Community Leader Workshop Summary Report

Enhancing Coastal Resilience on Virginia's Eastern Shore

November 12 and 13, 2014

A project funded by the Department of Interior Hurricane Sandy Coastal Resilience Fund

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Cover Photo:

Aerial view of the Seaside village of Willis Wharf in Northampton County. The community supports clam aquaculture businesses that are vital to the local economy (*Photograph ©2014 Gordon Campbell/At Altitude Photography)*

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Executive Summary

Since 2010, over 30 agencies have participated in meetings of the Eastern Shore of Virginia Climate Adaptation Working Group (CAWG) to address the mounting challenges from recurrent flooding and sea-level rise facing the region by providing education and outreach, soliciting local data and information needs, and developing tools to assist with local planning and decision-making. In 2014 a major milestone was achieved when the U.S. Department of the Interior awarded $1.46 million to The Nature Conservancy and CAWG partners to meet local planning needs through the development of a customized Coastal Resilience Planning Tool that will equip Eastern Shore communities with the tools necessary to address climate-related hazards and enhance the area's natural resilience.

On November 12 and 13, 2014, the Enhancing Coastal Resilience on Virginia's Eastern Shore Community Leader Workshop was conducted as the first of a series of stakeholder workshops and part of a comprehensive Coastal Resilience Project. Over 40 community leaders from local, state, and federal governments and non-government organizations provided input that is being used to customize the *Coastal Resilience* planning tool (maps.coastalresilience.org) that will include various applications for addressing sea-level rise, marsh migration, storm surge, and seaside barrier island-inlet evolution. Workshop participants partook in a series of interactive exercises and presentations to provide scientific background for the information included in the various applications and to provide insight into the utility of the planning tool's applications.

Participants provided their input into how applications for simulating sea-level rise and corresponding marsh migration could best be developed to address local levels of risk tolerance, local planning horizons, and local rates of sea-level rise. The majority of participants indicated that they perceived the likelihood of impacts as "possible to likely" and that consequences from flooding impacts were expected to be "moderate to major". Additionally, 25 years was the most commonly desired planning horizon and the group almost unanimously agreed that the "High" sea-level rise scenario curve (1.2' by 2050, 2.3' by 2075, 4.5' by 2100) was preferred by participants since it was recommended by the science community.

The storm surge application included in the *Coastal Resilience* tool will provide multiple simulations for storm tracks and storm types/intensities. Participants provided information regarding locations of historic storm tracks and areas known to be most vulnerable to storm surge as well as areas expected to become increasingly vulnerable to future storm surge with accelerated sea-level rise. Many coastal communities and places were identified along the bayside and seaside and the storm surge application will be developed to address vulnerabilities accordingly.

The seaside barrier island-inlet evolution application to be included in the *Coastal Resilience* tool is expected to provide a comprehensive perspective for how various shoreline management actions along the seaside barrier islands may impact the adjacent barrier island shorelines. The agencies involved in actively managing shorelines, the U.S. Fish and Wildlife Service Chincoteague National Wildlife Refuge, National Park Service Assateague Island National Seashore, and the NASA-Wallops Flight Facility, provided various management actions currently being considered. Multiple combinations of these actions are planned to be included in the application.

Project team members have worked closely with the modelers responsible for developing the *Coastal Resilience* tool applications to communicate the planning needs identified during the workshop. While it was determined that some of the local planning needs cannot be addressed under the scope of this project, it is important to note that the CAWG partners will continue to pursue the funding necessary to adequately address these needs.

1.0 INTRODUCTION

This report represents the proceedings from the Enhancing Coastal Resilience on Virginia's Eastern Shore Community Leader Workshop held on November 12 and 13, 2014 at the Chincoteague Bay Field Station in Wallops Island, Virginia. The workshop is the first of a series of stakeholder workshops and part of a comprehensive Coastal Resilience Project, both of which are described in the following sections.

This report was prepared by the Accomack-Northampton Planning District Commission (A-NPDC) as part of the ongoing leadership and coordination of the Eastern Shore Climate Adaptation Working Group. Founded in 2010, the Eastern Shore Climate Adaptation Working Group, led by A-NPDC, is dedicated to providing education, outreach, and information to local communities to plan for and adapt to sea-level rise, recurrent flooding, and storm surge. These efforts have resulted in achieving a major new milestone: The U.S. Department of Interior has awarded **$1.46 million** from the Hurricane Sandy Coastal Resiliency Fund to The Nature Conservancy and Climate Adaptation Working Group partners **to equip coastal communities with the tools and information urgently needed to reduce the risks posed by climate-related hazards and enhance the area's natural resilience.**

1.1 Project Overview

Virginia's Eastern Shore lies within one of the nation's most threatened coastal regions. Sea levels are rising at three to four times the global average and storms are predicted to intensify. Both threats are linked, in part, to climate change. The Eastern Shore is not alone in its plight, yet it is poised to be a leader for communities facing similar challenges.

The community has an unprecedented opportunity through the Department of Interior's Hurricane Sandy Coastal Resilience Funds awarded to The Nature Conservancy to catalyze solutions for adaptation to these increasingly variable conditions by providing local land use managers, planners, and landowners with decision-making knowledge and tools that can be used to mitigate hazards and reduce risks where nature is part of the solution.

The Nature Conservancy is leading a two year grant project in partnership with the A-NPDC, the members of the Eastern Shore Climate Adaptation Working Group, the University of Virginia's Long-Term Ecological Research project, NASA's Wallops Flight Facility, the U.S. Fish and Wildlife Service, elected community leaders, and a variety of other academic and community partners to accomplish the following overarching goals:

ENHANCING COASTAL RESILIENCE PROJECT GOALS

1. ***Stakeholder Engagement.***
   Climate Adaptation Working Group meetings have provided a platform for local stakeholder groups to identify information and planning tool needs for preparing for natural hazards. The Nature Conservancy and partners have leveraged a unique opportunity to meet these information and planning tool needs and plan to work closely with Eastern Shore community leaders to create a customized planning tool developed in a manner that best meets local needs.
2. ***Create Eastern Shore* Coastal Resilience *Planning Tool.***
   The *Coastal Resilience* tool (maps.coastalresilience.org) will incorporate the best available science, data, and state-of-the-art analytical tools for assessing risks of coastal hazards on people, the economy, and the ecosystems of the Eastern Shore using local information. The novelty of this tool is that it will also enable identification of nature-based solutions like oyster and wetland restoration to mitigate risk and enhance resilience.
3. ***Demonstrate Nature-Based Solutions.***
   The Nature Conservancy and partners will restore a total of five oyster reefs, which will be used to demonstrate and quantify how natural infrastructure can dampen wave energy and mitigate coastal erosion. Three of these reefs will be restored along eroded roads at Chincoteague National Wildlife Refuge and two will be built fronting marsh near the Village of Oyster.

The full cost of the project is $2,285,000. Of this, $1.46 million was awarded to The Nature Conservancy and partners from the National Fish and Wildlife Foundation/Department of Interior (DOI) Hurricane Sandy Coastal Resiliency Fund, $525,000 was awarded to US. Fish and Wildlife Service's Chincoteague National Wildlife Refuge directly from DOI, and another $300,000 have been privately fundraised by The Nature Conservancy as match for the project. The Nature Conservancy contracted the A-NPDC to assist with identifying and engaging community leaders and stakeholders to ensure that the *Coastal Resilience* planning tool is developed with local input in a manner that best suits local needs.

1.2 Community Leader Workshop Overview

The project was kicked off on November 12 and 13, 2014 with a Community Leader Workshop at the Chincoteague Bay Field Station in Wallops Island, Virginia. The purpose of this workshop was to bring together community stakeholders and the project team to determine the sea-level rise and storm surge scenarios most useful for local planning and decision-making. This will in turn inform the development of the models and application (apps) for building the *Coastal Resilience* tool. Specific workshop goals were as follows:

COMMUNITY LEADER WORKSHOP GOALS

- Bring together community leaders, decision-makers and project team members to identify the issues of greatest concern on the Eastern Shore regarding the reduction of coastal hazard risks and the enhancement of socio-economic and environmental resilience, and to discuss how the project can be most relevant, applicable, and beneficial for local decision-making.
- Provide an overview of the sea-level rise, storm surge, marsh migration, and barrier island-inlet evolution models that will be used in carrying out the project including model capabilities, potential outputs and a discussion of how these models can be applied to assist in identifying solutions for reducing risk and enhancing resilience on the Eastern Shore.
- Engage community leaders, decision-makers and project team members in the process of identifying future conditions and management actions that are most likely and of greatest concern, and therefore, most useful and relevant to address as part of the project in support of Eastern Shore adaptation planning and hazard mitigation actions.

The workshop agenda was focused on introducing the project and each of the models to be included in the *Coastal Resilience* tool and to solicit feedback and input regarding specific needs and areas of interest that the tool could best serve. The workshop agenda is included in **Appendix A**. The workshop was attended by over 70 people that included over 40 community leaders and stakeholders in addition to the almost 30 project team members representing the various partner organizations leading the project. A list of participants and project team members is included in **Appendix B**. In addition, a field trip was held at the end of the first day where the group visited local sites on Chincoteague Island and Assateague Island where coastal resilience challenges and opportunities exist. One of these sites was along the Chincoteague National Wildlife Refuge service road, the site of one of the grant-funded oyster reef restoration sites. **Appendix C** has additional information about this dimension of the project.

2.0 Workshop Outcomes and Summary

The following sections describe all input received during discussions that followed presentations, group exercises, and breakout group exercises.

2.1 Introductory Presentations and Exercises

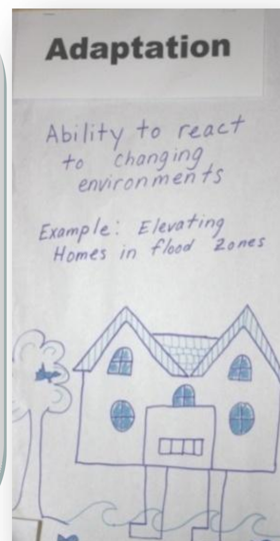
2.1.1 Pre-Workshop Participant Survey

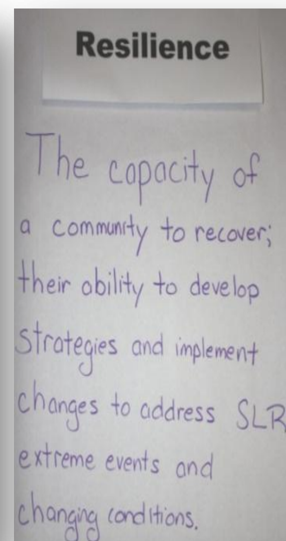
In order to gauge the effectiveness of the workshop, the group was asked to participate in pre- and post-workshop surveys. The surveys consisted of the same questions and were administered by the workshop team. The results of the pre-workshop survey are summarized below and included in their entirety in **Appendix D**. The outcomes of the post-workshop survey and comments on reported effectiveness of the surveys are summarized in Section 3.1 later in the report. Additionally, questions addressed during the workshop from the "Problem Post" are included in **Appendix E**.

