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New Guidance to Build Resiliency and Mitigate for Sea Level Rise as Elements of the Chesapeake Bay Preservation Act

Pamela Mason
Virginia Institute of Marine Science

Julie Herman
Virginia Institute of Marine Science

Christine Tombleson
Virginia Institute of Marine Science

Jessica Hendricks
Virginia Institute of Marine Science

Karen Duhring
Virginia Institute of Marine Science

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2020 VIRGINIA COASTAL ZONE MANAGEMENT PROGRAM

Section 309 Environmental Enhancement Program Strategy

Project of Special Merit

New Guidance to Build Resiliency and Mitigate for Sea Level Rise as Elements of the Chesapeake Bay Preservation Act

Final Report for NOAA Coastal Zone Management

Prepared by:
Pamela Mason, Julie Herman, Christine Tombleson, Jess Hendricks, Karen Duhring
Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
mason@vims.edu

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Table of Contents

List of Figures

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Introduction

The Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS), worked in collaboration with the Virginia Department of Environmental Quality (DEQ) and the Virginia Coastal Policy Center (VCPC) to develop guidance to inform the implementation of Chesapeake Bay Preservation Act (CBPA) regulations promulgated in 2021. The 2021 regulations added provisions to require local governments to consider climate changes, specifically flooding, sea level rise and storms, and the preservation of mature trees in the administration of the CBPA program. Specifically, CCRM developed analytical data using criteria specified in the CBPA regulations, of the National Oceanic and Atmospheric Administration (NOAA) intermediate high sea level rise curve for the year 2050, to project future shoreline and Resource Protection Area (RPA) features.

Background

In 1988, the Virginia General Assembly enacted the Chesapeake Bay Preservation Act as a critical element of Virginia's non-point source management program. In 1989, the Chesapeake Bay Preservation Area Designation and Management Regulations (Regulations) were adopted. The CBPA Program is intended to improve water quality in the Chesapeake Bay and other waters of the State by requiring the use of effective land use planning and management.

The CBPA is designed to enhance water quality while still allowing reasonable development to continue. The CBPA balances State and local economic interests and water quality improvement by creating a unique cooperative partnership between State government and Tidewater local governments to reduce and prevent nonpoint source pollution from entering the Bay and its tidal tributaries. Tidewater local governments, defined in the Act as 84 counties, cities, and towns located within the Chesapeake Bay watershed that drain to tidal waters, are illustrated on the map below. The CBPA recognizes that local governments have the primary responsibility for land use decisions and establishes a specific relationship between water quality protection and local land use decision-making.

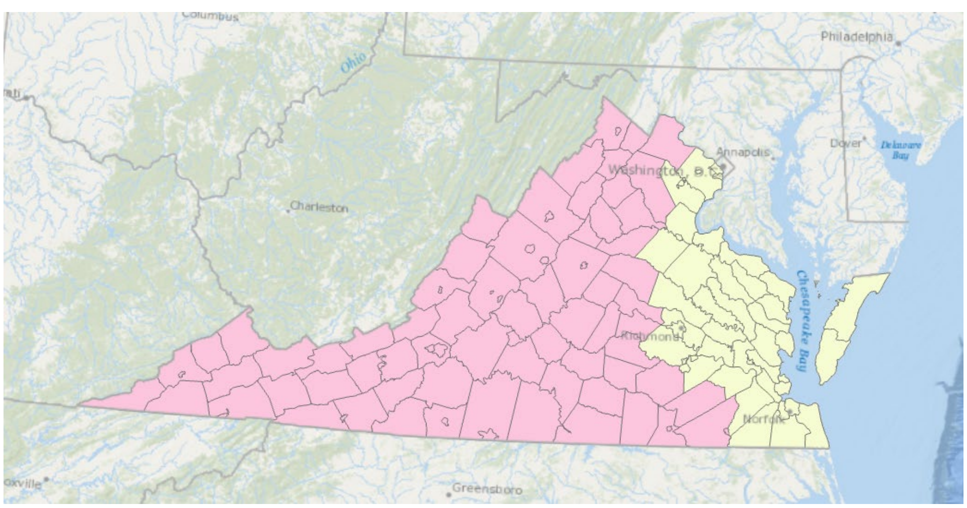

Figure 1. Tidewater Virginia showing Chesapeake Bay Preservation Act jurisdiction.

