

Sustainable Shorelines Community Management in Northern Virginia

Phase II Report December 2012

Prepared by Northern Virginia Regional Commission

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Northern Virginia
Sustainable Shoreline and Community Management Project





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Phase II Report December 2012

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Introduction

The Sustainable Shorelines and Community Management Project is a collaborative planning effort between the localities, major landholders, and universities in Northern Virginia that border the tidal Potomac River. The project regionalizes planning efforts for relative sea level rise and storm surge, along Northern Virginia's approximate 100 miles of tidal shoreline.

Phase II, of this three phase project, refines the risk and vulnerability assessment and initiates the development of draft adaptation strategies for local consideration.

This report fulfills the product requirements set forth in the 2009 Virginia Coastal Zone Management Program Grant, Task 12.06 (NOAA Grant #NA09NOS4190163) for:

1. Workgroup Outcome Report
2. Vulnerability Maps and Report (Vulnerability Assessment)
3. Draft Adaptation Strategy Report

To support the development of these products, NVRC and its partners conducted a variety of efforts to engage a diverse group of constituents through surveys, meetings, and workshops.

Additionally, during this time a concurrent effort with the Metropolitan Washington Council of Governments began, as they worked to develop a Guidebook for Regional Adaptation, with the US Environmental Protection Agency. NVRC staff were active participants throughout this process.

About the Project



Sustainable Shorelines Community Management in Northern Virginia addresses coastal hazards and sea level rise preparation in a collaborative manner. The project focuses on inventorying existing data resources and policies to determine the vulnerability and risks to natural and man-made resources, identify data gaps, and understand current local shoreline management regulations. The project has a region-wide importance as several jurisdictions have significant resources and communities located within the tidal area of the Potomac River and its tributaries.





Workgroup Outcome Report





Workgroup Outcome Report

NVRC and the Virginia Network for the Education of Municipal Officials (NEMO) program coordinated a workgroup comprised of staff representatives from localities, military installations, universities, major land managers, including the National Park Service, DCR – State Parks, and the US Fish and Wildlife Service – Occoquan Complex, VDOT, George Mason University, and key staff from Arlington County and the City of Alexandria. Individual meetings were held with organizations and agencies such as the Towns of Quantico, Dumfries and Occoquan, who might be interested in participating due to their vested interest in the Potomac River shoreline.

The workgroup engaged in discussions and work sessions facilitated by NVRC and Virginia NEMO, which focused on the economic implications of sea level rise in the region, the refinement of the vulnerability analysis based on data collected by the Virginia Institute of Marine Sciences, the coordination of the information collected through the project with the Northern Virginia Hazard Mitigation Plan, and the development of a survey to better understand the knowledge, attitudes, and concerns of waterfront property owners in Northern Virginia.

Economic Implications

The workgroup decided that there was no need to express the value of areas lost in dollar amounts, as it is clear to see from the vulnerability maps that there will be significant economic impacts and assumptions could be made simply based on the general value of the region’s residential and commercial waterfront properties. Workgroup members shared their experiences determining and implementing protective strategies in areas with frequent inundation from storm surge and riverine flooding events. They shared that many of the strategies are based on a cost-benefit analysis and that perhaps the draft adaptation strategy could include a consistent method for conducting a cost-benefit analysis and matrix of adaptation strategies.

Vulnerability Assessment Refinement

Using the shoreline condition report data collected and prepared by the Virginia Institute of Marine Sciences, NVRC prepared new maps that feature shorelines that are currently hardened and those that are currently “natural.” The workgroup reviewed this information to identify the implications to areas



Discussions with the workgroup supported the successful integration of projected sea level rise and storm surge information into the 2010 Northern Virginia Hazard Mitigation Plan.

This is the first time that the region’s Mitigation Plan includes these future scenarios.





with significant natural resource assets, such as tidal wetlands that require soft shorelines for potential migration.

Northern Virginia Hazard Mitigation Plan

Discussions with the workgroup helped to shape elements of the vulnerability report and the draft adaptation strategy, as well as proved successful in integrating pertinent information and maps into the Northern Virginia Hazard Mitigation Plan. The workgroup discussed the important similarities between the mitigation strategies of the plan and adaptation strategies under discussion. Specifically Feedback from the workgroup was solicited regarding the outreach and messaging of the project. There was consensus that an emphasis should be placed on the similarities between the risks of increased frequency of events. The messaging can make the connection for the public between storm surge, hurricane categories, 100 year storms, and sea level rise. There is a need to depict each of these risks as having similar impacts with varying timelines. The threat of loss of insurance on at risk properties (as identified by insurance agencies) is a growing concern, and a possible avenue to address land use planning strategies.

Also, since the plan is often referenced by floodplain managers and emergency response personnel, it provides a vehicle for ensuring that strategies and efforts are consistent across various disciplines. (NV Hazard Plan to be included in final report)

Waterfront Property Owner Survey

The workgroup recognized the importance of public perceptions in planning for future considerations, particularly the perspectives of the region's waterfront property owners who are the most vulnerable population to sea level rise and storm surge. With support from NOAA – Coastal Services Center and Virginia NEMO, NVRC developed a draft survey which the workgroup members helped to revise. Major elements of the survey included questions address the condition of the property, and whether or not the property has been adversely affected by weather events, such as:

"In the past, has your waterfront property and/or shoreline been affected by adverse weather events and subsequent physical impacts, such as shoreline erosion and/or flooding?"

Many of the respondents stated their property and shoreline have been affected by past adverse weather events. Hurricane Isabel (2008) was most frequently referenced, with other events Hurricane Fran (1996) and Hurricane Floyd (1999). However, the results of the survey reveal frustrations with non-weather related events,

Respondents and Residence

The majority of respondents who stated their waterfront property is their primary residence have owned their property for more than 10 years, with an average residence of 21 years. One resident stated they have lived in their current place of residence for 56 years.

Additionally, the majority of Northern Virginia's waterfront property owners plan to own their property for an additional 20 years or more, with the intent of passing it along to heirs.



particularly the adverse effects of Hydrilla and shoreline erosion from boat wakes.

Respondents are split evenly regarding their level of concern over the effects of current erosion, flooding, increased high tide and sea level rise on their property and structures. Those respondents who described being affected by adverse weather events in the past more frequently stated they are concerned that erosion, flooding, increased high tides, and/or sea-level rise would affect them over the next 30 years.

Waterfront property owners in Northern Virginia are more likely to implement a hardened structure to protect their property. The vast majority are familiar with floodplain maps and information available regarding their property. Respondents seem willing to support potential changes to zoning and regulation that would change the location of future development and redevelopment to better protect from the impacts of coastal natural forces. However, a significant number of respondents would not be willing to support this initiative or do not have enough information to make a judgment.

The full survey results can be found in the Appendix B.

There was tremendous value in engaging a diverse workgroup early in this project. By participating in the workgroup meetings, these individuals have become resources for their respective organizations, as well as for additional efforts taking place across the region, including the development of the Northern Virginia Hazard Mitigation Plan and the development of a Regional Adaptation Guidebook by the Metropolitan Washington Council of Governments. Although it is difficult to ensure complete attendance at every meeting, NVRC staff attempted to keep workgroup members as informed as possible.



Vulnerability Assessment





Map of the Region



Study Area





Vulnerability Assessment

Introduction

When compared to more traditional coastal communities that have expansive low-lying areas, Northern Virginia's shorelines are relatively high. Therefore the region will not experience wide-scale inundation from sea level rise and the areas at risk ("hot spots") are those that are most likely to currently experience temporary inundation from storm surge or riverine flooding.

The vulnerability maps and report begins with a general overview of regional conditions and considerations for two of the four following hot spots. This report will focus on Arlington County and the City of Alexandria with an analysis of the demographic and general economic considerations. The following are the four area "hot spots".

Arlington County

- National Airport
- Four Mile Run Corridor

City of Alexandria

- Four Mile Run Corridor
- Daingerfield Island
- Old Town
- Jones Point

Fairfax County

- Huntington
- Belle Haven/New Alexandria
- Dyke Marsh
- Tidal Embayments
- Hallowing Point

Prince William County

- Occoquan River
- Occoquan National Wildlife Refuge
- Tidal Embalyments
- Town of Quantico



Methodology

The vulnerability assessment is based on the following sea level rise scenarios identified in Phase I of the project:

| Scenario | Definition | Rate |
|---------------------|--|---|
| Steady State | Observed historic trend at Washington, D.C. tide gage. (NOAA Tides and Currents, Station 8594900) | 3.2 mm/year (1 foot by 2100) |
| Average Accelerated | Average projected sea level rise rate for the Chesapeake Bay region. (IPCC, 2007; STAC, 2008; and GCCC, 2008) | 11.6 mm/year (1.9 feet by 2050; 3.8 feet by 2100) |
| Worst Case | Highest projected rate for the mid-Atlantic and Chesapeake Bay regions. (STAC, 2008 and GCCC, 2008) | 16 mm/year (2.6 feet by 2050; 5.2 feet by 2100) |

Using a simple topographic assessment, NVRC mapped these scenarios using LiDAR data collected by the US Department of Defense in October 2008. To understand the extent of inundation that could occur on a daily basis, the scenarios were added to the mean high high water level, the average of the highest tides each tidal day, as observed over a 19-year period¹.

