Woods tribal reservation.
- Hurricane Sandy washed away the bluffs at the Great Peconic Bay area.
- Burial ground located near the beach and on the north and south sides of it have tidal marshes always filled with stagnant water unable to flush due to damaged culverts in place for drainage.
- Improper drainage caused the water to be stagnant which increased the mosquito population.
- Homes had flooded basements from Hurricane Sandy.

- Winters that are not as cold as in recent past history.
- Shorter summers.
- Some species of plants bloom earlier.
- Insects normally present only in summer are still around throughout the year.
- Less ice in the bay during winter months.
- There are less shellfish for harvesting along the shorelines.

3. Vulnerability and Risk

Shinnecock Nation invited a coastal engineer to visit Nation lands on January 8, 2013 to observe the erosion caused and areas flooded by Hurricane Sandy, as well as gain a general understanding of the Nation's concerns related to climate change and sea level rise. A few of the pertinent observations are highlighted below:

1. The Shinnecock Indian Cemetery (burial ground) is located in the southern portion of the peninsula along the western shoreline and experienced flooding during Hurricane Sandy. This will likely become increasingly common as sea level rises (see section on preliminary analysis of potential flooding) and storm frequency and intensity increases. Currently, the western facing shoreline is protected with a crude barrier of large cement blocks (Figure 7). Although this provides some bank protection, because the structural units are haphazardly placed, they do not provide as much protection as an engineered revetment or seawall, and the loose cement pieces may be dislodged by severe storms and strong waves. In order to protect the cemetery from future flooding, engineering adaptations will be required. This may consist of additional coastal protection measures, such as improved coastal engineering structures (revetments, seawalls, etc.), soft coastal engineering measures (coir logs, dune restorations, etc.), flood protection measures (earthen dams, embankments, etc.), and improved drainage measures (as discussed below).

Figure 7. Current shoreline protection for Shinnecock Indian Cemetery.

2. The cemetery is also bordered on both the north and south by tidal marshes. Each marsh has a degraded drainage pipe that is intended to facilitate drainage of stormwater impoundment from

the upland marsh area (following a storm or heavy rain event), and possibly to allow adequate tidal flushing to and from the marsh area. However, both pipes are damaged, partially buried, and clogged (Figure 8), resulting in poor drainage and limited tidal exchange capacity. Ultimately, this results in increased flooding potential and drainage times in the vicinity of the cemetery, and also results in substandard ecological habitat in the marsh systems. These two small tidal systems need to be evaluated, and likely the existing culverts need to be replaced with appropriate engineered and sized flow control, to improve drainage, reduce flooding potential, enhance tidal exchange, and restore water quality and marsh habitat.

Figure 8. Culverts/pipes adjacent to Shinnecock Indian Cemetery. Both culverts are clogged, damaged, and in need of repair.

3. Cuffee's Beach, which is located directly north of the cemetery along the Western-facing shoreline, has likely experienced ongoing shoreline retreat and coastal erosion concerns. Observations during the site visit indicated that there has been erosion, and makeshift methods of coastal erosion mitigation have been implemented in certain areas. For example, directly south of the Cuffee's Beach parking area, old oyster cages have been placed in an attempt to reduce erosion and facilitate sand build-up (Figure 9). However, the Nation may want to consider more environmentally friendly options to managing the coastal erosion at this location, which represents a significant value. Potential adaptations may include, but not be limited to, bio-engineered solutions or dune restoration approaches that may fit more seamlessly into the natural surroundings of Cuffee's Beach. In addition to a more natural aesthetic, these types of solutions may also be more effective methods of bank protection then the current lobster trap solution.

Figure 9. Oyster cages used as temporary shoreline protection along Cuffee's Beach.

4. Just north of Cuffee's Beach there is a dynamic coastal area where an extended spit forms a significant embayment and estuarine habitat area (Figure 10). This area is susceptible to ongoing transformations due to variations in sediment transport and overtopping, erosion, and reformation of the coastal spit, which can result in transitions of the ecological features of the area. In addition, there is existing infrastructure that is situated directly landward of the coastal embayment. As such, changes to the embayment region may have direct influence on the upland infrastructure. For example, a loss of the coastal spit may lead to an increase in wave energy or flooding potential in the landward areas. It may be reasonable to further assess this area to understand potential changes that may occur in the future.

Figure 10. Coastal spit extending north of Cuffee's Beach and forming a coastal embayment.

5. The current wetland and salt marsh regions directly south of the dump and dump road has the potential for significant change due to climate change and projected sea level rise. Figure 11 shows a portion of this area under current conditions; however, with increased mean sea level, this region has the potential to undergo significant changes.

Figure 11. Wetland and salt marsh area located directly south of the Nation dump and Dump Road.