The CBPA Program is the only program in Virginia State government that comprehensively addresses the effects of land use planning and development on water quality. It is also the only program that has, as one of its core elements, a requirement to assist local governments with land use planning to meet water quality goals. An integral component of this requirement is the development of guidance documents to assist local governments subject to the CBPA in their land use decisions.

On April 3, 2018, Governor Ralph Northam signed Executive Order Six (EO-6): Supporting the Critical Role of the Virginia Department of Environmental Quality in Protection of Virginia's Air, Water and Public Health, which required DEQ, in consultation with the Secretary of Natural Resources, to begin a process to thoroughly assess DEQ's ability to carry out its mission. This included the identification of critical, time-sensitive updates to regulations or guidance, and to work with stakeholders to improve communication with the public. One of the recommendations included in the Secretary of Natural Resources' report to the Governor was "restore technical assistance and training service funding to help localities implement the Chesapeake Bay Preservation Act, including delineation and protection of riparian buffers critical to Bay water quality." Budget cuts over the years have reduced the number of State staff administering the CBPA from 34 to 5, limiting staffs' ability to provide technical assistance and training, including updating existing guidance documents and developing new ones to address current issues such as coastal resiliency and mitigation from recurrent flooding due to climate change and sea level rise.

Much of rural coastal Tidewater Virginia is comprised of gently sloping, low elevation uplands with wetlands immediately adjacent to or near tidal waters. Lands exhibiting these characteristics are at risk for increased frequency of flooding and gradual inundation from rising sea levels due to climate change. In developed areas, the effect of recurrent flooding and rising sea level, also known as "sunny-day flooding", can have profound consequences on homes, roads, and other infrastructure (Reay & Erdle, 2011). According to NOAA, this flooding will only get worse over time. For example, NOAA's Office for Coastal Management reports that Virginia's Hampton Roads region is experiencing the highest rates of sea level rise along the entire Atlantic seaboard and is second only to New Orleans as the largest U.S. population center at risk. Researchers estimate that 3 feet of sea level rise in the Hampton Roads region would affect between 59,059 to 176,124 people and would inundate 162 to 877 miles of road, either permanently or regularly. Impacts would be similar, although affecting a smaller population, in other Tidewater regions such as the Middle Peninsula and Northern Neck.

As a result of the growing threat to properties in rural coastal Tidewater Virginia, many property owners have expressed a desire to reduce and/or mitigate impacts from recurrent flooding. These impacts occur primarily in sensitive near-shore areas identified under the CBPA and Regulations as the Resource Protection Area (RPA). RPAs are lands adjacent to water bodies with perennial flow that have an intrinsic water quality value due to the ecological and biological processes they perform or are sensitive to impacts from development and land disturbing activity, which may result in significant degradation to the quality of State waters. RPAs include tidal wetlands, certain non-tidal wetlands, tidal shores, and a 100' vegetated buffer area adjacent to these features and along any perennial water body.

There are many restrictions and requirements specified in the CBPA Regulations for activities in the RPA, including the 100' buffer area, to protect intact, fully vegetated buffers that existed at the time of local program adoption. For example, the placement of large amounts of soil or fill material within the RPA, one solution proposed by Tidewater localities to mitigate recurrent flooding, would require approval by the local government through a formal exception process. Other activities, such as those associated with shoreline erosion control, are permitted under an administrative approval process. On land with homes that pre-date the CBPA, the buffer area has often been maintained in turf grass or other managed landscaping, and there is some flexibility in implementing the CBPA Regulations in those circumstances. Because local government oversight is required for activities within RPAs, Tidewater localities have requested that DEQ clearly frame options available to them under the CBPA Regulation when assisting property owners experiencing recurrent flooding. These options must protect coastal areas from recurrent flooding while maintaining the environmental protections envisioned by the CBPA and should include innovative practices not previously considered before recurrent flooding became a widespread issue in coastal Virginia.