Therefore, the maps feature the following five inundation scenarios:

| | |
|------------------------------|--|
| Mean High Water (MHW): | the area that inundates currently at an average high tide |
| Mean High High Water (MHHW): | the area that inundates at the average of the highest tides each tidal day, as observed over a 19-year period. |
| Steady State: | MHHW + 1 foot of projected sea level rise |
| Average Accelerated: | MHHW + 3 feet of projected sea level rise |
| Worst Case: | MHHW + 5 feet of projected sea level rise |

¹ National Oceanic and Atmospheric Administration. *Tidal Datums*.
http://tidesandcurrents.noaa.gov/datum_options.html



This raster data of each scenario was converted to features in order to perform the analysis of impacts to infrastructure and natural assets provided through local GIS datasets. Impacts were quantified by intersecting the extent of scenarios with the following shapefiles:

| Category | Data Layers Used in the Assessment |
|-----------------------|--|
| "Planned" Environment | <ul style="list-style-type: none"> • Zoning • Parcels • Floodplains |
| "Built" Environment | <ul style="list-style-type: none"> • Roadways and Parking Lots • Buildings • Schools • Hospitals • Fire & Rescue • Police Stations • Other Critical Infrastructure (Water Pollution Control Plants) |
| "Natural" Environment | <ul style="list-style-type: none"> • Tidal Wetlands • Intact Forest Cover • Parkland |

Census datasets provided access to demographic information to characterize the hot spots. Each hot spot is characterized by the following demographic information: population, % age 60+, disability, poverty, race & ethnicity, and financial characteristics of the households. A general economic evaluation of hot spots was conducted as well using the following census information characterizing business and industry: assets & capital, employment, and sales, receipts, revenues, and shipments.

Protection strategies should be considered for critical infrastructure located along the Potomac River shoreline. Underutilized lands that are directly adjacent to the Potomac River located in the following hot spot areas should be viewed as potential investment areas for adaptation strategies to occur. The majority of the region’s shorelines will not change in the future. Areas of Northern Virginia’s shorelines that are actively eroding will continue to experience this erosion. Protection strategies can provide multiple long-term benefits to the shoreline.

To assess the economic impact of each hot spot, the number of structures including homes, businesses, roads and existing shoreline hardening, and the amount of acres inundated by sea level rise is necessary to quantify to calculate the total long term impact costs of sea level rise. This impact analysis can then be used to pose pertinent questions that local governments will need to consider concerning public health, safety and welfare.



Detailed Study Area One: Arlington County

In Arlington County, the National Park Service owns the majority of Potomac River frontage as part of the George Washington Memorial Parkway. With an average elevation of roughly 16 feet (5 meters) the Parkway serves as a natural barrier to rising waters. However, two areas outside of the National Park Service jurisdiction are vulnerable to permanent inundation due to sea level rise, based on a



worst-case scenario of five feet above current Mean High High Water. Both Ronald Reagan Washington National Airport and infrastructure located within the Four Mile Run corridor are significant resources.

Ronald Reagan Washington National Airport

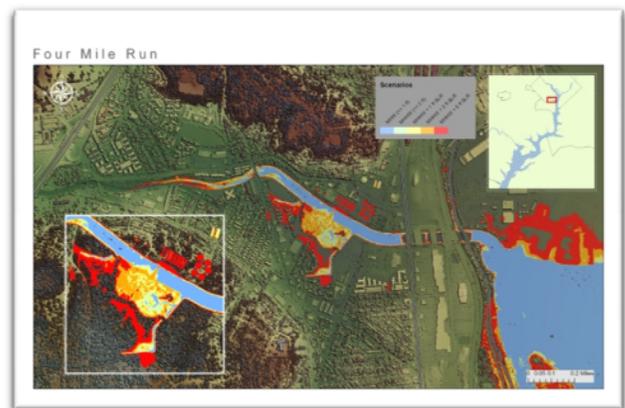
Located adjacent to the Potomac River, Ronald Reagan Washington National Airport services over 18 million passengers annually². The lowest-lying areas along the airport perimeter are most vulnerable to permanent inundation from a five-foot rise in sea level rise. These areas include existing stormwater management trenches and significant portions of a parking lot at the southern tip of the airport.

Based on the assessment, there will not be significant impacts to existing buildings, runways, and other infrastructure critical to sustaining operation at the airport.

Four Mile Run Corridor

Forming the border between Arlington County and the City of Alexandria, the Four Mile Run Corridor is a resource of local importance. Four Mile Run's flood history resulted in the channelization of the stream by the US Army Corps of Engineers in the early-1980s. In 2006, the localities, NVRC, and the Corps released a master plan to restore the stream channel using bio-engineering techniques.

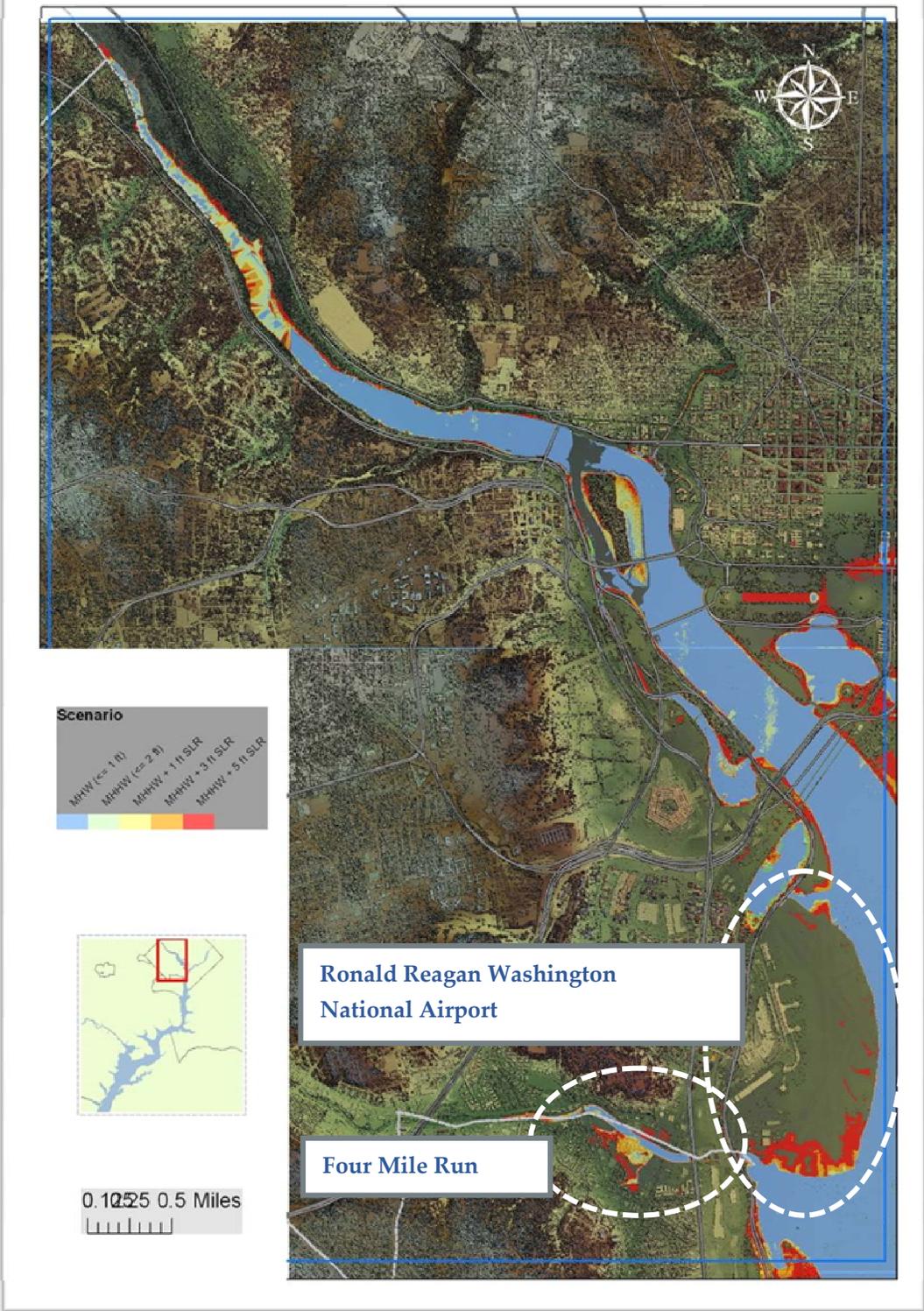
The armoring of the channel acts as a barrier to rising waters. However, areas along the water pollution control plant along the tidal portion of the waterway are low enough in elevation that it will experience some inundation, particularly at the worst-case scenario. Additionally, considerations should be made regarding the future capacity of the channel to maintain flood mitigation purposes.