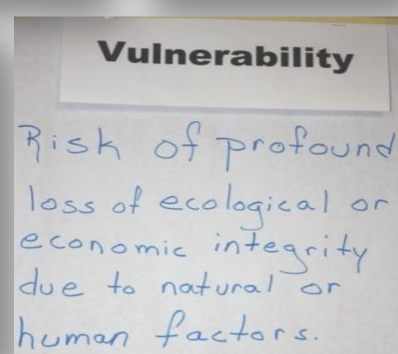
Summary of Pre-Workshop Survey Outcomes	
The majority were affiliated with a government agency and resided on the Eastern Shore.	*The majority agreed that the CR approach and tool will benefit local communities and fill an urgent local need.*
The group was mostly uncertain if the CR approach and tool will offer unique benefits.	*The group was mostly uncertain if they would use and apply the CR tool for planning and decision—making.*
Responses were evenly distributed between disagreeing and agreeing that political, technological, and social barriers may prevent the use of the CR approach and tool within their group.	*The majority strongly agreed that nature-based solutions were an important priority for increasing coastal resilience and reducing risk of coastal hazards.*

2.1.2 Coastal Resilience Science Primer

Participants were led through an exercise by Jill Bieri of the Nature Conservancy to ensure that terminologies to be utilized during the workshop were commonly understood by the group. Teams were designated and assigned a specific term. Participants were instructed to develop a definition before being provided with a master list of terms as defined by NOAA. Teams were asked to note any differences among their definitions and report-back their findings to the entire group. The results are summarized in the table on the following page:







Term	Participant Definition (NOAA Definition in Bold and Italicized)
Adaptation	Ability to react to changing environments (Example: elevating homes in flood zones). ***Adjustment in natural or human systems in response to current natural hazards and actual or expected climate change impacts. Actions taken to help communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in weather and climate conditions. (Modified from IPCC, 2007)***
Coastal Erosion	Loss of land at the shoreline into coastal waters caused by water inundation, wave action, movement of sediments, wind and tidal action accelerated by storms and sea-level rise (Example: Smith Beach). ***The wearing away of land or the removal of beach or dune sediments by wave action, tidal currents, wave currents, or drainage. A combination of episodic inundation events and relative sea level rise will serve to accelerate coastal erosion.***
Coastal Hazard	An event like a hurricane, harmful algal bloom, toxic phytoplankton, or other extreme event that is likely to affect ecosystems and human communities and in ways that we consider as negative impacts (Example: shoreline erosion, storm surge, flooding and inundation). ***A source of potential danger or adverse condition. Hazards include naturally occurring events that strike populated areas and have the potential to harm people or property. Examples of coastal hazards are shoreline erosion, storm surge, flooding, and inundation.***
Global Sea-Level Rise	Inundation of coastal shorelines and adjacent land masses by water worldwide. Melting water from glaciers increases volume of water due to temperature increases. ***Caused by a change in the volume of the world's oceans due to temperature increase, deglaciation (uncovering of glaciated land because of melting of the glacier), and ice melt.***
Inundation	Temporary or permanent overwhelming volume of water in a place where formerly there was less water (Example: when your toilet overflows and inundates the immediate area). ***Water covering normally dry land is a condition known as inundation.***
Marsh Migration	1) Marsh migration is due to a changing ecosystem. Marsh migration is limited to a vertical limit that is determined by water level as the ecosystem must be supported by a certain volume of water. 2) The point where kinetic energy moving a land mass is dissipated to a velocity where the land matter settles to the lowest level and is conducive to the propagation of marsh grasses. ***The movement of wetland plant communities into adjacent, higher elevation land. Marsh migration represents a natural response to sea level rise, where marsh plants gradually replace trees, lawns, and agricultural crops in wet soils.***
Mitigation	To reduce damage due to the effects of an event. (Example: beach replenishment on Wallops Island). ***Sustained actions taken to reduce, minimize or eliminate long-term risk and vulnerability from hazards and their effects.***
Relative Sea-Level Rise	1) Combined effect of global sea-level rise and local subsidence or other geological changes in land elevation. 2) Rise of sea level relative to land (Example: Norfolk is sinking while sea level rises. The two numbers combine to provide relative sea-level rise which is around 14 inches at some points). ***Occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise or land subsidence.***
Resilience	1) The capacity of a community/system to adapt to change (event, gradual) and maintain function/well-being. 2) The capacity of a community to recover; their ability to develop strategies and implement changes to address sea-level rise, extreme events, and changing conditions. ***The capacity of a system, community, or society potentially exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures. (SDR, 2005)***
Risk	To a harmful consequence is a quantitative and qualitative measure of natural or human-induced hazard and exposure to that hazard. ***The probability of harmful consequences or expected losses (death and injury, losses of property and livelihood, economic disruption, or environmental damage) resulting from interactions between natural or human-induced hazards and vulnerable conditions. (SDR, 2005)***
Scenarios	A range of possible future drivers (e.g. sea-level rise, storms, management approaches) and responses (e.g. erosion, stabilization, abandonment), both natural and human. ***The term "scenarios" describes qualitative and quantitative information about different aspects of future environmental change to investigate the potential consequences for society. Scenarios do not predict future changes, but describe future potential conditions in a manner that supports decision-making under conditions of uncertainty.***
Shallow Coastal Flooding	Areas of low-lying land that are affected by storm surge, high mean tides, and coastal flooding. These areas are also vulnerable to erosion as they can experience regular exposure to flooding. Climate change may increase the chances of shallow coastal flooding and may have an adverse effect because a small rise in sea level/storm surge may impact shallow areas significantly. Heavy rainfall and onshore winds can cause even greater inundation. (Examples: Coastal development and lower elevation in Charleston, SC and Savannah, GA). ***The inundation of land areas along the coast caused by higher than average high tide and worsened by heavy rainfall and onshore winds (i.e., wind blowing landward from the ocean).***
Storm Surge	The abnormal rise of water associated with a land-falling hurricane. The surge combined with normal tides result in the hurricane storm tide, which can increase water level by 15 feet or more. ***Water that is pushed toward the shore by the force of the winds swirling around the storm.***
Subsidence	The sinking of land; in a climate change context, combined with sea-level rise, creates “relative sea-level rise”. As a result, the land is more susceptible to flooding and sea-level rise. Caused by: Chesapeake Bay Impact Crater, isostasy, and ground water withdrawal. ***Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials.***
Uncertainty	The confidence or lack thereof in a prediction or measurement (i.e. the range around a value of measurement or prediction caused by a lack of information about some contributing processes or factors). ***Scientists think of uncertainty as a specific, quantifiable measure of how well something is known. For example, uncertainty is used to define the range of probable sea level rise (SLR) outcomes. The predicted SLR values within the range of uncertainty are those scenarios most likely to occur. SLR values beyond the range of uncertainty are not as likely to happen.***
Vulnerability	Risk of profound loss of ecological or economic integrity due to natural or human factors. ***Susceptibility of people, property, and resources to negative impacts from hazard events.***

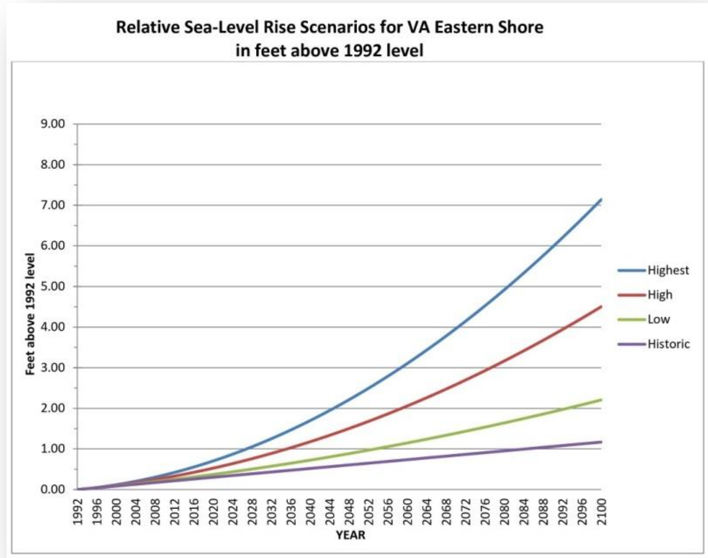
2.1.3 Local and State Climate Adaptation Activities and Local Applications of Coastal Resilience Tool – Curt Smith, A-NPDC

Main Messages (from presenter)	Questions & Concerns (from participants)
Eastern Shore communities inherited many of the challenges they face today.	*Some participants again stated that they needed to know more about the cause of the actual problem. "What is the cost of doing nothing? No one has told me that. What is the next best thing to not building this model?"*
The ESVA Climate Adaptation Working Group has provided a local voice on the state and national level.	*A lack of clear policy statements or frameworks within which local government staff can act in the realm of climate change and sea level rise could pose a challenge for getting definitive answers moving forward.*
	Participants expected that keeping elected officials and staff on equal footing in terms of understanding science an on-going challenge.
Current and historic adaptation activities are moderate but need to anticipate future changes.	*The model should consider and include "no action" alternatives for shoreline management.*
	Modeling "no action" alternatives would serve an outstanding need of local communities.

2.1.4 Overview of Coastal Resilience Approach & Tool – Zach Ferdana, TNC

Main Messages (from presenter)	Questions & Concerns (from participants)
The CR tool was developed to address climate adaptation issues more comprehensively than had previously been accomplished by government agencies.	*As communities think about adaptations, can those be inserted into the tool to show how that affects the scenarios? Answer: No. We will monitor results of adaptations and over time, this feedback will inform the model. TNC is working with insurance companies to calculate cost-benefits of using natural infrastructure.*
Coastal Resilience is an online mapping platform and decision support tool that can be customized to fit the needs of communities on the Eastern Shore.	
The CR Tool offers a variety of potential apps for scenario planning based on community needs that include a sea-level rise and flooding app, a future habitats app, a restoration explorer app and a coastal defense app to name a few.	*The tool will inform both the built environment and natural solutions and how the two can co-exist, as well as consequences of no action vs. natural solutions.*
The CR Tool goes beyond just assessing vulnerability of communities and helps planners identify nature-based solutions like marsh or oyster restoration that may help adapt to rising seas and storms.	*Multiple scenarios can be simulated together within the tool.*

2.2 Sea Level Rise and Marsh Migration Modeling Overview and Discussion



For the purposes of selecting scenarios of sea-level rise over time, the project team decided to use sea-level rise projections customized for Virginia by the Virginia Institute of Marine Science Center for Coastal Resources Management (VIMS CCRM) as part of the 2013 Recurrent Flooding Study for Tidewater Virginia (Mitchell et al. 2013). These projections are considered the most authoritative, peer-reviewed source for the Virginia coastal zone, and as such, we deemed they would have the most buy-in and recognition from Eastern Shore community leaders. VIMS CCRM adjusted the 2014 National Climate Assessment (Parris et al. 2012) sea-level rise curves by adding an average regional rate of subsidence based on a recent USGS publication (Eggleston and Pope 2013) and a 1974 survey of changes in benchmark elevation (Holdahl and Morrison 1974). While the USGS publication suggests that the average rate of subsidence for tidewater Virginia is 3.1 mm/yr, this rate is high for the Eastern Shore area. Instead a more conservative estimate for the Eastern Shore of 2.7 mm/year was used based on both the USGS report and more recent elevation survey data from the Shore (see figure above and Appendix F). In summary, the four relative sea-level rise curves that project sea-level rise under different emission scenarios are defined as follows:

a) The lowest or **"historic"** scenario is a projection of observed long-term rates of sea-level rise going back a century or more. It incorporates no acceleration.
b) The **"low"** scenario is based on the Intergovernmental Panel on Climate Change 4th Assessment model using conservative assumptions about future greenhouse gas emission (the B1 scenario).
c) The **"high"** scenario is based on the upper end of projections from semi-empirical models using statistical relationships in global observations of sea level and air temperature.
d) The **"highest"** scenario is based on estimated consequences from global warming combined with the maximum possible contribution from ice-sheet loss and glacial melting (a practical worst-case scenario based on current understanding).

Using these curves, the participants considered scenarios of time horizons and sea-level rise projections (levels) that were most useful and relevant for their particular agency, institution or organization. These decisions are summarized below and will inform all of the scenarios used in the multiple modeling efforts incorporated into the *Coastal Resilience* tool.

2.2.1 Briefing on Accelerated Sea-Level Rise and Mainland Tidal Salt Marsh Response – Matt Kirwan, VIMS

Main Messages (from presenter)	Questions & Concerns (from participants)
Sea levels are rising on the Eastern Shore faster than the global average due to increased ocean volume (thermal expansion, ice melt), sinking land (glacial warping, impact crater), and changing ocean currents (position of Gulf Stream).	*What is the rate of sea level rise that would out-pace the natural ability of marshes to adapt?* *Answer: It is estimated that the limit would be about 10-15 mm/year, but additional modeling is needed to have any confidence.*
Historic sea-level rise rates from the mid-16th century until the late 19th century were steady at approximately 1 mm/year and have been around 3 mm/year for the last century or more. Projections (based on National Climate Assessment and VIMS CCRM work) show different scenarios of relative sea-level rise based on different methods of prediction, varying from two to seven feet by 2100 based on a 1992 baseline.	
Mainland marshes tend to be resilient, migrating to higher land and keeping pace with moderate rates of sea level rise.	
There is enough land available to accommodate expansion of mainland marshes in response to sea level rise.	
For edge marshes to survive, shoreline transgression must be at least 0.2 meters/year.	