Site Specific Existing Conditions and Areas of Concern

During a 100-year storm in 2050, not only do all coastal properties experience flooding, but the cemetery, the dump, and many houses and structures located a considerable distance from the shore (e.g., houses along Dump Road and East Point Road) will be flooded. Roads will also be impacted during the storm, inhibiting emergency access and evacuation routes to and from the southern part of the peninsula. Some of the key areas that have been identified as vulnerable to flooding, include, but are not limited to:

- **Cemetery Area** – Although the cemetery itself will not be inundated by high tides on a daily basis in 2050, it is flanked on both the north and south by wetland areas that will experience elevated water levels. This will increase the cemetery's vulnerability to flooding during even minor storms in the future. Therefore, this area represents a region where near-term action may be required to prepare for projected sea level rise and provide protection during moderate storm events.

- **The wetland areas south of Dump Road** – The waste collection facility at the end of Dump Road is not directly affected by flooding associated with sea level rise predictions or associated with normal tides. However, the wetland areas to the south are significantly influenced by the increased sea levels, resulting in transformation of the ecology in this area. In addition, during a 100-year storm, both the access road and the dump facility itself will likely experience flooding.

This may result in a requirement to relocate this facility and/or has the potential to create debris problems, as floatables are transported from the dump to other locations.

- **Areas North of Cuffee's Beach** – This region, consisting of a coastal spit and embayment, is projected to change significantly with sea level rise. The coastal spit will be regularly overtopped by daily tides, the wetland areas will expand, and coastal properties, houses, and structures surrounding the fringes of the wetland areas will likely experience minor flooding. During 100-year storm events, significant flooding is expected along the western shoreline in this area.

- **Old Point Road** – Access to the properties at the southern end of the road will likely be flooded and potentially impassable during high tides in 2050. Additionally, the properties along the eastern side of Old Point Road may experience some minor flooding on a daily basis in 2050. During 100-year storm events, a majority of Old Point Road properties, specifically those on the eastern coastline, will be inundated with flood waters.

- **Wetland and Salt marsh areas** – Much of the predicted inundation will occur in undeveloped areas, with the majority being salt marsh habitat. Since the majority of these areas are not bordered by roads, hardened structures or other developed infrastructure, it's likely that the altered water levels and tidal regimes will cause salt marsh habitats to migrate landwards into areas that are now upland. Exact transitions will depend on topographic elevations of the surrounding areas.

In addition to the main peninsula of the Shinnecock Nation located on Shinnecock Bay, there is an additional land parcel owned by the Nation on Great Peconic Bay. The coastal bank at this site is experiencing some erosion (Figure 12); however, this erosion only occurs during significant storm events like Hurricane Sandy. The area also has a substantial coastal beach and adequate natural sediment supply. There is also no vital infrastructure to protect on the upland portion of this site, and it fronts a relatively protective water body (Great Peconic Bay). Therefore, it is recommended that this area continue to be monitored, but no specific adaptation is recommended currently.

Figure 12. Peconic Bay shoreline of the Shinnecock Nation lands off Bayview Avenue.

Summary of Potential Climate Change Vulnerabilities

Sectors and Potential Climate Change Impacts	
Sector	**Impacts**
Hydrology and water resources	• Flooding occurs during significant storm surges • Warmer temperatures during winter
Agriculture	• Increased risk of pest outbreaks • Increased risk of lyme disease
Biodiversity	• Increased risk for invasive species
Forests (incuding parks and urban forests)	• Reduced opportunities for cold season recreation due to decreased snowpack and/or reduced snow or ice quality
Energy	• Reduced heating demand during winter months • Increased cooling demand during summer months
Transportation	• Evacuation routes needed in case of flood and storms
Infrastructure	• Need for new upgraded flood control and erosion control structures • Need for protection of flood control and erosion control structures from off road vehicles (no vehicle access)

Sectors and Potential Climate Change Impacts	
Sector	**Impacts**
	• Need to replace and upgrade drainage system of salt marshes near burial ground to allow adequate tidal flushing to and from the marsh area
Coastal resources and ecosystems	• Increased erosion or damage to coastal infrastructure, dunes, beaches and other natural features due to sea level rise and storm surges • Increased risk of saltwater intrusion in drinking water wells • Increased risk in loss of cultural and historical sites on coastline to sea level rise and related impacts
Aquatic ecosystems	• Shifts in species range and distribution • Sandbar formed in a new location • Increased risk of bacteria contaminating shellfish
Business	• Impacts on business infrastructure and buildings • Need for generators for Nation offices for back-up power
Health	• Heat-related stress, particularly among the elderly, the poor and other vulnerable populations • Increase in vector-borne illnesses (e.g. West Nile, Lyme Disease)
Emergency response	• Increased demands on emergency response services related to extreme weather events • Increased demand for warming center for Nation residents during power outages • Need for generators for Nation offices for back-up power