² Metropolitan Washington Airports Authority. *Ronald Reagan Washington National Airport (DCA) Air Traffic Statistics*. <http://www.metwashairports.com/reagan/1279.htm>



Arlington County





Detailed Study Area Two: City of Alexandria

The City of Alexandria has a rich maritime history, serving as an important port to Washington, D.C. during the 18th century. The waterfront remains a defining characteristic of the City, with significant residential, commercial, and park assets located adjacent to the Potomac River. The City grapples with frequent flooding of the Old Town area on an annual basis and will experience more frequent flooding as sea levels rise. The risk and vulnerability assessment identified the four hot spots identified on the previous page and located along the City's waterfront.



Four Mile Run Corridor

The Four Mile Run corridor serves as the boundary between the City of Alexandria and Arlington County. In the City, the area at risk is part of a City-owned park, which includes both passive and active recreation features. Additionally, a large wetlands complex built as part of the mitigation efforts from the Woodrow Wilson Bridge expansion is located within this area.

The City does not have any critical infrastructure located within this area that is vulnerable to permanent inundation nor is there any concern about implications to residences. However, there will be impacts along Four Mile Run Park and to the wetlands complex should space not be available for upland migration.

Daingerfield Island

Although Daingerfield Island is currently a peninsula, it may become a true island should there be a moderate rise in sea level. At just over 100 acres and part of the George Washington Memorial Parkway, Daingerfield Island features a marina, restaurant, and passive parkland, which are all vulnerable to sea level rise.

Old Town Alexandria

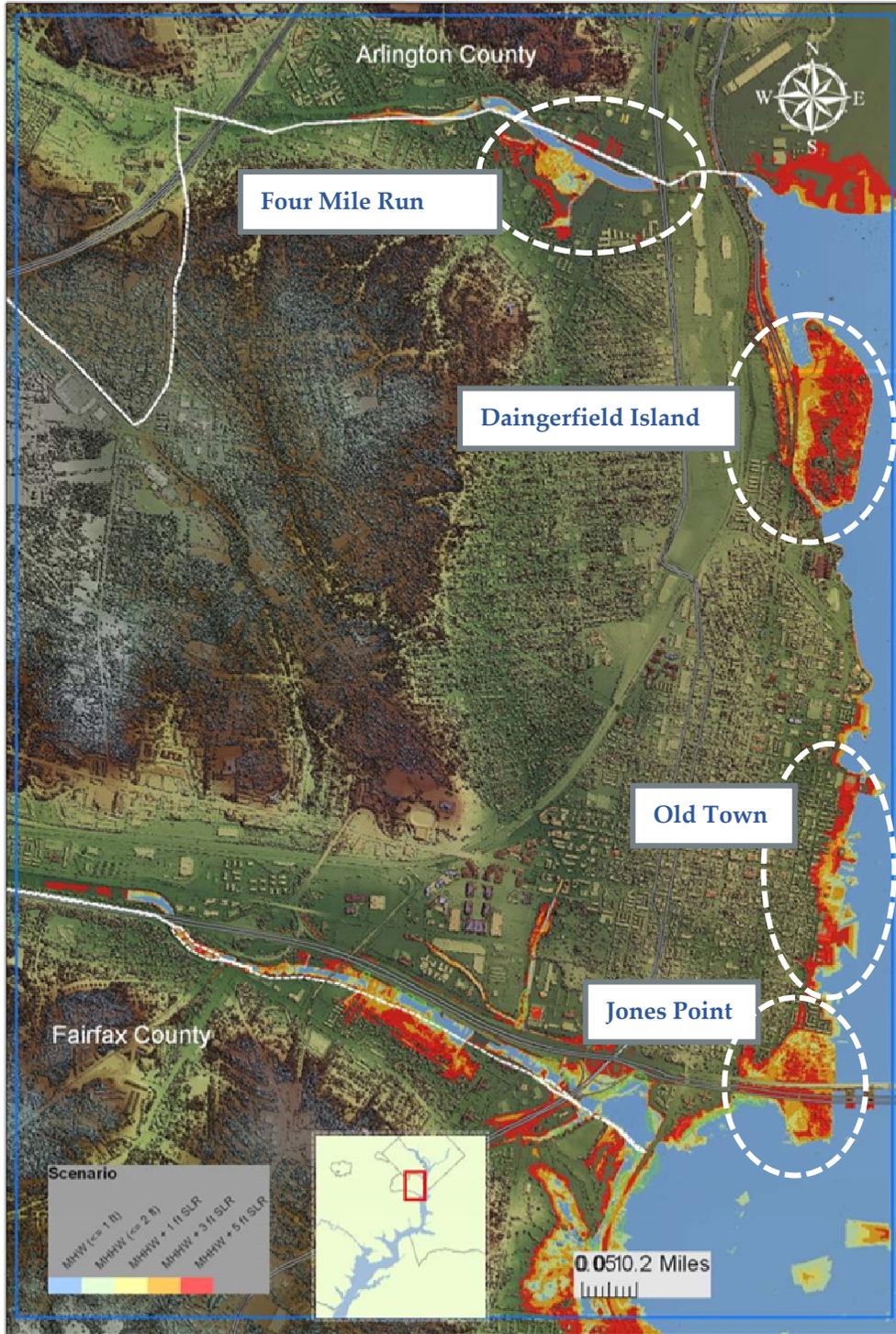
The City of Alexandria may be best known for its Old Town. The lower portion of King Street, near the Torpedo Factory currently experiences frequent inundation during high tides and storm events. The City has a plan in place, currently employed to utilize sandbags in order to protect the commercial areas located in this low-lying area. This strategy has proven effective, though evaluation information is not yet available for this simple effective measure.

Jones Point

Jones Point, located at the southern most tip of Alexandria is the area that will most be affected with moderate rise in sea level. Jones Point is a NPS federally owned, City operated park that includes a fishing pier, passive and semi-active recreation areas. The park includes wetland and marsh areas.



City of Alexandria



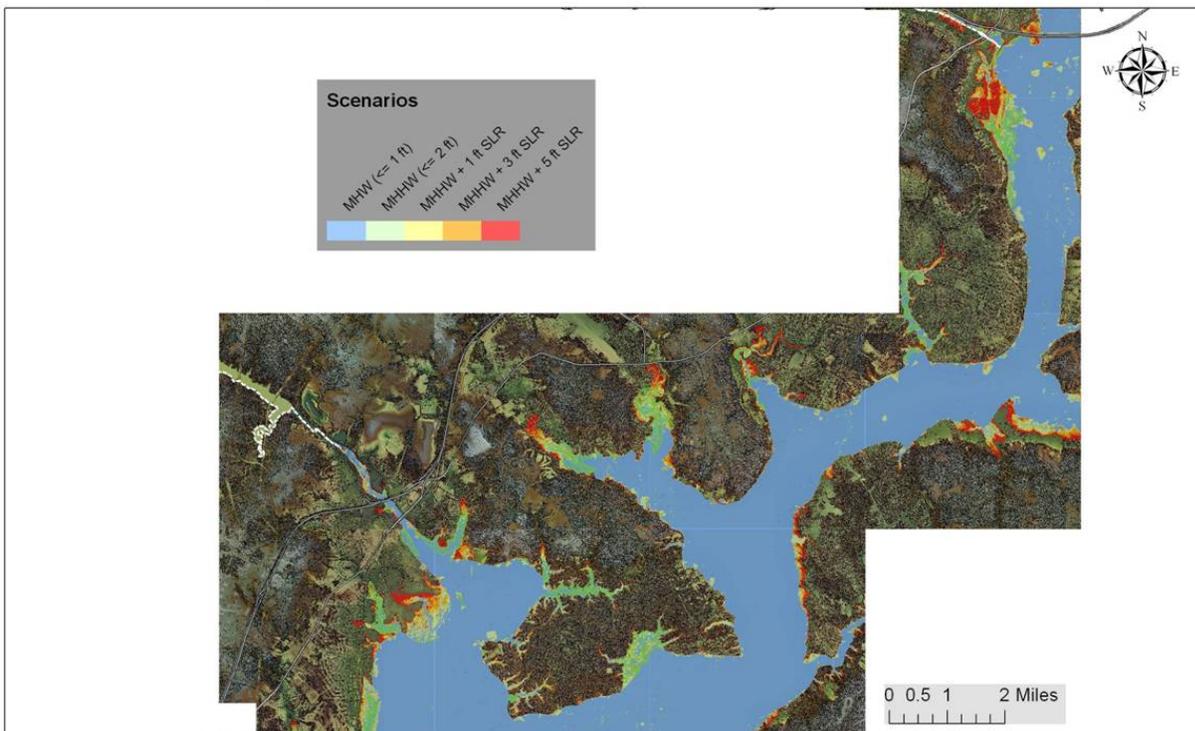


Fairfax County

As part of the Study, data concluded that the hot spots in Fairfax County include:

Huntington, Belle Haven/New Alexandria, Dyke Marsh, Hallowing Point and Tidal Embayments. Emphasis has been placed on Huntington based on recent storm activity. A full set of recommendations are underway for the area, including new levees and pump stations. In the case of Huntington political decisions were made to keep the neighborhoods intact, creating challenges to protection. As with all strategies, economic, political and social goals and objectives combine to create a solution for a specific area.

Fairfax County

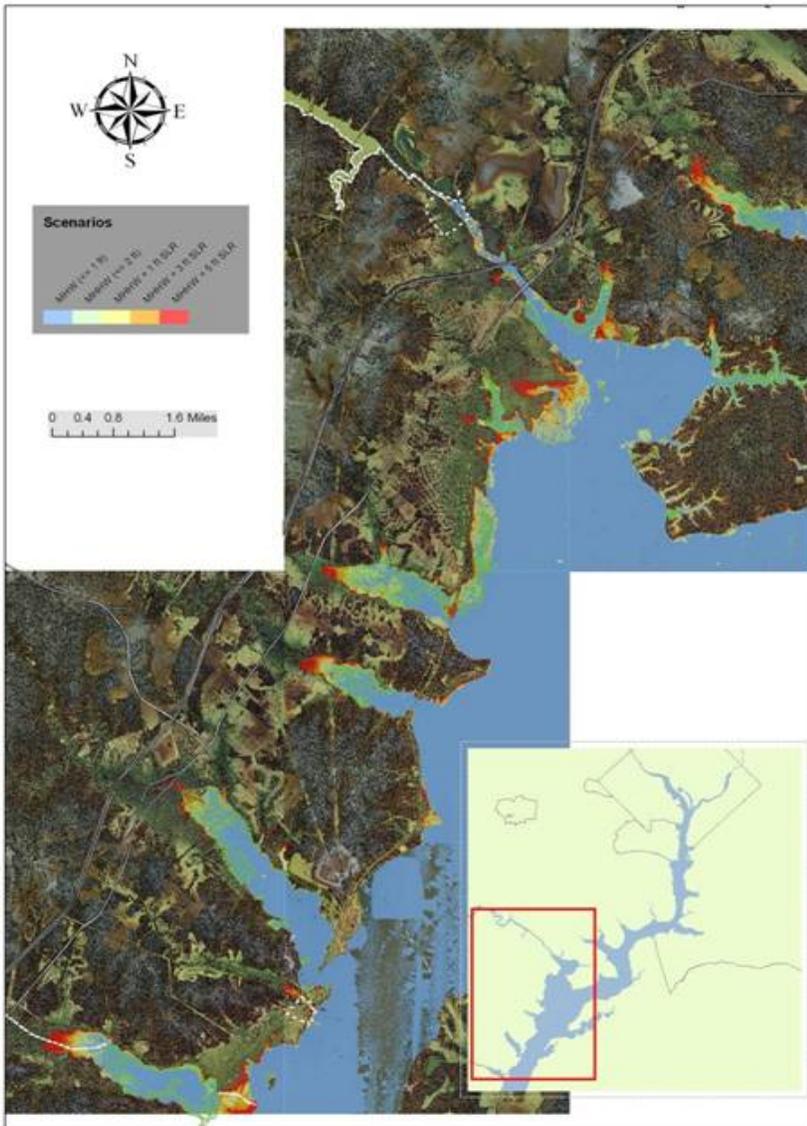


Prince William County

Also as part of the Vulnerability Analysis, the following were designated as hot spots in Prince William County: Occoquan Riverfront Properties, Occoquan National Wildlife Refuge, Tidal Embayments and the Town of Quantico



Prince William County



Summary

Northern Virginia will not experience wide-scale inundation due to sea level rise. However, there are hot spot locations that on a small scale will see impacts to their social, economic, and environmental assets. Some of these areas, such as Old Town Alexandria, the Occoquan Riverfront, Dyke Marsh, and the Town of Quantico are important and vibrant characteristics of the Northern Virginia region.

NVRC recommends that localities focus their attention on these areas, along with the other hot spots identified through the assessment to determine adaptive management strategies to protect communities from future permanent inundation.



Draft Adaptation Strategy





Draft Adaptation Strategy

Resilience Re-sil-ilence \ri-'zil-yen(t)s\

An ability to recover from or adjust easily to misfortune or change.

Merriam-Webster Dictionary

Introduction

Preparing communities for climate change-related events requires a proactive approach that anticipates events and recognizes uncertainty.

The Draft Adaptation Strategy provides recommendations for Northern Virginia’s local governments to consider as they support local coastal communities in preparing and anticipating inundation from sea level rise and storm surge events. The intent of this strategy is to serve as a guide and list of options, which each community/locality may incorporate into a plan that is tailored to their unique interests and challenges.

Strategies are divided into Short-term, Mid-term, and Long-term:

| | Built Environment | | Natural Environment |
|------------|---|--|---|
| | Existing | Future | |
| Short-term |  |  |  |
| Mid-term |  |  |  |
| Long-term |  |  |  |

Short-term: efforts completed within the next 20 years. Benefits will build awareness and trust with local governments.

Homeowners and Community Associations should develop funding mechanisms for establishing a monetary trust for larger scale structural improvements and protections.



Structural designs should incorporate adaptive measures, such that they may be raised and/or reinforced into the future. Design with the life cycle in mind. Use life-cycle cost analysis in weighing benefits against costs of adaptation investments. It is essential to calculate the economic effect of expected climate change impacts on the local economy

Mid-term: Efforts that include strategies that will last 20 – 50 years. Many of Northern Virginia’s jurisdictions are already considering adaptation strategies in their existing planning documents.
Long-term: 50+ years. Many of Northern Virginia’s jurisdictions integrate hazard mitigation planning into their planning cycles. The strategies in these documents are similar to those one might suggest for adapting to climate change.

All Strategies should include scenarios for existing development, future development, critical infrastructure and natural resources. Strategies are necessary to improve resilience of communities & structures located in areas at risk. The region is more vulnerable to temporary inundation from storm surge and has a history of impacts from storm surge carried by Hurricanes and Tropical Storms.

Resilience to impacts from storm surge (coastal hazards) and adaptive capacity must be linked. The higher the level of adaptive capacity can lead to the ability to absorb the impacts of climate change and the rebound capacity to further build resilience.

There is a great deal of information and research on how to develop strategies for adaptation. Successful adaptation strategy development and effective implementation often include using pilot projects to test the social and environmental benefits of the adaptation measure. Encouraging a focus on common threats and common interests will ensure the strategy moves forward. Understanding the benefits of one measure over another, including costs will help prioritize the strategy implementation.

There is an association between the cost of doing nothing vs. the costs of the adaptation measures. The absence of the information between these extremes makes it difficult to move any measure forward. Both the cost of implementing the measures, as well as the “do nothing” scenario must be determined to inform the decision making process.

The Policy Inventory Toolbox

The Policy inventory toolbox contains the essential tools to prioritize and implement Adaptation Strategies: Public Health Programs; Hazard Mitigation Planning; and Land Use Planning.

Public Health Programs provides the avenues to allow adaptation strategies to move forward through Awareness & Alerts, Air Quality, Immunizations & Vaccinations, Pollution Prevention and Pest Surveillance & Control.



Hazard Mitigation Planning ensures that regardless of the stance on the science of sea level rise, the threat exists and must be mitigated. These natural hazards such as flooding, winter storms, droughts, and wildfires require mitigation goals and objectives. An implementation strategy to accommodate the storm surge relating to flooding and winter storms, and the impact of erosion and sediment with drought and wildfires can counter the adverse effects of climate change and sea level rise.