2.2.2 NOAA Inundation Model: Overview, Applications, and Limitations – Chris Bruce, TNC

Main Messages (from presenter)	Questions & Concerns (from participants)
NOAA's model is a "bathtub" model that relies on high-resolution elevation data (LiDAR: light detection and ranging) with a vertical accuracy of 0.53' for the Eastern Shore.	*Can the elevation data in the NOAA model support sub-foot accuracy for short term sea-level rise scenarios? Answer: The elevation data do not support this because the margin of error in the data is 0.5' thereby creating excessive uncertainty and lack of reliability for short-term sea-level rise scenarios.*
The elevation data is tied to a fixed datum. For inundation modeling, NOAA transformed the data to mean higher high water (MHHW).	
Limitations of the NOAA model include data accuracy, level of detail in hydrology data, it does not consider potential management actions, and does not consider natural processes (erosion, marsh migration, etc.).	

2.2.3 Sea-Level Affecting Marshes Model (SLAMM) Overview – Marco Propato, Warren-Pinnacle

Main Messages (from presenter)
SLAMM goes beyond the NOAA basic "bathtub" model of inundation and takes into account that marshes are dynamic and migrate in response to changes in accretion and erosion of sediments thereby enhancing planners' abilities to make decisions about protecting current and future marsh habitat.
Advantages to this model are that it is quick and easy to run, there are minimal data requirements, and it provides information to decision-makers.
Disadvantages and limitations are that SLAMM does not consider how water flows, the modeled processes are simple, anthropogenic actions are not included, and large storm effects are under-estimated.

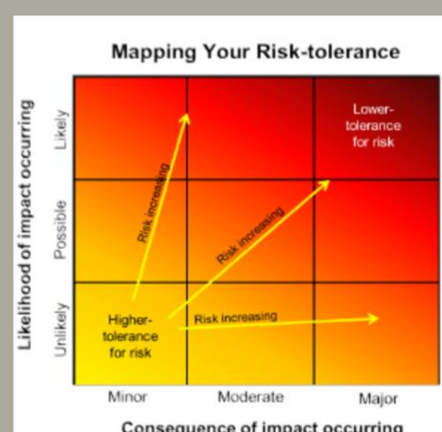
2.2.4 Sea-Level Rise & Marsh Migration (SLAMM) Modeling Breakout Group Outcomes

Overview & Goals

Workshop participants were organized into three breakout groups to solicit input from community leaders on scenarios and planning horizons of most interest and relevance to stakeholders regarding inundation and marsh migration models that will eventually be incorporated into the *Coastal Resilience* tool. Members of the project team served as facilitators for each breakout group and scribes were assigned to record all discussions.

Groups were provided a handout explaining how risk tolerance is considered and presenting a series of four sea level curves developed for the Eastern Shore. Groups were then asked to respond to the following questions:

1) *How much risk is your agency, organization, institution able to tolerate with regards to coastal hazards related to accelerated sea-level rise and storm surge (e.g. shoreline erosion, flooding)? Or, another way, how much flexibility do you have to accommodate the consequences of these coastal hazards?*
2) *What future planning horizon(s) can your organization realistically and feasibly plan to address? (e.g. 1 year, 5 years, 10, years, 25, 50, 75, 100). Why?*
3) *Given your risk tolerance and planning horizons, which sea-level rise scenarios are you most interested in seeing modeled for the Eastern Shore?*



2.2.4 Sea-Level Rise & Marsh Migration (SLAMM) Modeling Breakout Group Outcomes (Continued)

Risk Tolerance Outcomes

- The majority of participants indicated that they perceived the likelihood of impacts as "possible to likely" and that consequences from the impacts were expected to be "moderate to major".
- Participants indicated that risk tolerance and impacts were driven by external factors such as what occurs on neighboring lands.
- Priority must be given for preparing for immediate risks then plan ahead for longer-term risks.
- Participants expressed a need to distinguish between wildlife versus human impacts. Wildlife habitat will change to a different kind of habitat, but human impacts are not as adaptable.



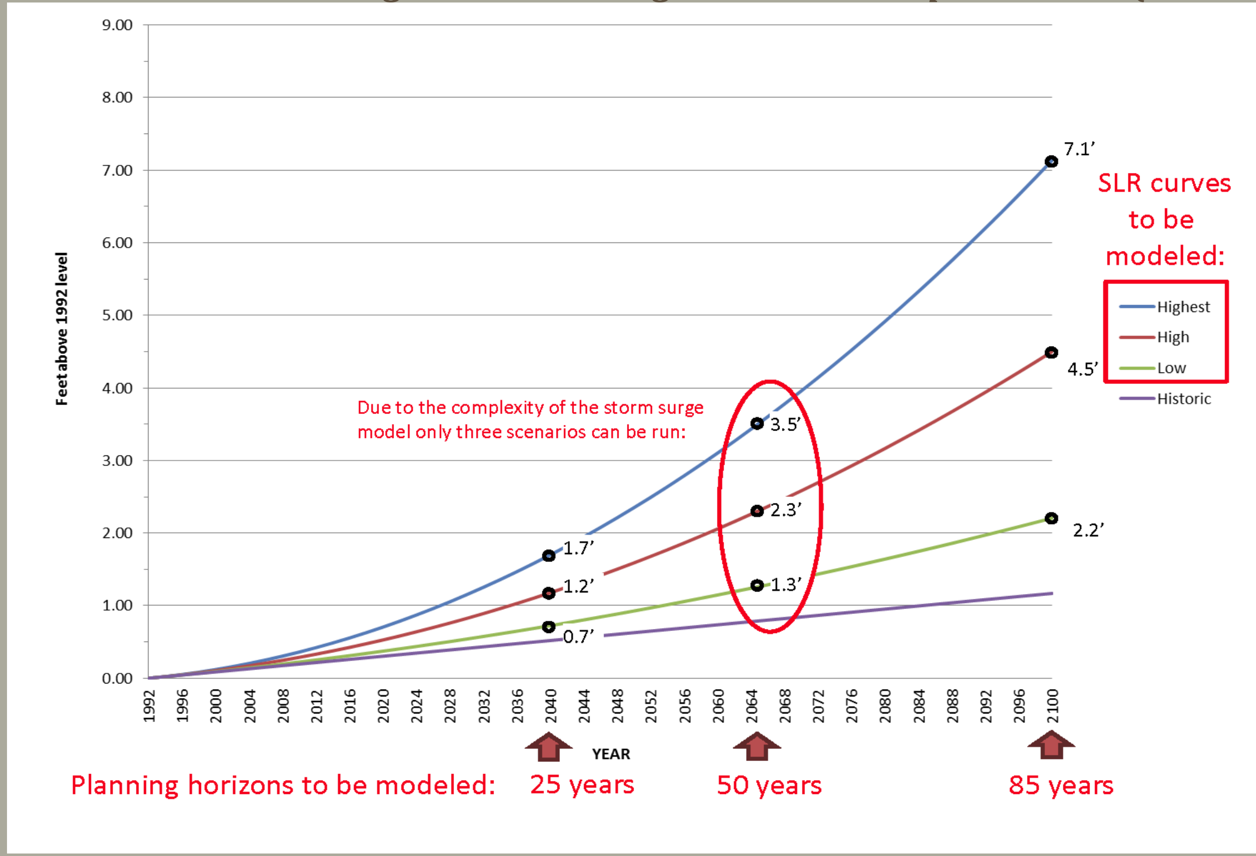

Planning Horizon Outcomes

- Most participants voted for the following planning horizons: 10 years (2025), 25 years (2040) and 50 years (2065), with some interest in a longer term planning horizon (2100). Overall, 25 years was the most commonly desired planning horizon. More specifically,
  - Local governments' preferences ranged from 10-20 years.
  - Federal governments' preferences ranged from 15-50 years.
  - Local non-government organizations' preferences ranged from 10-50 years.
- Since the elevation data used as the basis for our modeling efforts has an accuracy of +/- 0.5 feet it is not practical to model a 10 year planning horizon as the elevation data cannot support sub-foot SLR increments. ***Therefore, the three planning horizons chosen for models are 25, 50, and 85 years*** (Figure 2.2.4).

Sea-Level Rise Scenario Outcomes

"High" scenario curve was almost unanimously preferred by participants because it is most recommended by scientists, whereas the "low" scenario followed by a distant second and the highest scenario had some interest. There was very little interest in using the "historical" (no acceleration) rise scenario. ***Therefore, the three sea-level rise scenario curves chosen for the models are highest, high, and low*** (Figure 2.2.4).


2.2.4 Sea-Level Rise & Marsh Migration Modeling Breakout Group Outcomes (Continued)



Based on stakeholder input, the project team chose to model time frames of 25 years (2040), 50 years (2065), and 85 years (2100), and all three projected accelerating sea-level rise curves ("low", "high" and "highest"). The storm surge model requires extensive computing resources and very lengthy run times so only three scenarios are within the budget of this project for storm surge modeling. A 50-year time frame using the "low", "high" and "highest" sea-level rise curves was chosen for storm surge modeling. Note however that this allows for two additional scenarios to be inferred. In terms of relative sea-level rise, the 50-year time frame on the "low" curve is roughly equivalent to the 25-year time frame on the "high" curve. And the 50-year time frame on the "high" curve is also roughly equivalent to the 85- year time frame on the "low" curve.

2.3 Storm Surge Modeling Overview and Discussion

2.3.1 Overview of Storm Surge Dynamics and Modeling – John Atkinson, Arcadis U.S.

Main Messages (from presenter)	Questions & Concerns (from participants)
The Saffir-Simpson tropical storm scale is inadequate for predicting storm surge. There is a need to define the physical system and include topography, bathymetry, and land cover.	*The final simulations are based on only a few "synthetic" simulations.*
The model uses an advanced circulation model (ADCIRC) and a simulating waves nearshore model (SWAN) prior to being validated through hindcasting (replicating past events).	*Need to improve shallow-water bathymetry data. UVA-LTER has data for some seaside areas that could be useful. Also, Wallops' scientist group may have some input with a new partnership with USGS.*
FEMA Flood Insurance Rate Maps are completed with modeling similar to what will be used for the CR tool.	
Thousands of "synthetic" storms will be simulated. Only a few of the scenarios will be chosen due to financial constraints.	*Will the model be able to simulate nor'easters rather than just subtropical storms (i.e., hurricanes)? Answer: Yes, the model has the ability to simulate various wind speeds, directions and durations.*
The scenarios will be integrated so that the model is updated as the situation changes. For instance, SLAMM will track changes in vegetation, but if marsh grass is not able to keep up with climate change, then it will dramatically affect the role of friction in slowing storm surge.	

2.3.2 Storm Surge Modeling Breakout Group Outcomes

<u>*Overview & Goals*</u>

Workshop participants were organized into three breakout groups to solicit information about places on the Eastern Shore where community leaders are most concerned about future storm impacts that they want to be addressed by the storm surge model and incorporated into the *Coastal Resilience* tool. Members of the project team served as facilitators for each breakout group and scribes were assigned to record all discussions.