4. Recommended Goals and Actions

Below are several specific recommendations for further assessment that may be useful in further refinement and implementation of the Climate Change Adaptation Plan. Specific recommendations include:

- **Local shoreline change analysis** - A shoreline change analysis provides long-term trends of erosion or accretion along a shoreline, can assess effects of anthropogenic structures, and determine the impact major storms. Woods Hole Group conducted a review of previously performed shoreline change analyses for the Shinnecock area. There are a number of privately funded studies analyzing shoreline change along the Atlantic coast of Long Island's southern barrier islands. Additionally, the U.S. Geological Survey (USGS) compiled shorelines from 15 different years between 1830 and 2007, but these also only encompass the Atlantic shoreline of the southern Long Island barrier islands, and therefore do not assess shoreline change on the Shinnecock Nation lands. Given the lack of currently available data for the long- and short-term trends in shoreline change along the Shinnecock coastline, Woods Hole Group recommends performing a shoreline change analysis and assessment of overall erosion rates as part of future storm planning.

- **Development of a long-term monitoring program** – An important aspect of climate change adaptation and planning is monitoring changes in physical processes and shoreline response. For example, with appropriate monitoring data, the actual rate of site-specific sea level rise can be determined and decisions can be made on timing of potential coastal hazard mitigation options. Development of a monitoring program, including appropriate instrumentation, protocols, and data management could easily be developed for the Nation such that they could conduct their own monitoring of coastal erosion and water level changes. It is expected that a monitoring program would include, but not be limited to, observations of water levels and shoreline change.

- **Assessment of estuaries and wetlands in the Shinnecock Nation peninsula** – This recommendation involves assessment of the existing estuary areas around the Shinnecock Nation peninsula. Specifically, assessment of tidally restricted estuaries would be conducted. This would include the marsh systems directly adjacent to the cemetery that likely have reduced flushing, drainage ability, and water quality.

- **Identify possible conceptual engineering adaptations (phased) that the Nation could consider pursuing** – This recommendation involves identifying potential engineering adaptations at site-specific locations through the Shinnecock Nation lands. This may include structural alternatives, adaptable and modular engineering concepts, flood proofing, bioengineered technology, managed retreat/relocation, elevating, flow control structures, and evacuation plans. It is expected that both hard (structural) and soft (e.g., dune restoration) engineering solutions will be considered.

Coastal Climate Adaptation Plans that integrate projected sea-level rise influences into their planning process typically assess the ability of coastal and other structural engineering alternatives (specifically modular and adaptable solutions) to function in response to potential future sea-level rise and/or storm surge events. Conceptual engineering alternatives typically include site-specific solutions and more regional approaches. Solutions include engineering alternatives that address vulnerable pathways of flood waters to intercept flooding before it reaches vulnerable infrastructure. Coastal protection and flood management alternatives can include, but are not limited to, structural alternatives, adaptable and modular engineering concepts, flood proofing, bioengineered technology, managed retreat/relocation, elevating, flow control structures, and evacuation plans.

Many solutions are focused on alternatives that are adaptable with time. For example, adjustable modular seawalls can be installed (increase or decrease crest, modify thickness, etc.) as sea levels change. These concepts provide alternatives and planning approaches to mitigate, minimize, or adapt to effects of sea level rise and storm events. Pros and cons of the potential adaptation options and alternatives should be evaluated, along with approximate construction and maintenance costs for planning purposes. Due to the inherent uncertainty in sea-level rise predictions, the planning should be supplemented with ongoing observations to help guide the selection, design, and implementation timeframe for potential solutions. Certain adaptations or engineering solutions may not be required at the present time, but may become more critical in the future.

Figure # Building oyster reef at Point Peter *©Mike Horak/TNC*

Offshore

Changing climate will likely lead to more, stronger nor'easters and hurricanes. Building oyster reefs and restoring submersed aquatic vegetation will lessen wave action and reduce shoreline erosion. New reef and submersed aquatic vegetation beds created today will also ensure that oysters along with other fish and shellfish, continue to thrive in the face in the face of climate change.

On The Shore

As salt water moves over the land, the ecosystem will change. Native plants and trees may disappear and along with them the stability that their roots have provided. Removing nonnative invasive plants such as *Phragmites australis* and restoring native marsh grasses will build back the shoreline's natural resilience. Planting flood tolerant trees like black gum and bald cypress now will help make the shoreline more stable as water moves inland.

Inland

Man has altered the land by cutting drainage ditches. As sea level rises, these canals will allow saltwater to move deeper into the refuge. Plugging ditches and installing water control structures will allow us to manage the water levels and reduce saltwater intrusion.

Shaping The Future

As the world heats up, sea level rises. The shoreline erodes. Salt water intrudes inland into freshwater areas. Some species will disappear. Others will appear. We must act now to make sure that this new ecosystem is thriving and productive.

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