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Land Use Planning is a critical component that can promote adaptation strategies through:

- Comprehensive Plan
 - Floodplain Management
 - Shoreline Management
 - Zoning Ordinances
 - Overlay Districts
 - Subdivision Ordinances
 - Wetlands Ordinances
 - Open Space & Recreation
 - Chesapeake Bay Preservation
- Master Plans
 - Public Space
 - Waterfront/Shoreline
 - Watershed



- Local Initiatives
 - Eco-City Charters
 - Smart Growth
 - Cool Counties
 - Cool Cities

The City of Alexandria, in their 'ECO CITY PLAN' has outlined adaptation measures that straddle and include all department initiatives.

City of Alexandria Energy and Climate Change Action Plan 2012 - 2020

Preliminary List of Climate Change Impacts and Preparedness Goals and Actions

| Impact 1*: Sea-level rise and the likely increase in hurricane intensity and associated storm surge will be among the most serious consequences of climate change | |
|---|---|
| Goal: | Preparedness Action: |
| Reduce property damage from erosion, flooding events, sea-level rise, high wind events | <ul style="list-style-type: none"> • Update the flood management program to take into account anticipated rises in Potomac River levels and the increased intensity of storm-related flooding • Fund and implement the Four Mile Run Master Plan and demonstration project and continue implementation of Cameron Run/Holmes Run feasibility study to maintain flood protection infrastructure • Move or abandon infrastructure in hazardous areas • Change zoning to discourage development in flood hazard areas • Update building codes to require more flood resistant structures in floodplains • Use optimal waterfront locations and infrastructure to avoid or minimize damage that will result from sea/river level changes or surges • Investigate building design standards for buildings that currently experience high wind events (i.e., Gulf Coast states) similar to events that Alexandria may experience in the future • Identify areas that would allow for burial of existing power lines to avoid interruptions due to increased rain or wind events |
| Increase capacity to safely manage storm water | <ul style="list-style-type: none"> • Support and provide information regarding mechanisms to finance infrastructure improvements • Establish long-term dedicated funding mechanisms such as storm water utility fees or other taxes to improve and maintain stormwater infrastructure • Require developers of new buildings to build separate sanitary sewer and stormwater infrastructure as a condition of development approval • Consider use of permeable surfaces to reduce stormwater runoff |
| Reduce flooding and erosion impacts on roads and bridges | <ul style="list-style-type: none"> • Conduct vulnerability assessment of major roadways and bridges in the city to projected rises in Potomac River levels • Increase capacity of stormwater collection systems to accommodate projected changes in precipitation • Use permeable surface treatments wherever possible |
| Impact 2*: Decreased water availability is very likely to affect the region's economy and natural systems | |
| Goal: | Preparedness Action: |



Shoreline Managementabout living shorelines

The Chesapeake Bay Trust defines "Living shorelines" as shoreline stabilization techniques that use natural habitat elements to protect shorelines from erosion while also providing critical habitat for Chesapeake Bay wildlife.

The benefits of living shorelines include:

- Stabilization of the shoreline.
- Protection of surrounding riparian and intertidal environment.
- Improvement of water quality via filtration of upland run-off.
- Creation of habitat for aquatic and terrestrial species.

As the jurisdictions prepare Shoreline Management Plans, these plans need to highlight options for controlling erosion and other shoreline issues. A Living Shoreline Adaptation Strategy in Northern Virginia is currently underway.

Leesylvania Living Shorelines Project:

The project will restore roughly 800 feet of Potomac River shoreline at Leesylvania State Park in Woodbridge, VA.

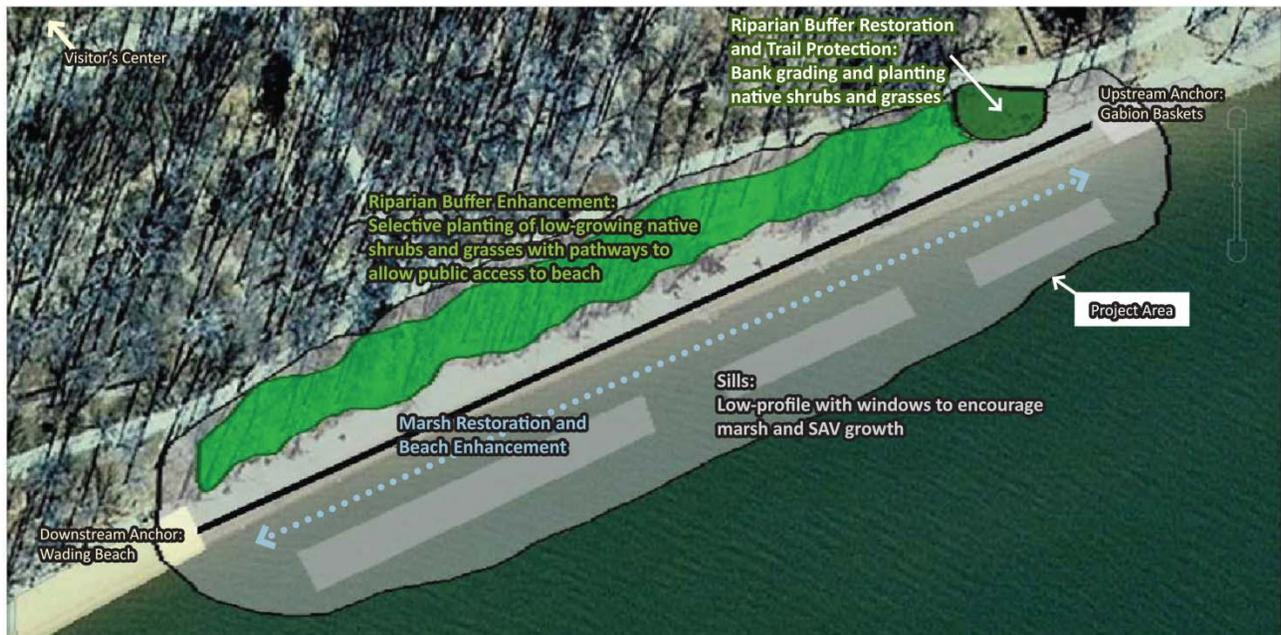
Design includes the restoration of marsh and beach through the installation of sills and vegetation.



Collaborative effort between the Northern Virginia Regional Commission, Virginia State Parks, Prince William County, Virginia Institute of Marine Sciences, NOAA, and the Chesapeake Bay Trust create a synergy to move the effort forward. The design will be complete at the end of calendar year 2012, with a hope to initiate construction in 2013. Leesylvania receives roughly half a million visitors per year, providing excellent exposure of Living Shorelines concepts.



Additionally, the site is located near the visitor’s center, which will be the location of future trainings and seminars for waterfront property owners and contractors. George Mason University is conducting pre-construction monitoring of the fish community at the site, which will help in determining the project’s success in the future.

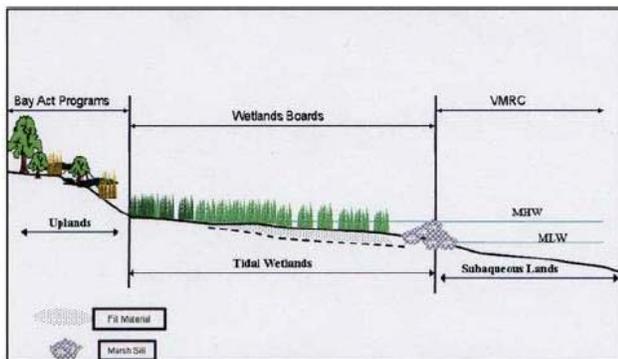


DRAFT PLAN

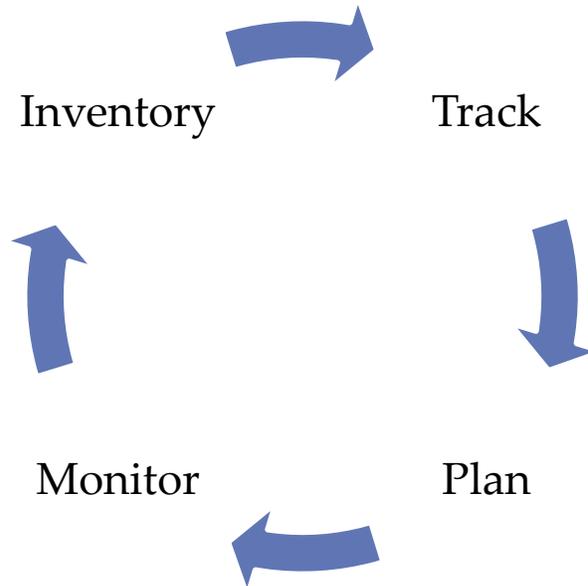
Anticipated Benefits

- 800 linear feet of stabilized shoreline with 22,000 square feet of enhanced riparian buffer habitat
- 25,000 square feet of restored intertidal marsh and beach habitat

Encourage the use of living shorelines and bio-engineering practices along shorelines where SAV and marsh plants are located. Inventory, tracking, planning and monitoring are needed to truly measure successful project objectives and ensure future project development.