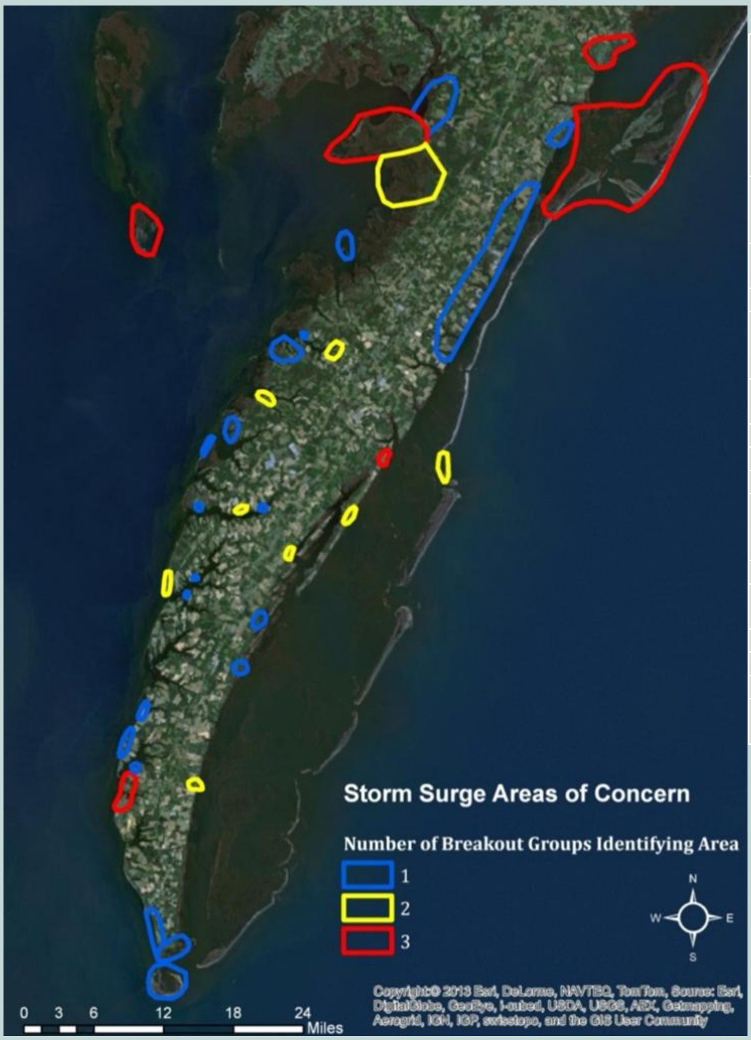
Groups were provided a handout explaining how storm surge is magnified by elevated water levels and then asked to respond to the following questions:

1) ***What places of importance on the Eastern Shore have been heavily impacted by storm surge in the past?***
2) ***Where do you think recurrent flooding may cause the most significant impact on daily life?***
3) ***What places are you most concerned will be impacted by storm surge in the future?***
4) ***What kind of information would be helpful to plan for future flood protection?***

2.3.2 Storm Surge Modeling Breakout Group Outcomes (Continued)

Summary of Places Experiencing Historic Storm Surge Impacts

Participants in each of the three breakout groups were asked to draw on maps to illustrate areas known to have historically experienced storm surge impacts. The following table and map summarize the outcomes from all three breakout groups. This information will be used for selecting and modeling future storm events in combination with the selected sea-level rise scenarios.



Areas identified by all 3 groups	*Additional areas identified by at least 2 groups*	*Additional areas identified by only 1 group*
Cape Charles	*Oyster*	*Eastern Shore & Fisherman's Island NWR*
Wachapreague	*Silver Beach area*	*Kiptopeke State Park area*
Saxis/Sanford	*Willis Wharf*	*Cherrystone*
Wallops/Chincoteague/Assateague Islands	*Shields Bridge area*	*Savage Neck*
Greenbackville/ Captain's Cove	*Quinby*	*Smith Beach area*
Tangier?	*Harborton area*	*Box Tree area*
	Cedar Island	*Red Bank*
	Onancock area	*Bayford area*
	Mears area	*Camp Occohannock area*
		Nandua Creek
		Broadway Landing area
		Poplar Cove
		Gargatha area
		Atlantic area
		Holdens/Bullbeggar Creeks

The map above illustrates a digitized compilation of areas identified by the three breakout groups during the workshop. Map by Chris Bruce, TNC.

2.3.2 Storm Surge Modeling Breakout Group Outcomes (Continued)

Summary of Ways Flooding May Cause Significant Impact on Daily Life

- Utilities
- Transportation: Emergency Services, Commercial/Industrial Business, Schools
- Economic Impacts – Aquaculture, Tourism
- Human and Environmental Health Concerns
- Exacerbated impacts on socioeconomically disadvantaged populations
- Impacts to social and culturally important places and landmarks

Summary of Places That May Be Impacted by Future Storm Surge

- All places identified as being currently and historically impacted by storm surge are expected to continue to be impacted in the future
- Seaside Barrier Islands
- Tidal marshes – Bayside marshes appear to be more vulnerable and less healthy as compared to Seaside marshes
- Additional specifically emphasized areas included:
  - Chincoteague – population center and causeway issues
  - Saxis – homes destroyed in the past and causeway issues

Summary of Identified Information Needs for Future Flood Protection

- Considering nor'easters as well as extra-tropical storms is a critical need
- Information about expected storm frequencies
- Clarifying impacts on Bayside and Seaside for various storm tracks
- Identification of areas vulnerable to erosion
- Consideration of impacts from saturated soils and rainfall amounts associated with storms. Breaches on islands occur from seaside lagoons filling during heavy rain events and times when soils are saturated prior to arrival of storm.

2.4 Barrier Island-Inlet Evolution Modeling Overview and Discussion

2.4.1 Overview of Geologic Background & Local History of Change – Mike Fenster, Randolph-Macon College & Overview of Coastline Change Processes – Laura Moore, UNC-Chapel Hill

Main Messages (from presenters)	Questions & Concerns
During the last glaciations, the shoreline was near the edge of the continental shelf.	*Does sea level rise erode beaches? Answer: Sea level rise will lead to erosion because it will move the zone of storm impacts upward and therefore landward over time, which tends to move sand far onshore or offshore during storms, thus leading to sand loss.*
Sea level rose rapidly from about 10,000 years ago until about 5,000 years ago when it slowed down enough for barrier islands to form. For most of the last 2500 years sea level has been rising 1/5-2mm/yr but tide gauge records (last ~100 years) indicate sea level on the Virginia Eastern Shore is now rising at about 3-4 mm/yr .	
The shape of the coastline affects how much sand the alongshore current carries. There are areas of accretion such as Fishing Point at Tom's Cove and areas of chronic erosion as well.	*What causes chronic shoreline erosion? Answer: Chronic erosion occurs when there is more sand being lost from a stretch of coast than coming in. This could occur for multiple reasons, e.g., sea level rise and storms, blocking of alongshore transport by structures, changing coastline shape, etc.*
Shoreline management efforts can affect the alongshore transport of sand, potentially resulting in a loss of sand downdrift. Structures such as seawalls, revetments and artificially high dunes prevent barrier islands from receiving overwash sand, which prevents them from building elevation and moving landward, leading to island loss.	
Whether or not erosion occurs is determined by the balance of losses and gains of sand (accretion vs. erosion). When there is more sand being lost from a stretch of coast then is coming in, erosion occurs. Gains and losses occur both locally and on larger scales alongshore as a function of gradients in the amount of sand carried alongshore by the alongshore current. On the Eastern Shore Seaside the net alongshore transport direction is south.	*What are the effects of climate change on the islands? Answer: Increasing storm activity is increasing the frequency of overwash. Other changes in storm characteristics are affecting wave patterns and shoreline change patterns.*



2.4.2 Briefing on Barrier Island-Inlet Evolution Modeling System – Dylan McNamara, University of North Carolina at Wilmington

Main Messages (from presenter)	Questions & Concerns (from participants)
In using a mode,l we are trying to understand barrier islands on the human lifetime scale; that is, on the time scale of planners and decision-makers.	*Is it expected that the model will provide answers for those responsible for managing barrier islands? Answer: The model will not provide "answers" but will provide valuable information that will enhance abilities to make management decisions and determine what kind of future is desirable.*
Bulk sand movement will be expressed through combining and utilizing two models: a coastline evolution model (CEM) for horizontal movement and a barrier island model (BIM) for vertical movement.	
The BIM will show changes to the shape of natural barrier islands but not the overall mass. The BIM will consider economic factors such as beach nourishment and dune nourishment.	*What is the effectiveness of hardscaping vs. natural management? Answer: This answer requires a cost-benefit analysis. What the model will show is what the landscape will tend to look like when these different approaches are used.*

2.4.3 Barrier Island-Inlet Evolution Modeling Group Discussion Outcomes

Overview & Goals

Workshop participants remained as one large group to discuss, identify, and explore combinations of management actions on Wallops, Chincoteague, and Assateague Islands that are most likely and of greatest concern, and therefore most useful and relevant to address in the Barrier Island-Inlet Modeling System and incorporated into the *Coastal Resilience* tool. Members of the project team served as facilitators for the group discussion and scribes were assigned to record all discussions.

Prior to the workshop, the project team contacted staff from the following Seaside Barrier Island stakeholder groups: U.S. Fish and Wildlife Service, NASA, and the Town of Chincoteague to create a list of potential future management actions that served as options for inclusion in the model. Workshop participants were provided a handout (included in **Appendix G**) presenting the following questions and the summary list of current and potential management actions considered by each stakeholder group:

1) ***What potential future management actions are missing from the provided list and what should be added?***
2) ***What potential future management actions appeal to you, concern you, or interest you the most and why?***
3) ***Which management actions are the most important to model?***

***Participants were also asked to consider the following criteria when discussing and identifying management actions to be included in the model:

- Is the management action likely to be considered in the future?
- Is the management action feasible given regulatory constraints and authorities?
- If the action is modeled, will the information be used by decision-makers to inform future adaptation/coastal resilience decisions?

2.4.3 Barrier Island-Inlet Evolution Modeling Group Discussion Outcomes (Continued)

Summary of Questions and Concerns Raised About the Barrier Island-Inlet Evolution Model

- ***Will the geographic scope of the model take into account The Nature Conservancy's barrier islands or just Wallops and Assateague Islands?***
  The modelers responded that the model will cover scenarios of sea-level rise and storms for the Atlantic Delmarva barrier island from Assateague to Fisherman's Island. In addition, where management actions occur for Atlantic-facing barrier island only (not Chincoteague) like Assateague and Wallops, the effects of selected actions in combination with sea-level rise and storm scenarios will be modeled for the entire barrier island system.
- ***Can the model simulate the effect of management actions on Chincoteague Island?***
  No, the modelers clarified that is not possible given the design of the model which is about barrier islands only, not back barrier islands.
- ***Will the model show the effects of barrier island change on the back barrier marshes and lagoons, and in turn make predictions of how the islands could impact the aquaculture industry or mainland infrastructure in Northampton County?***
  The modelers stated that while the model outputs will provide a good estimate of future configuration of the shoreline face of the barrier island and their westward movement, it is not going to be possible to deduce how these changes will shift sediments behind the islands in the sub-tidal and intertidal habitats of the lagoon.
- ***Will the model show the impacts of dredging the Chincoteague Inlet and how Fisherman's Point on the south end of Assateague will change?***
  The modelers responded that in a very general way they can evaluate some of the effects of inlet dredging on Fisherman's Point, but the model is not designed to explicitly simulate the effect of inlet management actions in the same way it is designed to simulate the effects of management actions on barrier islands. Changes to the seaward edges of Fishing Point arising from changes in alongshore sediment transport arising from management actions or changes in climate will be simulated by the model (since Fishing Point is part of the barrier island system).
- ***Can the model show what happens if inlet breaches on Assateague Island are allowed to persist?***
  The modelers responded that the model may be able to predict the likelihood that breaches will persist versus naturally filling in, as well as the effects of new inlets on patterns of shoreline change.
- ***What are the management actions being considered by The Nature Conservancy on their barrier islands?***
  The Conservancy stated that they will continue to allow natural barrier island migration to occur in order to achieve their mission and conservation goals for the Virginia Coast Reserve. While several options to protect shorelines such as sediment fencing, dune building or beach renourishment were suggested, the Conservancy said these options would interfere with natural processes necessary to support ecological goals.

2.4.3 Barrier Island-Inlet Evolution Modeling Group Discussion Outcomes (Continued)

Summary of Identified Management Actions for Inclusion in the Barrier Island-Inlet Evolution Model

- U.S. Fish and Wildlife Service Chincoteague National Wildlife Refuge and National Park Service Assateague Island National Seashore:
  - Sand fencing along dune line of Assateague Island beaches between Swan Cove Trail and the old Coast Guard Station on Toms Cove Hook.
  - Sand fencing and dune recontouring between Swan Cove Trail and the old Coast Guard Station on Toms Cove Hook.
  - Beach replenishment between Swan Cove Trail and the old Coast Guard Station on Toms Cove Hook.
  - Permanent inlet breaches that occur along Assateague Island caused by storms that are maintained and allowed to persist versus filling in and repairing.
- NASA Wallops Flight Facility:
  - Continue to protect Wallops Island by full beach fill and extension and maintenance of 4,600-ft seawall.
- The Nature Conservancy Barrier Islands:
  - Natural migration (no action)

    Please note: At the request of participants, The Nature Conservancy agreed to follow up with the modelers to determine whether modeling erosion control actions on the islands would provide useful information regarding impacts of rising seas and storms on islands to the aquaculture industry and the mainland. In conversations with the modelers since the workshop, the Conservancy has concluded that the model will not directly provide this type of information, and thus only natural migration will be modeled for Conservancy-owned islands.

3.0 NEXT STEPS

Since the workshop the following activities are underway by the project team: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- The Nature Conservancy continues to follow up with partners and community leaders who both attended the workshop and could not participate to identify concerns, questions, issues, and find common ground for moving the project forward.
- Based on stakeholder input at the workshop, the modeling teams convened to decide on scenarios and snapshots to be used to run in the various models.
- A project website has been created entitled **Enhancing Coastal Resilience on Virginia's Eastern Shore** (tiny URL is: http://nature.ly/1yEHZp6) that includes general information about the NFWF project including the project fact sheet, original proposal abstract and narrative, a link to project resources, workshop materials and summary, and additional general project information.
- SLAMM model is underway and will be followed by storm surge and then barrier island-inlet evolution models.
- The Nature Conservancy and USFWS are in the process of obtaining permits for oyster restoration work at Chincoteague National Wildlife Refuge and Man and Boy Marsh near Oyster. This work will take place between April and June 2015.
- UVA LTER researchers are planning long-term experimental field research studies for marsh edge and oyster reefs sites.

Community leaders will continue to play a vital role as the Coastal Resilience Project continues. The next steps and schedule for the project are described in detail in **Appendix C** and summarized below:

- The *Coastal Resilience* tool will continue to be populated with pertinent local data and outcomes of the various models.
- A second Community Leader Workshop will be scheduled for Fall 2015 to present a preview of the draft applications to be included in the *Coastal Resilience* tool and solicit additional input and suggestions for how to best refine the applications to best meet local needs.
- A third and final Community Leader Workshop will be scheduled for Summer 2016 to introduce the completed *Coastal Resilience* tool and applications.
- Additional focused trainings for how to utilize the tool will be made available for any interested community leaders.
- The *Coastal Resilience* tool will go live and online available to the public during the Summer/Fall of 2016.

Appendix A

Workshop Agenda

Enhancing Coastal Resilience on Virginia's Eastern Shore Community Leader Workshop Agenda

A project funded by the Department of Interior Hurricane Sandy Coastal Resilience Fund

November 12 and 13, 2014

Workshop Goals

- Bring together community leaders, decision-makers and project team members to identify the issues of greatest concern on the Eastern Shore regarding the reduction of coastal hazard risks and the enhancement of socio-economic and environmental resilience, and to discuss how the project can be most relevant, applicable and beneficial for local decision making.
- Provide an overview of the sea-level rise, storm surge, marsh migration, and barrier island-inlet evolution models that will be used in carrying out the project, including model capabilities, potential outputs and a discussion of how these models can be applied to assist in identifying solutions for reducing risk and enhancing resilience on the Eastern Shore.
- Engage community leaders, decision-makers and project team members in the process of identifying future conditions and management actions that are most likely and of greatest concern, and therefore most useful and relevant to address as part of the project in support of Eastern Shore adaptation planning and hazard mitigation actions.

Enhancing Coastal Resilience on Virginia's Eastern Shore Community Leader Workshop

Day One – Wednesday, November 12

8:30 am	➢ **Registration (Breakfast Items and Refreshments)**
9:00 am	➢ **Welcome - *Amber Parker, Chincoteague Bay Field Station***
9:05 am	➢ **Introductions, Overview of Meeting Purpose and Agenda - *Curt Smith, ANPDC***
9:15 am	➢ **Overview of U.S. Department of Interior Hurricane Sandy Coastal Resilience Fund Project for Eastern Shore - *Jill Bieri, TNC***
9:30 am	➢ **Coastal Resilience Science Primer - *Jill Bieri, TNC***
10:00 am	➢ **Coastal Resilience: Interactive Survey and Exercise - *Gwynn Crichton, TNC***
10:45 am	➢ **Local and State Climate Adaptation Activities and Potential Local Applications of Coastal Resilience Tool - *Curt Smith, ANPDC***
11:15 am	➢ **Overview of Coastal Resilience Approach and Tool – *Zach Ferdana, TNC***
12:00 pm	➢ **LUNCH (Provided in Chincoteague Bay Field Station Cafeteria)**

Sea-Level Rise and Marsh Migration Modeling Overview & Discussion	
1:00 pm	➢ **Briefing on Accelerated Sea-Level Rise and Mainland Tidal Salt Marsh Response - *Matt Kirwan, VIMS***
1:15 pm	➢ **NOAA Inundation Model: Overview, Applications, and Limitations - *Chris Bruce, TNC***
1:25 pm	➢ **Sea-Level Affecting Marshes Model (SLAMM) Overview - *Marco Propato, Warren-Pinnacle***
1:45 pm	➢ **Breakout Group Instructions and Presentation of Questions for Discussion - *Gwynn Crichton, TNC***
1:55 pm	➢ **Breakout Group Discussions for Sea-Level Rise and Marsh Migration Modeling**
2:40 pm	➢ **Sea-Level Rise and Marsh Migration Breakout Group Reports - *Curt Smith, ANPDC***

Community Leader Field Trip and Reception	
3:00 pm	➢ **Field trip to the Town of Chincoteague & Chincoteague National Wildlife Refuge to observe local shoreline conditions & oyster reef restoration sites – *Bill Neville, Town of Chincoteague*; *Bo Lusk, TNC; Patricia Wiberg, UVA and Kevin Holcomb, USFWS***
6:30 pm	➢ **Reception for Community Leaders at Chincoteague Bay Field Station *(Courtesy of the Nature Conservancy)***

Enhancing Coastal Resilience on Virginia's Eastern Shore Community Leader Workshop

Day Two – Thursday, November 13

8:30 am	➢ **Registration (Breakfast Items and Refreshments)**
9:00 am	➢ **Recap of Day One and Overview of Agenda and Goals for Day Two -** ***Curt Smith, ANPDC***

Storm Surge Modeling Overview and Discussion	
9:15 am	➢ **Overview of Storm Surge Dynamics and Modeling -** ***John Atkinson, ARCADIS US***
9:45 am	➢ **Breakout Group Instructions and Presentation of Questions for Discussion -** ***Curt Smith, ANPDC***
10:00 am	➢ **Breakout Group Discussions for Storm Surge Modeling**
10:30 am	➢ **Storm Surge Breakout Group Reports -** ***Gwynn Crichton, TNC***

Barrier Island-Inlet Evolution Modeling Overview and Discussion	
11:00 am	➢ **Overview of Geologic Background and Local History of Change -** ***Mike Fenster, Randolph Macon-College***
11:15 am	➢ **Overview of Coastline- Change Processes –** ***Laura Moore, UNC-Chapel Hill***
11:30 am	➢ **Briefing on Barrier Island-Inlet Evolution Modeling System –** ***Dylan McNamara , UNC-Wilmington***
12:00 pm	➢ **Barrier Island-Inlet Evolution Model Q&A**
12:30 pm	➢ **LUNCH (Provided in Chincoteague Bay Field Station Cafeteria)**
1:15 pm	➢ **Breakout Group Instructions and Presentation of Questions for Discussion -** ***Curt Smith, ANPDC***
1:30 pm	➢ **Breakout Group Discussions for Barrier Island-Inlet Management Scenarios**
2:15 pm	➢ **Barrier Island-Inlet Breakout Group Reports -** ***Gwynn Crichton, TNC***

Enhancing Coastal Resilience Workshop Conclusion	
2:45 pm	➢ **Next Steps in NFWF Project, Opportunities for Engagement, and Project Communications -** ***Gwynn Crichton, TNC***
3:00 pm	➢ **Coastal Resilience: What do you think NOW? Survey and Exercise -** ***Gwynn Crichton, TNC***
3:15 pm	➢ **Adjourn**

Appendix B

Workshop Participant and Project Staff List

Enhancing Coastal Resilience on Virginia's Eastern Shore
Community Leader Workshop

A project funded by the Department of Interior Hurricane Sandy Coastal Resilience Fund

Workshop Attendees

Alan Silverman – Accomack County Planning Commission -alan_silverman@verizon.net
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Enhancing Coastal Resilience on Virginia's Eastern Shore
Community Leader Workshop

A project funded by the Department of Interior Hurricane Sandy Coastal Resilience Fund

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Appendix C

Coastal Resilience Project Overview

and Project Timeline

Coastal Resilience on Virginia's Eastern Shore

An unprecedented effort to develop effective, forward-thinking strategies for confronting sea-level rise and storm surges.

The Eastern Shore of Virginia lies within one of the nation's most threatened coastal regions. Sea levels are rising at three to four times the global average and storms are predicted to intensify. Both threats are linked, in part, to climate change. Tens of millions of dollars have been spent in the past on piecemeal and reactive approaches to addressing the mounting challenges of climate-related hazards. Often these efforts have exacerbated the area's vulnerability.

Goal: Equip Coastal Communities with the Knowledge and Means to Strategically Plan for the Future.

The National Fish and Wildlife Foundation has awarded The Nature Conservancy $1.46 million over the next two years to work with community and academic partners to achieve the following:

- ***Build a State-of-the-Art Coastal Resilience Planning Tool.*** The Nature Conservancy and its partners will develop and implement a powerful *Coastal Resilience* planning tool for the Eastern Shore. This online tool will incorporate the best available science so that communities can visualize the risks imposed by sea-level rise and storm surge on the people, economy, and coastal habitats of the Eastern Shore. Knowing the risks will empower communities to adapt and thrive for the long term.
- ***Develop Nature-Based Solutions.*** The Conservancy and its partners will construct three oyster reefs, which will be used to demonstrate and quantify how natural infrastructure can dampen wave energy and mitigate coastal erosion. Once built, these oyster reefs will continue to accrete vertically, thereby increasing their capacity for storm protection capacity, water quality benefits, and habitat functionality over time.

The Eastern Shore is not alone in its plight, yet it is poised to be a leader for communities facing similar challenges. The science and the support tools that emerge from this effort will transfer broadly to other coastal systems, transforming the Eastern Shore into a model of resilience for coastal communities around the globe.

Why the Eastern Shore

Though rural in character, the Eastern Shore is an increasingly important economic engine for the Mid-Atlantic. The region is home to the nation's largest clam aquaculture industry and to NASA's Wallops Flight Facility, with over $1 billion of mission-critical infrastructure on Wallops Island. The Chincoteague National Wildlife Refuge and Assateague Island National Seashore collectively are visited by 2.2 million tourists annually, which generates millions in spending and creates thousands of otherwise limited jobs for residents of the many traditional waterfront villages and towns that dot the peninsula.

The natural richness of Eastern Shore is unparalled on the U.S. Atlantic. Its seaside is the world's longest expanse of naturally functioning barrier island ecosystem: habitat critical for migratory birds and abundant in marine life, which has drawn intensive scientific research. Since 1987, the University of Virginia has received funding from the National Science Foundation to operate a prestigious Long-Term Ecological Research site on the Eastern Shore, one of only 26 such in the nation. The largest seagrass restoration project in the world is there—more than 5,000 acres—as are more than 2,000 acres of oyster reef sanctuaries and 60 acres of restored oyster reefs.

The Future

The Conservancy will work closely with the Eastern Shore Climate Adaptation Working Group, led by the Accomack-Northampton Planning District Commission, and scientists from the LTER to ensure the *Coastal Resilience* tool provides the kind of information most urgently needed by decision-makers and planners in the community. Other key collaborators on the project include NASA-Wallops Flight Facility, the U.S. Fish and Wildlife Service, and well as independent climate modeling experts. The applications in the Coastal Resilience tool will greatly inform hazard mitigation plans, storm water management plans, federal National Environmental Policy Act environmental reviews, and the comprehensive planning process for towns and localities among a few examples.