Example of shoreline enhancement – Fairfax County Government



Inventory --- Track ---- Plan ---- Monitor

...the mantra to successful development and implementation of Adaptation Strategies

There are on-going efforts in the regional arena that will influence the Draft Adaptation Strategies:

- Regional Hazard Mitigation Plan development
 - Economic Evaluation
- Knowledge, attitudes, opinions of residents
- Continue assessment with VIMS August 2010 Shoreline Situation Reports for City of Alexandria, Fairfax & Prince William Counties

Adaptation Approach must be tailored to each situation, each special environmental conditions.

Adaptation Options Relevant to Estuarine Management Goals (In Northern Virginia)

Management Goal A: Maintain/restore wetlands

Management Goal B: Maintain sediment transport

Management Goal C: Preserve coastal land/development (including infrastructure)

Management Goal D: Maintain Shorelines utilizing “soft” measures

Management Goal E: Maintain Shorelines utilizing “hard” measures

Management Goal F: Invasive species management



Management Goal G: Preserve habitat for vulnerable species

Management Goal H: Maintain water quality

Management Goal I: Maintain water availability

In choosing appropriate adaptation options specific to the above management goals further information is needed for the following adaptation options.

Management Goals which may be applicable to Northern Virginia:

Management Goal A: Maintain/restore wetlands

| Adaptation Option | |
|---|--|
| Incorporate wetland protection into infrastructure planning (e.g., transportation planning, sewer utilities) | |
| Preserve and restore the structural complexity and biodiversity of vegetation in tidal marshes, seagrass meadows, and mangroves | Seagrass meadows and mangroves do not exist, but the concept of preserving biodiversity is valuable for Northern Virginia. |
| Identify and protect ecologically significant (“critical”) areas such as nursery grounds, spawning grounds, and areas of high species diversity | |

Management Goal B: Maintain Sediment Transport

| Adaptation Option | |
|---|--|
| Develop adaptive stormwater management practices (e.g., promoting natural buffers, adequate culvert sizing) | |

Management Goal C: Preserve Coastal Land/Development (Including Infrastructure)

| Adaptation Option | |
|--|----------|
| Land exchange programs – owners exchange property in the floodplain for county-owned land outside the floodplain | TDR, PDR |
| Integrate coastal management into land use planning | |
| Land acquisition program – purchase coastal land that is damaged or prone to damage and use it for conservation | |
| Incorporate consideration of climate change impacts into planning for new infrastructure (e.g., homes, businesses) | |



Management Goal D: Maintain Shorelines Utilizing “Soft” Measures

| Adaptation Option | |
|--|--|
| Replace shoreline armoring with living shorelines – through beach nourishment, planting vegetation, etc. | |
| Remove shoreline hardening structures such as bulkheads, dikes, and other engineered structures to allow for shoreline migration | |
| Plant SAV to stabilized sediment and reduce erosion | |
| Create marsh by planting the appropriate species – typically grasses, sedges, or rushes – in the existing substrate | |
| Install rock sills and other artificial breakwaters in from on tidal marshes along energetic estuarine shoals | |
| Restrict or prohibit development in erosion zones | |
| Redefine riverine flood hazard zones to match projected expansion of flooding frequency and extent | |
| Increase shoreline setbacks | |
| Composite systems – incorporate elements of two or more methods (e.g., breakwater, sand fill, and planting vegetation) | |

Management Goal E: Maintain Shorelines Utilizing “Hard” Measures

| Adaptation Option | |
|--|--|
| Harden shorelines with bulkheads – anchored, vertical barriers constructed at the shoreline to block erosion | |
| Harden shorelines with revetments that armor the slope face of the shoreline | |
| Harden shorelines with breakwaters – structures placed offshore to reduce wave action | |

Management Goal F: Invasive Species Management

| Adaptation Option | |
|--|--|
| Strengthen rules that prevent the introductions of invasive species (e.g., enforce no discharge zones for ballast water) | |
| Remove invasive species and restore native species | |

Management Goal G: Preserve Habitat for Vulnerable Species

| Adaptation Option | |
|--|--|
| Retreat from, and abandonment of, coastal barriers | |
| Purchase upland development rights or property | |



| | |
|---|--------------------------------|
| rights | |
| Expand the planning horizons of land use planning to incorporate longer climate predictions | |
| Connect landscapes with corridors to enable migrations | Conservation Corridors Project |
| Design estuaries with dynamic boundaries and buffers | |
| Replicate habitat types in multiple areas to spread risks associated with climate change | |

Management Goal H: Maintain Water Quality

| | |
|---|--|
| Adaptation Option | |
| Incorporate sea level rise into planning for new infrastructure (e.g., sewage systems) | |
| Develop adaptive stormwater management practices (e.g., remove impervious surface, replace undersized culverts) | |

Management Goal I: Maintain Water Availability

| | |
|--------------------------|--|
| Adaptation Option | |
| | |

Adaptation Options which under research:

Management Goal A: Maintain/restore wetlands

| Adaptation Option | Research/Information Needed |
|---|---|
| Allow coastal wetlands to migrate inland (e.g., through setbacks, density restrictions, land purchases) | |
| Prohibit hard shore protection | *only appropriate in areas that are identified for upland migration |
| Establish rolling easements | Exploration of Dillon Rule state recognized authority to establish rolling easements. |

Management Goal B: Maintain sediment transport

| Adaptation Option | Research/Information Needed |
|--|---|
| Create a regional sediment management plan | Exploration of Dillon Rule state recognized authority to create sediment management plan. |



Management Goal C: Preserve coastal land/development (including infrastructure)

| Adaptation Option | Research/Information Needed |
|--|--|
| Create permitting rules that constrain locations for landfills, hazardous waste dumps, mine tailings, and toxic chemical facilities. | |
| Manage realignment and deliberately realign engineering structures affecting rivers, estuaries, and coastlines | |
| Integrated Coastal Zone Management (ICZM) – using an integrated approach to achieve sustainability | Determine if the scale of ICZM is appropriate at a regional or local level for Northern Virginia |

Management Goal D: Maintaining shorelines through “soft” measures

| Adaptation Option | Research/Information Needed |
|--|---|
| Create dunes along backshore of beach includes planting dune grasses, and sand fencing to induce settling of wind-blown sands. | Additional data needed about dune location from VIMS. |

Management Goal E: Maintain Shorelines Utilizing “Hard” Measures

| Adaptation Option | Research/Information Needed |
|-------------------|-----------------------------|
| | |

Management Goal F: Invasive Species Management

| Adaptation Option | Research/Information Needed |
|-------------------|-----------------------------|
| | |

Management Goal G: Preserve Habitat for Vulnerable Species

| Adaptation Option | Research/Information Needed |
|-------------------|-----------------------------|
| | |

Management Goal H: Maintain Water Quality

| Adaptation Option | Research/Information Needed |
|-------------------|-----------------------------|
| | |

Management Goal I: Maintain Water Availability

| Adaptation Option | Research/Information Needed |
|-------------------|-----------------------------|
| | |



Adaptation Options which are not applicable to Northern Virginia

| Goal | Adaptation Option | Reason |
|------|---|---|
| A | Promote wetland accretion by introducing sediment | Most tidal areas in Northern Virginia currently have sediment overload. |
| A | Remove hard protection or other barriers to tidal and riverine flow (e.g., riverine and tidal dike removals) | |
| B | Trap or add sand through beach nourishment – the addition of sand to a shoreline to enhance or create a beach area | |
| B | Trap sand through construction of groins – a barrier type structure that traps sand by interrupting longshore transport | |
| D | Create dunes along backshore of beach; includes planting dune grasses and sand fencing to induce settling of wind-blown sands | |
| D | Use natural breakwaters of oysters (or install other natural breakwaters) to dissipate wave action and protect shorelines | |
| E | Fortify dikes | No existing dikes |
| E | Harden shorelines with seawalls | |
| H | Plug drainage canals | |
| H | Prevent or limit groundwater extraction from shallow aquifers | |
| I | Establish or broaden “use containment areas” to allocate and cap water withdrawal | |
| I | Integrate climate change scenarios into water supply system | |
| I | Manage water demand (through water reuse, recycling, rainwater harvesting, desalination, etc.) | |



Appendix A – Workgroup Summaries



Northern Virginia

Sustainable Shoreline and Community Management Project

Workgroup Meeting Summary

Northern Virginia Regional Commission Office
Chesapeake Conference Room

December 16, 2009
10 a.m. – noon

- I. Welcome and Introductions**
- II. Catch Up – any work being done across the region**
- III. Relative Sea Level Rise vs. Storm Surge**
- IV. Economic Analysis**
 - a. Comparison of Methodologies
 - b. Discussion



This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA09NOS4190163 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.