For More Information

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The Nature Conservancy
(757) 442-3049
jbieri@tnc.org

maps.coastalresilience.org

NFWF Year One

Phase I 8/18-9/30

Task 1 Execute subaward and contract agreements
Task 2 Determine operational norms for project team

Phase II 9/14 – 12/19

Task 1 Plan for first workshop
Task 2 Hold workshop and report results
Task 3 Implement communications plan

Phase III 12/14-8/15

Task 1 Define scenarios for model runs and model parameters
Task 2 Run and review models
Task 3 Create E. Shore CR platform
Task 4 Design experimental field studies
Task 5 Plan and implement one reef restoration project

NFWF Year Two

Phase IV 7/17-10/23

- Task 1 Plan for 2nd stakeholder workshop
- Task 2 Hold workshop and report results

Phase V 10/15-3/16

- Task 1 Refine scenarios for model runs and parameters based on stakeholder input
- Task 2 Refine and review models
- Task 3 Develop and test CR apps based on model outputs
- Task 4 Conduct field research on reefs and marshes
- Task 5 Implement 2 reef restoration projects

Phase VI 3/16-7/15

- Task 1 Plan capstone stakeholder workshop
- Task 2 Hold final stakeholder workshop
- Task 3 Hold CR trainings

Phase VII 6/1-8/18

- Task 1 Public roll of CR tool
- Task 2 Produce reports on final project deliverables
- Task 3 Submit final report to NFWF

Appendix D

Pre-Workshop Participant Survey Results

Enhancing Coastal Resilience on Virginia's
Eastern Shore Community Leader Workshop

PRE-WORKSHOP SURVEY

Please check the appropriate box.

1. What is your affiliation?
   - ☐ Government (note if Federal, State or Local)
   - ☐ NGO
   - ☐ Academia
   - ☐ Industry
   - ☐ Concerned Citizen
   - ☐ Other (specify):

2. Where is your primary residence?
   - ☐ Accomack county
   - ☐ Northampton County
   - ☐ Elsewhere in Virginia
   - ☐ Elsewhere outside Virginia

Please circle your response to the following questions where 0 = strongly disagree and 5 = strongly agree.

3. The *Coastal Resilience* approach and tool will help Eastern Shore communities assess risk vulnerability to coastal hazards including current and future storms and sea-level rise scenarios.

0	1	2	3	4	5
strongly disagree					**strongly agree**

4. The *Coastal Resilience* approach and tool will help Eastern Shore communities identify where nature-based and other solutions can be used for reducing risk of coastal hazards.

0	1	2	3	4	5
strongly disagree					**strongly agree**

5. The *Coastal Resilience* approach and tool will fill a critical and urgent need by making available best available information on hazard risks and potential solutions.

0	1	2	3	4	5
strongly disagree					**strongly agree**

6. The *Coastal Resilience* approach and tool will be a unique, value-added benefit to community leaders and decision makers regarding future hazard mitigation actions.

0	1	2	3	4	5
strongly disagree					**strongly agree**

7. My organization has a need for the information that will be included in the *Coastal Resilience* tool.

0	1	2	3	4	5
strongly disagree					**strongly agree**

8. I will use and apply the information and apps in *Coastal Resilience* once expanded for the Eastern Shore for my organization's planning and decision-making.

0	1	2	3	4	5
strongly disagree					**strongly agree**

9. Significant barriers (political, technological or social) prevent the use of the *Coastal Resilience* approach and tool in decision-making for my organization.

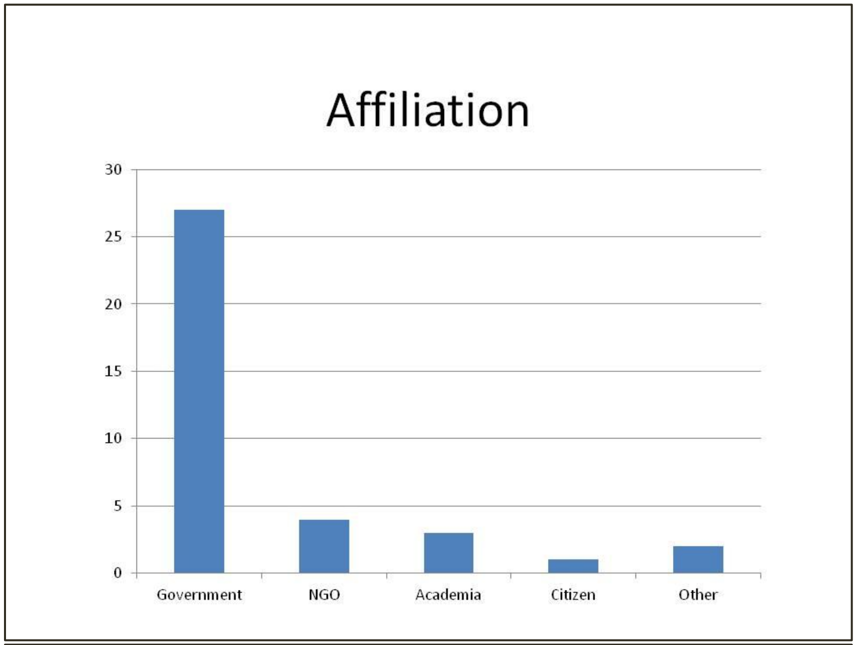
0	1	2	3	4	5
strongly disagree					**strongly agree**

10. Nature-based solutions to are an important priority to increase coastal resilience and reduce risk of coastal hazards on Virginia's Eastern Shore.

0	1	2	3	4	5
strongly disagree					**strongly agree**

11. What features would support my use of the resilience tool in decision-making (0= least likey and 5= most likely)

__Scientific knowledge of the issues and uncertainty
__Confidence in the underlying models
__My worries about climate change
__If other communities are using it
__How I learn about it and from whom
__ Ease of use
__Other: ______________________________________


Affiliation
30
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20
15
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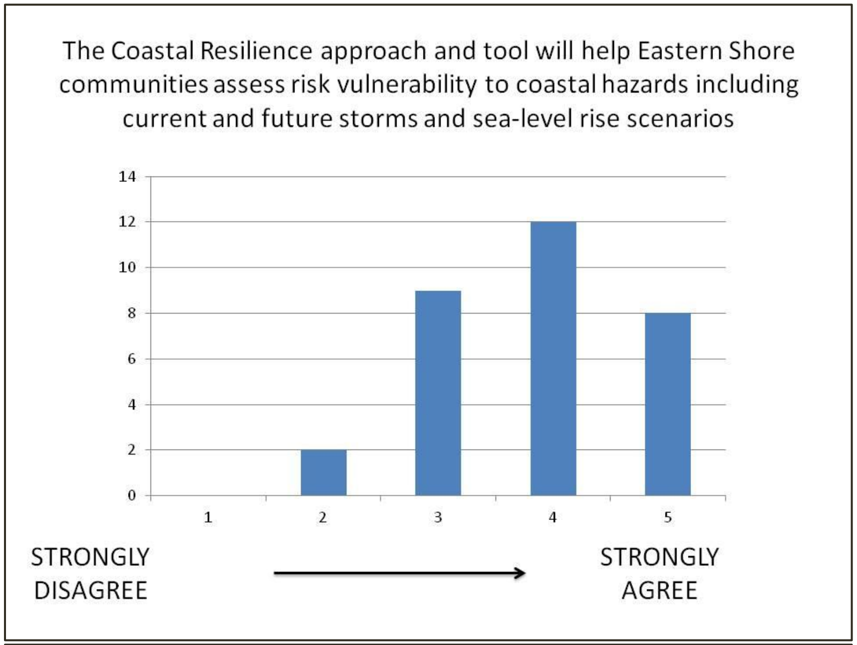
Government
NGO
Academia
Citizen
Other


The Coastal Resilience approach and tool will help Eastern Shore communities assess risk vulnerability to coastal hazards including current and future storms and sea-level rise scenarios
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1
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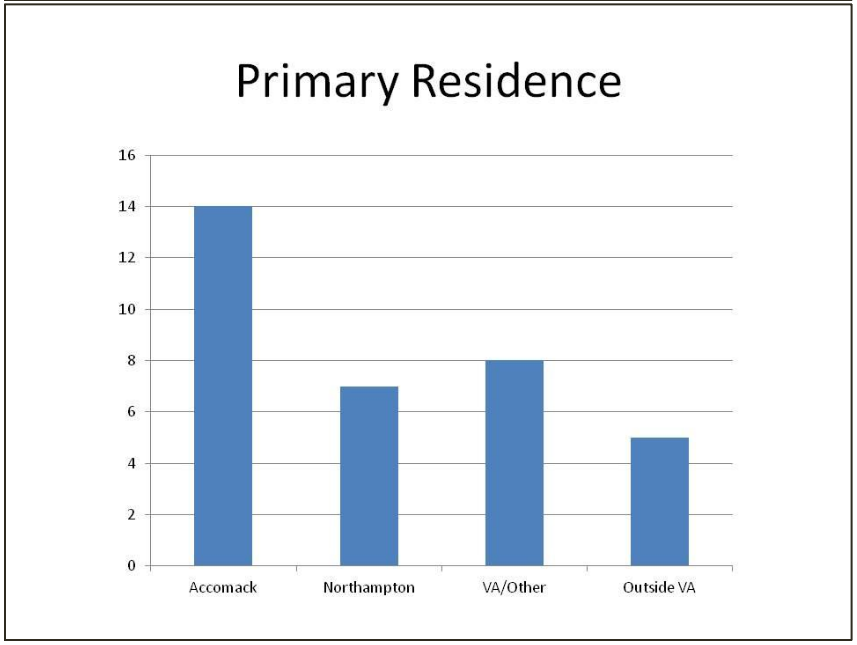
5
STRONGLY DISAGREE
STRONGLY AGREE


Primary Residence
16
14
12
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8
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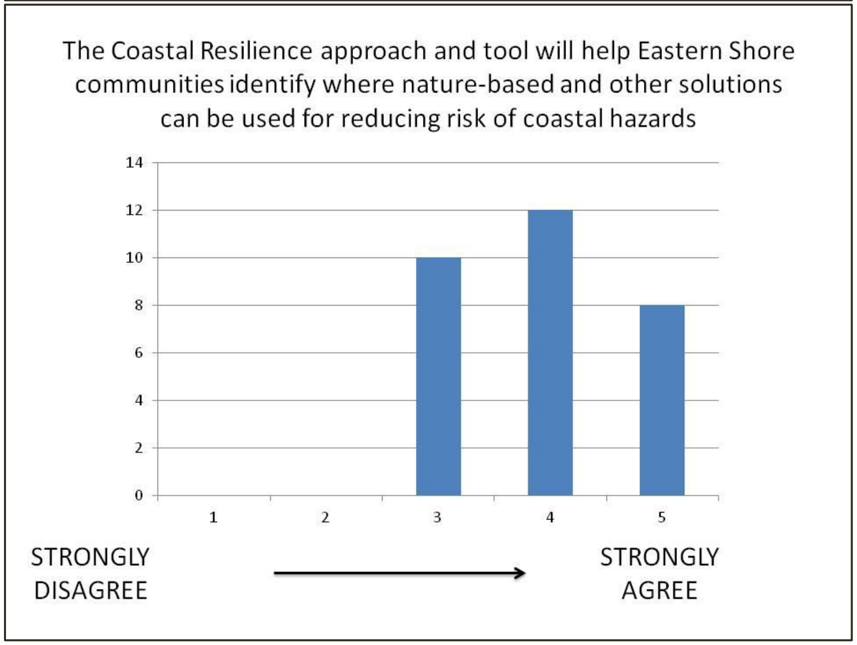
2
0
Accomack
Northampton
VA/Other
Outside VA


The Coastal Resilience approach and tool will help Eastern Shore communities identify where nature-based and other solutions can be used for reducing risk of coastal hazards
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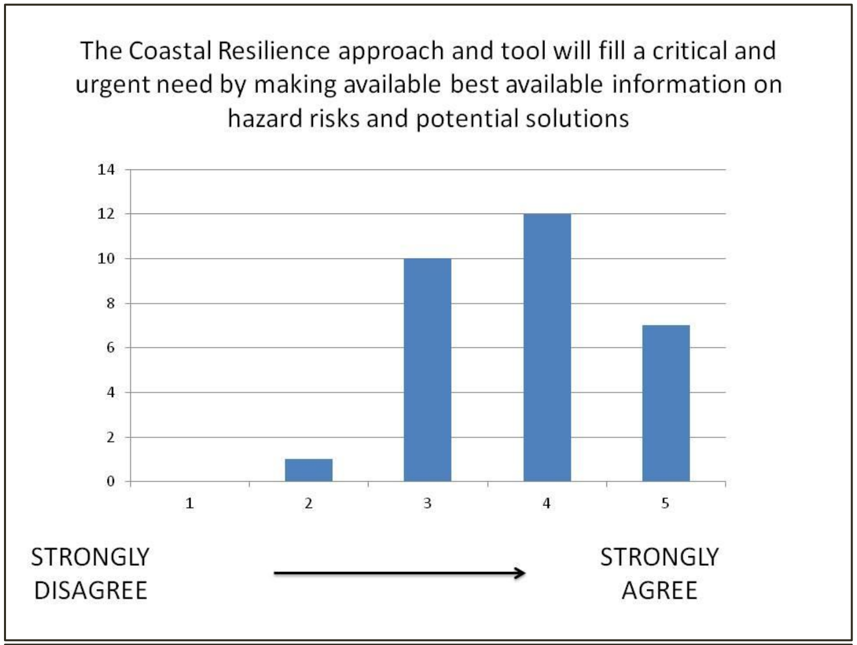
STRONGLY DISAGREE
STRONGLY AGREE


The Coastal Resilience approach and tool will fill a critical and urgent need by making available best available information on hazard risks and potential solutions
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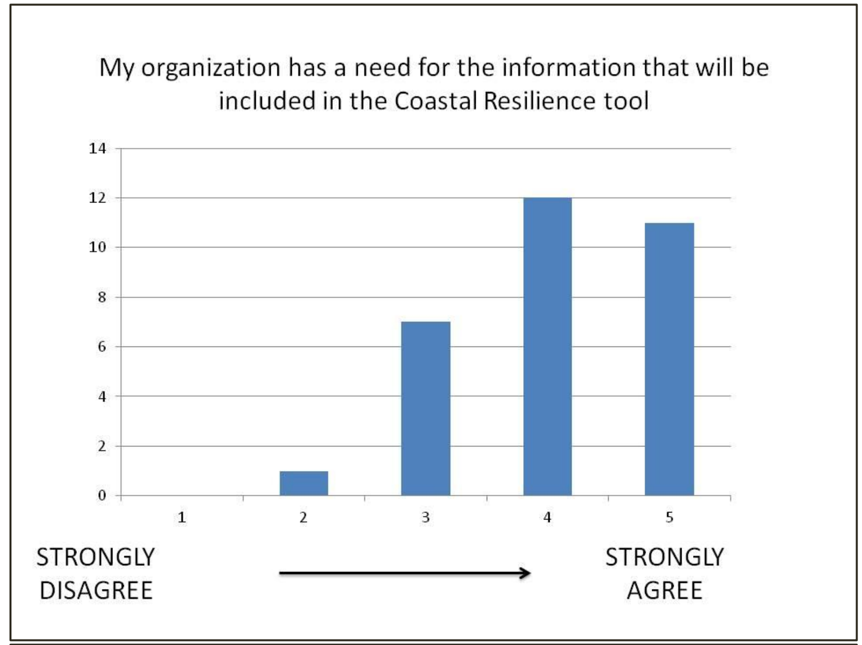
STRONGLY DISAGREE
STRONGLY AGREE


My organization has a need for the information that will be included in the Coastal Resilience tool
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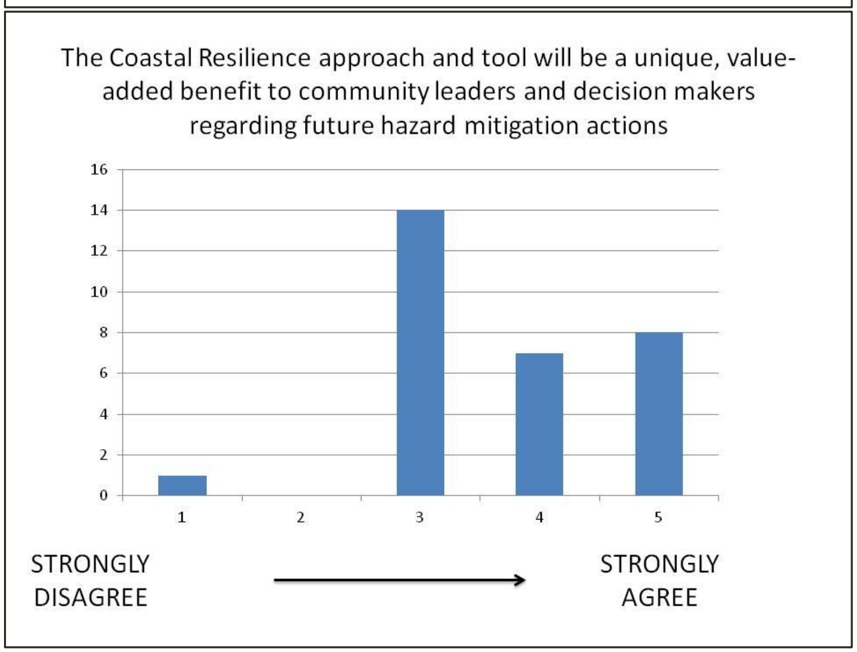
STRONGLY DISAGREE
STRONGLY AGREE


The Coastal Resilience approach and tool will be a unique, value-added benefit to community leaders and decision makers regarding future hazard mitigation actions
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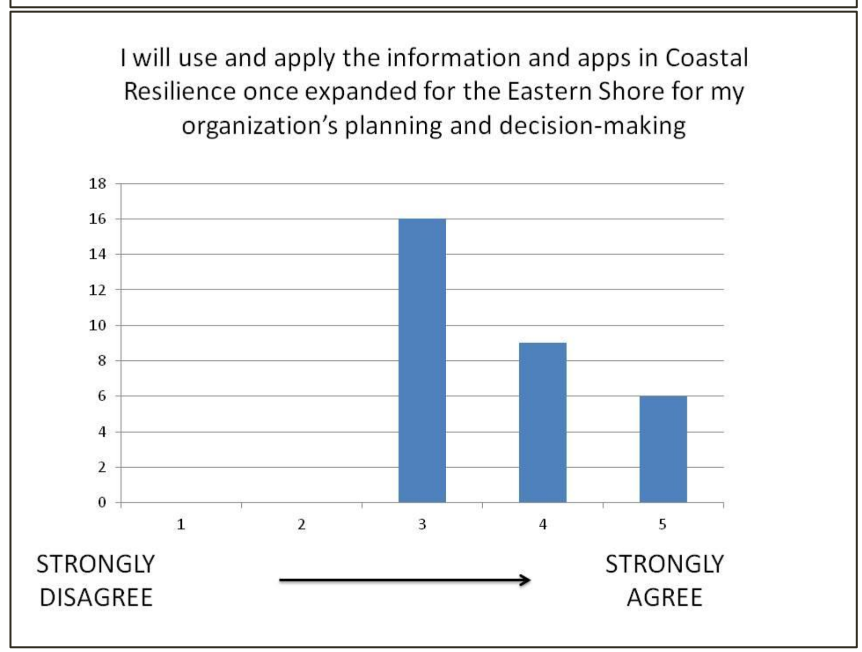
STRONGLY DISAGREE
STRONGLY AGREE


I will use and apply the information and apps in Coastal Resilience once expanded for the Eastern Shore for my organization's planning and decision-making
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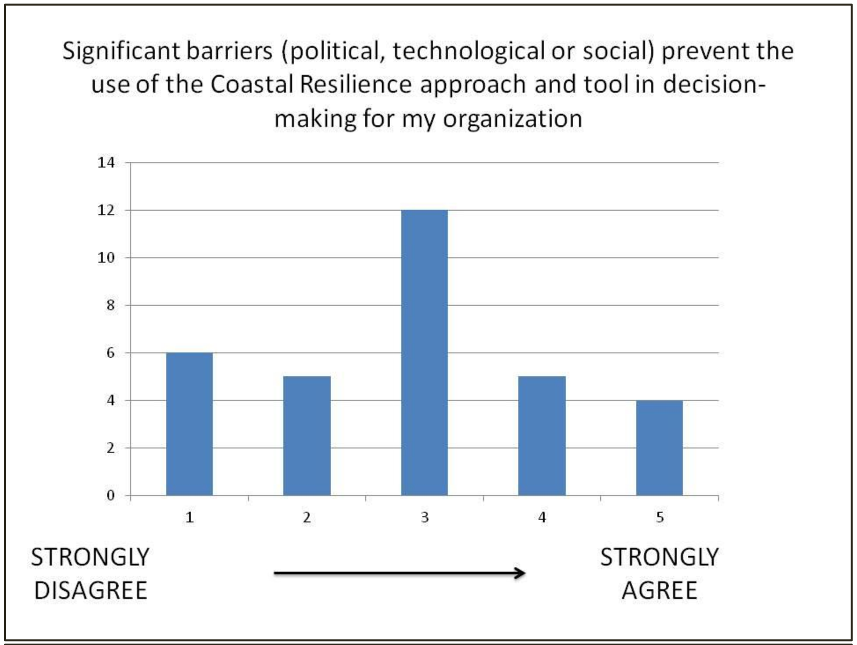
STRONGLY DISAGREE
STRONGLY AGREE


Significant barriers (political, technological or social) prevent the use of the Coastal Resilience approach and tool in decision-making for my organization
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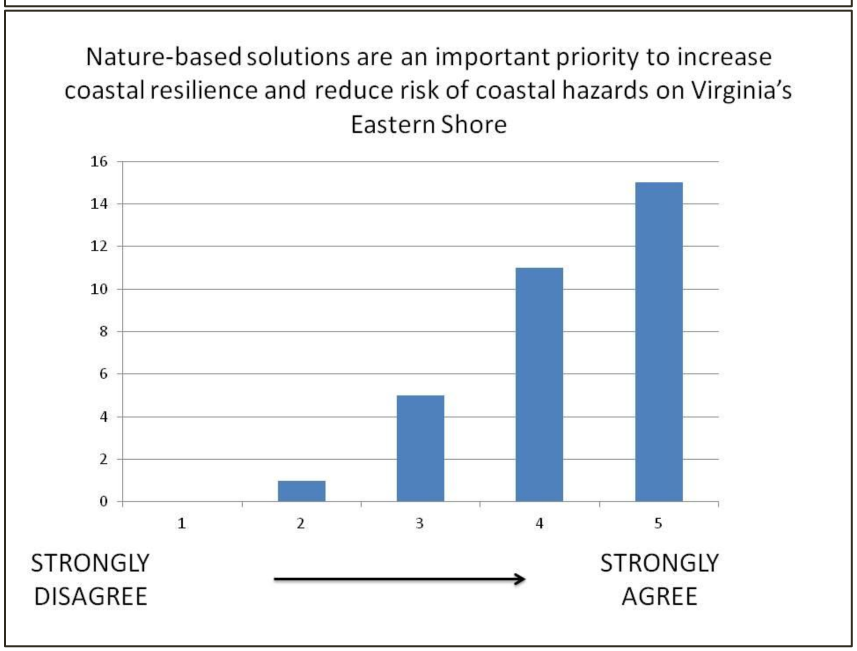
STRONGLY DISAGREE
STRONGLY AGREE


Nature-based solutions are an important priority to increase coastal resilience and reduce risk of coastal hazards on Virginia's Eastern Shore
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5
STRONGLY DISAGREE
STRONGLY AGREE

Appendix E

Problem Post Summary

Posts Submitted by Workshop Participants
How will this help to identify those who are at risk to storm surge inundation?
Can effective and useful projects be identified to enhance coastal resilience given economic, permitting requirements, etc.?
Can coastal resilience enhancement projects be done small scale (eg, one, or few, property owners)?
Cost benefit information steps relative to a base case of do nothing.
Credibility of “modeling” approach to decision making given TMDL “models” climate change “models” when inputs are incomplete or not understood.
Getting everyone on the same page.
Concern – some localities have exhibited very little in terms of efforts to enhance coastal resilience.
Education – “nonbelievers”.
Will sustainability be a major component?
Will these solutions really work?
Other coastal resilience/vulnerability tool development workshops I have attended have also identified beach/dune and coastal shrub as communities of concern. Will this tool address these areas?
Will the suggestions the tool/model make be in accordance with all permitting/laws? (Engineering permits, ACE, etc.).
In terms of towns/communities, sea level rise is going to have a major impact – Timespan? – Towns/communities affected?
Resilience of Assateague Island and the sand transport.
What is going on with Tom’s Cove Hook?
How does this project integrate and incorporate findings from other efforts? (N.A.C.C.S., VA General Assembly Joint Committee on Recurrent Coastal Flooding, etc.)
Will a tool be developed? A quick reference guide for those communities considering shoreline development.
How is consensus reached on what functions/resources have significant enough value to invest resources to protect / defend or adapt vs. retreat?
Transparent validation process for model in both interpolation of extrapolation. “Model statistics, please.”
Other than simply making sea level charts available for coastal planning purposes, can a reliable average mitigation cost be determined?
Kristen Tremblay – Informing the public
Will the products produced be usable?
Are we confusing short-term effects of changing climate with long-term? (Short: tidal surge) (Long: normal tidal ranges increasing in time)