In attendance:

| Name | Organization |
|------------------------|---------------------------------------|
| Jeff Harn | Arlington County – DES |
| Todd Janeski | Virginia NEMO |
| Mary Ann Welton | Fairfax County - DPZ |
| Noel Kaplan | Fairfax County - DPZ |
| Camlyln Lewis | Fairfax County - DPWES |
| Greg Weiler | U.S. FWS – Mason Neck Wildlife Refuge |
| Lauryn Sacha | DCR – State Parks |
| Claudia Hamblin-Katnik | City of Alexandria T&ES |
| Craig Perl | City of Alexandria T&ES |
| Randy McBride, PhD | George Mason University |
| Patty Dietz | Prince William County |
| John Muse | VDOT |
| Laura Grape | Northern Virginia Regional Commission |
| Sam Ference | Northern Virginia Regional Commission |

Summary

The workgroup convened to discuss several topics including ongoing work around the region, as well as the purpose and attributes of the upcoming Economic Analysis component of the project.

Recap of Local Initiatives and Regional Efforts

Laura Grape, Senior Environmental Planner with the Northern Virginia Regional Commission welcomed the workgroup and outlined the meeting agenda. Meeting participants introduced themselves and took a few minutes to bring the group up to date on continued progress within their jurisdictions. The group was prompted by Todd Janeski to comment on the use of the Chesapeake Network, the response was positive. It was specifically mentioned that using links in emails helped to navigate the site.

Ms. Grape shared a recommendation from NVRC’s legislative liaison to promote the project as focusing on impacts from “Coastal Hazards,” a broader term, that encompasses sea level rise, storm surge, and erosion, to



reduce the risk for controversy. She opened the floor to discuss the recommendation. Although there was some confusion expressed regarding the use of this term, and how to integrate it into ongoing projects, the group agreed that information should be tailored to the appropriate audience. Several group members highlighted ongoing work meant to raise awareness and public knowledge regarding environmental impacts related to sea level rise. Greg Weiler of U.S. FWS said that the Service has a new policy regarding climate change and that they are pursuing using exhibit space at local parks to explain climate change and potential local impacts. Patty Dietz shared Prince William County's initiative to reach waterfront landowners along the Occoquan Reservoir through workshops that will focus on soft shoreline stabilization methods. Todd Janeski reminded the group that educational initiatives and any work that raises awareness regarding climate change also falls within the President's Chesapeake Bay Executive Order (www.executiveorder.chesapeakebay.net).

For consideration of the workgroup members, Ms. Grape presented results from two studies conducted in Northern Virginia that relate to the group's efforts. These include the Hurricane Assessment Study for the Washington, DC area released by FEMA and USACE (June 2009) and a study of the probable locations of hardened shoreline management structures in response to sea level rise conducted by Titus, et. al., (published October 2009).

FEMA's Hurricane Assessment Study for the Washington, DC area, includes maps that depict inundation zones for worst-case scenario Category 1, 2, 3, and 4 Hurricanes based on outputs from Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model. When compared to the maps depicting relative sea level rise scenarios for the region, surge from a Category 2 hurricane will inundate low-lying areas beyond the worst case scenario for relative sea level rise (5 feet) at a Mean High High Water state, as determined by the Chesapeake Bay Scientific and Technical Advisory Committee (2008). NVRC has continued progressing towards more detailed analysis with the complete LiDAR data set. The newest maps show the potential inundations associated with Category 1-4 Hurricanes, as well as varying sea level rise projections. The purpose of the maps was to be able to visually compare the two impacts, and to visually understand that planning for the water level impacts of storm surge isn't very different than sea level rise. There was discussion among the members about coordinating efforts with local emergency managers, especially regarding the commitments that result from the regional emergency management plan. Ms. Grape specifically mentioned the city of Punta Gorda, Florida which tied their storm surge and sea level rise planning into disaster planning.

In October 2009, an article published in Environmental Research Letters entitled "State and local governments plan for development of most land vulnerable to rising sea level along the U.S. Atlantic Coast" (Titus, J., et al) summarizes the likelihood of shoreline protection as sea level rises. The study includes an assessment of the jurisdictions in Northern Virginia with maps dividing low lands into four categories: developed (shore protection almost certain), intermediate (shore protection likely),

Definitions of four generalized land use categories Titus, et al (2009).

Developed

Moderate and high density development

Intermediate

Existing low density development, places where land use plans anticipate future development, and military bases in rural areas.

Undeveloped

Areas expected to remain undeveloped.

Conservation

Conserved lands



undeveloped (shore protection unlikely), and conservation (no shore protection). Due to the intensely developed nature of Northern Virginia, aside from park and conservation lands, the study suggests that the majority of Northern Virginia's shorelines and low-lying communities are almost certain to be protected. The assessment reveals that shorelines surrounding tidal wetlands that are not already in conservation or park lands are almost certain or likely to be protected. Where applicable, the localities may want consider promoting living shoreline practices in these locations as alternatives to hardened structures thereby allowing upland tidal wetland migration in light of sea level rise. The shoreline condition report in development by the Virginia Institute of Marine Sciences (VIMS) and a future shoreline management plan for the region may support the identification of areas most appropriate for living shoreline techniques. It should be noted that the study's methodologies are based on four generalized land use classifications (see insert for definitions) at elevations between 0 and 5 meters above spring high water and land use classification and are not attributed to a particular rate of sea level rise.

Lastly, the group discussed the details of the economic component of the analysis. Ms. Grape presented two examples of methodologies used by Middle Peninsula Planning District Commission and Worcester County, Maryland. Market and non-market impacts, as well as the differences between sea level rise impacts and storm surge impacts were defined. Mr. Janeski prompted the group to consider which approaches could be the most powerful in effecting policy change. The group agreed to take a hybrid approach that potentially incorporates some modeling of economic impacts that could serve as a planning cost/benefit tool and could be used in support of a communication strategy. Additionally, the group agreed that it would be most useful to conduct economic impact assessments in smaller areas that are most vulnerable to rising sea level while also acknowledging the utility of a broader regional analysis. Through email and Chesapeake Network correspondence, the workgroup will continue to determine the methodology and identify the elements necessary to make the economic component of the effort most useful.

Next Meeting

The next workgroup will take place in March 2010.

Additional Information

Both the FEMA 2009 Hurricane Assessment Study and the article published in Environmental Research Letters are available on the project's Chesapeake Network site by respectively visiting:

<http://www.chesapeakekenetwork.org/library.htm?mode=view&lid=16001&ckey=96251260374532&did=31487>

<http://www.chesapeakekenetwork.org/library.htm?mode=view&did=29843&lid=16001&wf=16010&ckey=96251260374107>



Northern Virginia

Sustainable Shoreline and Community Management Project

Workgroup Meeting Summary

Mason Neck State Park

May 18, 2010
10 a.m. – noon

- I. Welcome and Introductions**
- II. Hazard Mitigation Planning** *Ryan Towell, Dewberry*
- III. Hot Spot Analysis**
- IV. Waterfront Property Owners Survey**
- V. Recent Conference Discussions & Ideas**
- VI. Other Items**



This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA09NOS4190163 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.



In attendance:

| Name | Organization |
|-----------------|---------------------------------------|
| Amy Handen | Chesapeake NEMO |
| Todd Janeski | Virginia NEMO |
| Mary Ann Welton | Fairfax County - DPZ |
| Noel Kaplan | Fairfax County - DPZ |
| Camryn Lewis | Fairfax County - DPWES |
| Ryan Towell | Dewberry |
| Lauryn Sacha | DCR – State Parks |
| Judy Okay | Chesapeake Bay Program |
| Craig Perl | Arlington County T&ES |
| Patty Dietz | Prince William County |
| Laura Grape | Northern Virginia Regional Commission |
| Samantha Kinzer | Northern Virginia Regional Commission |

Summary

The workgroup convened to learn about and discuss the opportunities with the Northern Virginia Hazard Mitigation Plan effort. The group also reviewed the Waterfront Property Owners draft survey and provided feedback.

Welcome and Introductions

Laura Grape, Senior Environmental Planner with the Northern Virginia Regional Commission welcomed the workgroup and outlined the meeting agenda. Meeting participants introduced themselves.

Hazard Mitigation Planning

Ms. Grape briefed the Workgroup on the ongoing efforts of a Hazard Mitigation Plan update that is a shared effort by the Northern Virginia jurisdictions with Arlington County Office of Emergency Management taking the lead role. The plan is a mandatory update required by the Disaster Mitigation Act of 2000 to be eligible for federal



funds. There is consideration to include a climate change component to the plan. Ms. Grape introduced Ryan Towell, a representative of Dewberry and a weather and climate consultant. Ryan is a part of the team of consultants working on the Plan update.

Mr. Towell introduced the components of plan process. The plan is in the Hazard Identification and Risk Assessment phase, which he feels is an appropriate place to consider climate change. There are several benefits to including climate change in the plan; primarily that it has an established funding source and a regular update cycle. Mr. Towell recognized that currently the plan looks at past weather events, but that they may not be a good predictor of future events. If climate change is to be considered, it would require additional modeling and methods to dealing with uncertainty in projections. Dewberry has identified a “low-regrets” approach as the most appropriate way to plan for climate change.

The climate change component of the plan is expected to address sea-level rise through a few mini case studies which look at potential scenarios for locations such as Reagan National Airport and Old Town Alexandria. Ms. Grape recognized the mitigation strategies component as an opportunity for synergy between the Emergency Managers and the Land Use planners. An opportunity for collaboration was recognized between Dewberry and Old Town Alexandria regarding their recent IF curve study. Ms. Grape reminded the workgroup that the 2005 Hazard Mitigation Plan is available on the NVRC website. There was some confusion as to how the two initiatives interact with one another. Ms. Grape clarified that ideally the mitigation strategies of the Hazard Mitigation Plan could be synonymous with adaptation strategies of the Sustainable Shorelines project and could be shaped by both Emergency Managers as well as land use planners.

Recent Conference Discussion and Ideas

Ms. Grape let the workgroup know she will be presenting at the Chief Administrative Officer’s meeting in the upcoming week and she solicited feedback from the workgroup regarding the outreach and messaging of the project as it progresses. There was consensus that an emphasis should be placed on the risks of increased frequency of events. The messaging needs to make the connection for the public between storm surge, hurricane categories, 100 year storms, and sea level rise. There is a need to depict each of these risks as having similar impacts with varying timelines. The threat of loss of insurance on at risk properties (as identified by insurance agencies) is a growing concern, and a possible avenue to address land use planning strategies. The workgroup recognized the need for a comprehensive look at available options, the costs associated with each, and the legal frameworks in which to implement the strategies. It was also agreed that State leadership could be a critical role in implementation.

Ms. Grape briefed the group on the recent Environment Virginia conference at which one session prompted a dialogue on varying approaches to coastal hazard planning. The conversation was led by Skip Styles and Eric Walburg, and the two emphasized following funding, and using existing mechanisms such as wetlands and dunes legislation.



Waterfront Property Owners Survey

Ms. Grape updated the workgroup on the progress of the Waterfront Property Owners Survey which was shaped based on needs identified in a Fall 2009 workgroup meeting. The goal of the survey is to get a baseline understanding of waterfront property owners perspective and priorities regarding coastal hazards and shoreline protection. There are roughly 800 waterfront property owners who will be contacted. The survey was developed with the NOAA Coastal Services Center. The workgroup reviewed the survey and had several recommendations. They suggested a thorough cover letter, graphic inclusions for clarity, and an incentive. They also suggested that there be some prompts that are more open ended.

Other Items

Ms. Grape reminded the workgroup that the Virginia Institute of Marine Science would be updating their shoreline conditions report. NVRC and VIMS are also applying for grant to develop a shoreline management plan, which would identify areas suitable for adaptation options.

Amy Handen, of Chesapeake NEMO provided an update on the Chesapeake Bay Executive Order restoration effort. She highlighted that the different agencies involved are developing actions regarding various aspects of the bay such as habitats, water quality, and public access. The final strategy is posted on the Chesapeake Bay website.

The July workgroup meeting will be a joint workgroup with the Hazard Mitigation Plan workgroup and the date has not yet been determined. Ms. Grape will be emailing the workgroup the Waterfront Property Owners Survey for comment by Friday the 28th.



Members of the Workgroup:

| | |
|------------------------|---|
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Appendix B – Waterfront Property Owner Survey

SURVEY OF NORTHERN VIRGINIA WATERFRONT PROPERTY OWNERS

SUMMARY

INTRODUCTION

In August and September 2010, NVRC mailed the *Survey of Northern Virginia Waterfront Property Owners* to property owners adjacent to the tidal waterways of the region. The purpose of the survey was to better understand the knowledge, attitude, and perceptions of existing and perceived risk due to the negative impacts to building and property resulting from coastal erosion, flooding, increased high tides, and sea level rise.

Additionally, the survey revealed actions homeowners are willing to take themselves and what the perceived role of local, state, and federal government ought to be in preparing for the adverse weather event and damage due to natural forces predicted to occur in Virginia. The summary concludes with some discussion and possible next steps to be considered.

SURVEY RESULTS

Many of the respondents stated their property and shoreline have been affected by past adverse weather events. Hurricane Isabel (2008) was most frequently referenced, with other events Hurricane Fran (1996) and Hurricane Floyd (1999). However, the results of the survey reveal frustrations with non-weather related events, particularly the adverse effects of Hydrilla and shoreline erosion from boat wakes.

Respondents are split evenly regarding their level of concern over the effects of current erosion, flooding, increased high tide and sea level rise on their property and structures. Those respondents

Respondents and Residence

The majority of respondents who stated their waterfront property is their primary residence have owned their property for more than 10 years, with an average residence of 21 years. One resident stated they have lived in their current place of residence for 56 years.

Additionally, the majority of Northern Virginia's waterfront property owners plan to own their property for an additional 20 years or more, with the intent of passing it along to heirs.



who described being affected by adverse weather events in the past more frequently stated they are concerned that erosion, flooding, increased high tides, and/or sea-level rise would affect them over the next 30 years.

Waterfront property owners in Northern Virginia are more likely to implement a hardened structure to protect their property. The vast majority are familiar with floodplain maps and information available regarding their property. Respondents seem willing to support potential changes to zoning and regulation that would change the location of future development and redevelopment to better protect from the impacts of coastal natural forces. However, a significant number of respondents would not be willing to support this initiative or do not have enough information to make a judgment.

To support decisions in pursuing efforts that may help to lessen future property damage, the majority of respondents agreed that grant funding (competitive receipt of money that does not need to be paid back) is the preferred method. However, many are influenced by the actions of their neighbors and the leadership of their local government, as well. In addition, many of the respondents stated they would be willing to apply for a low-interest loan (non-competitive receipt of money that will be paid back over time).

Responses to the question regarding the perceived effectiveness of actions that prepare communities to prevent or lessen damages due to adverse weather/natural forces reveal that the majority of respondents agree strongly or somewhat that Realtors should be required to disclose information about natural forces. The results reveal that there is no one of the suggested actions registers as being more effective over another and that more information is necessary to support decisions on the use of the actions over others.

DISCUSSION

Northern Virginia waterfront property owners need more information regarding their risk and vulnerability to coastal hazards. They are primarily concerned with current conditions, primarily issues related to nuisance vegetation and shoreline erosion due to boat wakes.

Most waterfront property owners feel as though they have the information necessary to prepare their waterfront property for future impacts from adverse weather events and damage due to project natural forces. Those who do not would like to know more about the expected adverse effects. It appears that many waterfront property owners perceive the use of bulkheads as the most effective means of protecting their property from inundation due to storm surge, while many are open to the idea of



alternatives. However, more information is necessary for waterfront residents in order for them to make decisions.

There is strong agreement that state and local governments do have a role in preparing communities for the effects of adverse weather events and damage due to natural forces predicted to occur in Virginia state and local governments. That said it is clear from the results that property owners do not want local or state governments to inhibit their ability to take risks on their property by limiting their rights to protect in the manner they feel is most effective.

NEXT STEP CONSIDERATIONS (for discussion)

Several measures could be taken through direct contact with homeowners and through larger forums such as the Washington DC Chapter of the Community Association Institute, including:

- ◆ Provide information through maps and narrative on projected inundation in Northern Virginia.
- ◆ Develop short fact sheets and other educational materials to disseminate information regarding coastal hazards in Northern Virginia.
- ◆ Compile and/or develop materials to support waterfront property owners in making informed decisions on shoreline management practices.
- ◆ Establish a grant program to support proactive measures by property owners to design and/or implement shoreline management solutions.
- ◆ Provide information regarding existing efforts to control Hydrilla and boat traffic in No Wake Zones, particularly.

Additionally, given the demographics of the region's waterfront property owners, educational materials should be made available on the web, in print, and in other media formats.

The full list of survey questions can be found at: www.novaregion.org.