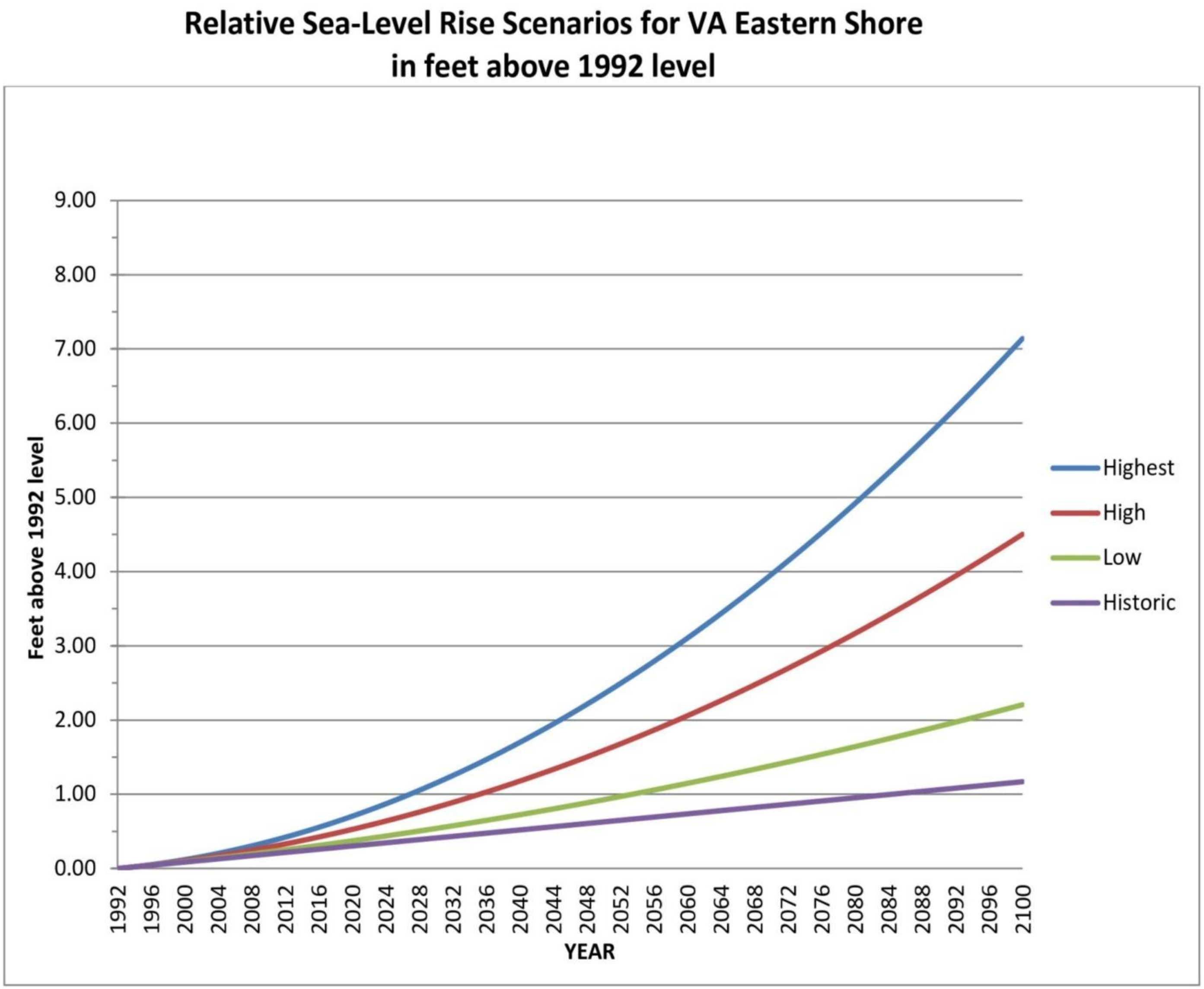
Posts Submitted by Workshop Participants
In the survey, would you include the question, “What is the genesis of the rise in water level? (Erosion, climate change, pumping of groundwater, other)
Do not know enough to have a concern yet.
To what degree of accuracy will the modeling be able to predict marsh migration?
Will the modeling help guide land acquisition for the purpose of protecting nature resources?
Protection of coastal communities as climate conditions change and barrier islands are threatened.
How will the approach/tool affect current permitting
How do activities in out of state, abutting areas affect the approach/tool?
How do the various decision support tools (models, visualization tools, etc.) complement each other, how to communicate that suite of options to users?
How we determined what the problem is?
Is erosion the cause or effect?
How can you assure that the process will utilize the best available science?
What is the basis for model and fundamental relationships used to build model?
Are there any negative drawbacks to oyster reefs/oyster castles on the natural environment?
Public buy in.
Money.
How will local communities be able to access / leverage / use the tool or project results?
What features other than oysters are recommended for implementation?
Will the tool be user friendly?
How is the input for stakeholders going to be used in creating/designing the model?
Impacts of rising water levels on groundwater and septic fields.
Marsh migration – The point where the kinetic energy moving mass is dissipated to velocity where the matter settles to the lowest land level.
Do we need any more grant money for climate change if it is already a fact?
Synchronized efforts of local, state, federal authorities and resources.
Does tool conflict with recommendations coming out of federal or state initiatives which could lead to confusion at a local level?
How large a factor of uncertainty!
Future impact to Eastern Shore with sea level rise – what are we really looking at?
Capability of marsh to occupy new areas or adapt to water level changes when current conditions become challenging.

Posts Submitted by Workshop Participants

Funding to address mitigation….

Appendix F

Relative Sea-Level Rise Scenarios for Virginia's Eastern Shore


Relative Sea-Level Rise Scenarios for VA Eastern Shore
in feet above 1992 level
Feet above 1992 level
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1992
1996
2000
2004
2008
2012
2016
2020
2024
2028
2032
2036
2040
2044
2048
2052
2056
2060
2064
2068
2072
2076
2080
2084
2088
2092
2096
2100
YEAR
Highest
High
Low
Historic

Relative Sea-Level Rise Scenarios for VA Eastern Shore

Table of Relative SLR in feet above 1992 Level

Year	Highest	High	Low	Historic
1992	0	0	0	0
1994	0.02	0.02	0.02	0.02
1996	0.05	0.05	0.04	0.04
1998	0.08	0.08	0.07	0.06
2000	0.12	0.10	0.09	0.09
2002	0.16	0.14	0.12	0.11
2004	0.20	0.17	0.14	0.13
2006	0.25	0.21	0.17	0.15
2008	0.30	0.25	0.20	0.17
2010	0.36	0.29	0.22	0.19
2012	0.42	0.33	0.25	0.22
2014	0.49	0.38	0.28	0.24
2016	0.55	0.42	0.31	0.26
2018	0.63	0.47	0.34	0.28
2020	0.70	0.53	0.37	0.30
2022	0.79	0.58	0.40	0.32
2024	0.87	0.64	0.44	0.35
2026	0.96	0.70	0.47	0.37
2028	1.05	0.76	0.50	0.39
2030	1.15	0.82	0.54	0.41
2032	1.25	0.89	0.58	0.43
2034	1.36	0.96	0.61	0.45
2036	1.47	1.03	0.65	0.48
2038	1.58	1.10	0.69	0.50
2040	1.70	1.18	0.72	0.52
2042	1.82	1.26	0.76	0.54
2044	1.95	1.34	0.80	0.56
2046	2.08	1.42	0.84	0.58
2048	2.21	1.50	0.89	0.61
2050	2.35	1.59	0.93	0.63
2052	2.49	1.68	0.97	0.65
2054	2.64	1.77	1.01	0.67
2056	2.79	1.86	1.06	0.69
2058	2.94	1.96	1.10	0.71
2060	3.10	2.06	1.15	0.74
2062	3.27	2.16	1.19	0.76
2064	3.43	2.26	1.24	0.78
2066	3.60	2.37	1.29	0.80
2068	3.78	2.47	1.34	0.82
2070	3.96	2.58	1.39	0.84
2072	4.14	2.70	1.44	0.87
2074	4.33	2.81	1.49	0.89
2076	4.52	2.93	1.54	0.91
2078	4.72	3.04	1.59	0.93
2080	4.92	3.17	1.64	0.95
2082	5.12	3.29	1.69	0.97
2084	5.33	3.41	1.75	1.00
2086	5.54	3.54	1.80	1.02
2088	5.76	3.67	1.86	1.04
2090	5.98	3.81	1.91	1.06
2092	6.20	3.94	1.97	1.08
2094	6.43	4.08	2.03	1.10
2096	6.66	4.22	2.09	1.13
2098	6.90	4.36	2.15	1.15
2100	7.14	4.50	2.21	1.17

This table represents the underlying data used to create the sea-level rise scenario curves. These numbers are based on the 2014 National Climate Assessment sea-level rise curves adjusted for the annual local subsidence rate in Wachapreague, Virginia (1.6 mm/year). Please see citations above for more information.

Appendix G

Barrier Island-Inlet Modeling System
Handout

Enhancing Coastal Resilience on Virginia's Eastern Shore Community Leader Workshop

Breakout Session #3: Barrier Island-Inlet Modeling System

Session goal: To identify and explore combinations of management actions on Wallops, Chincoteague, and Assateague Islands that are most likely and of greatest concern, and therefore most useful and relevant to address in Barrier Island-Inlet Modeling System and incorporated into the *Coastal Resilience* Tool.

<u>Discussion questions</u>:

1. What potential future management actions are missing from the list (below) and what should be added?
2. What potential future management actions appeal to you, concern you, or interest you the most and why?
3. Which management actions are the most important to model?

<u>**Potential Management Actions on Wallops, Chincoteague and Assateague Islands**</u>

Below is a list of potential future management actions to mitigate shoreline erosion and inundation that may be taken by US Fish and Wildlife Service, the Town of Chincoteague, or NASA-Wallops Flight Facility in response to future sea-level rise and storms in the future. The criteria for considering management actions to be modeled are as follows:

- Is the management action likely to be considered in the future?
- Is the management action feasible given regulatory constraints and authorities?
- If we model the action, will the information be used by decision-makers to inform future adaptation/coastal resilience decisions?

U.S. Fish and Wildlife Service Chincoteague National Wildlife Refuge
Summary of potential future management actions that might be considered on southern half of Assateague Island:

a) Sand fencing along dune line of Assateague Island beaches between Swan Cove Trail and the old Coast Guard Station on Toms Cove Hook.

b) Sand fencing and dune recontouring between Swan Cove Trail and the old Coast Guard Station on Toms Cove Hook.

c) Beach replenishment between Swan Cove Trail and the old Coast Guard Station on Toms Cove Hook.

d) Permanent inlet breaches that occur along Assateague Island caused by storms that are maintained and allowed to persist versus filling in and repairing.

e) No action.

NASA-Wallops Flight Facility
Summary of management actions considered in the 2010 Shoreline Restoration and Infrastructure Protection Program (SRIPP) Final Programmatic Environmental Impact Statement (PEIS):

a) Preferred alternative (that is the current, permitted management action): Continue to protect Wallops Island by full beach fill and extension and maintenance of 4,600-ft seawall.

b) Second alternative management action: Protect Wallops Island by full beach fill, seawall extension, and terminal groin (430-ft long by 50-ft wide) constructed on south end of the island's shoreline.

c) Third alternative management action: Protect Wallops Island by full beach fill, seawall extension, and offshore breakwater (300-ft long and 110-ft wide roughly 750-ft offshore).

d) No action alternative.

Town of Chincoteague
Summary of management actions that are being explored by the Town of Chincoteague:

a) Maintaining and expanding hardened shorelines (i.e. bulkheads, revetments) along working waterfronts and commercial property on the island.

b) Dredging of Chincoteague Inlet and redistribution of dredge spoils for marsh restoration along major infrastructure such as Chincoteague Causeway.

c) Replacement of Chincoteague Causeway with a bridge.

d) Placement of flood gates along tributaries and drainages around island to mitigate storm surge flooding to interior.