The Virginia Coastal Zone Management Program (CZM) is a network of State agencies and local governments that administer enforceable laws, regulations, and policies that protect Virginia's coastal resources. The Coastal Lands Management Program is an enforceable policy administered by DEQ through the CBPA and Regulations. The CZM Program directs State programs to study and develop plans for addressing adverse effects on the coastal zone from climate change and sea level rise. The Virginia CZM Program has developed successful riparian zone management initiatives through previous Section 309 strategies. CZM collaboration implemented strategies to improve shoreline management and increase the use of living shorelines resulting in new State living shoreline legislation in 2011 and 2020, site-specific shoreline management data and recommendations for the entire coastal zone, a fast-track permitting process, a revolving loan fund for living shorelines, and revised shoreline guidance documents. The Program was also successful in obtaining a Section 309 Project of Special Merit in 2015 to evaluate the results of this initiative, which showed a positive trend in the use of living shorelines (Berman, et.al, 2018).

Proposed Approach

DEQ submitted a proposal for NOAA Project of Special Merit funding in 2020 to contract with the CCRM/VIMS and the Virginia Coastal Policy Center (VCPC) at the College of William & Mary to assist in developing a new guidance document to inform development of new policies of the CBPA program. VIMS and VCPC both have considerable experience in exploring, analyzing, and drafting policies and scientific concepts around sea level rise and mitigation, and their connection to the CBPA. Several past reports have examined various aspects of this challenging topic and both partners are exceptionally qualified to assist in developing this guidance document. VIMS was proposed to provide scientific research, including models for sea level projections and RPA features projections and potential impacts of management actions on tidal and nontidal RPA features. The VCPC was proposed to analyze the document for legal conformance with the CBPA and other potentially applicable laws, regulations, and programs. A stakeholder workgroup facilitated by VCPC was proposed to meet at least three times during the development of the guidance to provide input and feedback during the process with a "kick-off" meeting to be held within the first three months of project inception.

Actual Approach

The project contract period was initially from October 1, 2020, to March 30, 2022. The project team, comprised of CCRM and VCPC personnel, initiated meetings in October 2020, resulting in a total of three monthly meetings being held in 2020. The project team was contacted by DEQ personnel to advise on pending legislative changes to the Chesapeake Bay Preservation Act (CBPA) authorizing legislation.

In the 2021 General Assembly session, a proposed change to CBPA was passed and signed into law. The critical changes include the addition of two specific requirements; the consideration of climate change: sea level rise and flooding and storms, and preservation of mature trees. DEQ was directed to develop regulations to implement the new requirements.

As the proposed project was to have been a guidance document to inform the potential development of new legal provisions, the project team and project priorities had to be re-set to reflect the new pending regulations. The project technical leads, Shep Moon and Jeff Flood DEQ/CZM and Justin Williams, Director, Office of Watersheds and Local Government Assistance met with the project team to modify project outcomes to reflect the new context for project deliverables. Two notable circumstances needed to be addressed: 1) DEQ Office of Watersheds and Local Government was now under the Administrative Processes Act (APA) requirements for regulation development, and 2) the universe of potential recommendations from the original project process were now defined in state law. DEQ was advised that the guidance project could not proceed outside the APA. And, as the VIMS and VCPC were already contracted to DEQ/ CZM for guidance development, it was decided that the project pivot to provide technical and advisory assistance to DEQ with the regulations and with guidance on how to implement the regulations to follow. The regulatory approval process was effective as of September 29, 2021.

The new project team for the remainder of the project included VIMS, VCPC, DEQ/CZM and DEQ/CBPA.

Bimonthly virtual team meetings were led by VIMS and DEQ/CBPA from January 2021 to January 2022. At that point with the shift from a combination of guidance document writing and modeling decisions and implementation to concentrated effort on the document writing, VCPC and DEQ/CBPA were lead for the remaining meetings.

Prior to the codification of the new CBPA provisions (and in anticipation of the complications of holding meetings seeking input from the public), VIMS held a meeting to solicit input on the technical decision points regarding the data to use for the projection scenario models as one of the project deliverables. The CBPA modeling, research, and analysis workgroup met once, Feb 24, 2021.

Partnerships and networks

During the development of the guidance document, it was imperative to engage local government officials/staff, coastal Planning District Commissions (PDCs), other State agencies, non-governmental organizations, and affected landowners to fully understand the magnitude of the issue and formulate solutions that will be embraced by those who will be using the guidance. Stakeholders engaged in the guidance development included Tidewater PDCs, the Virginia Department of Conservation & Recreation, the Virginia Department of Health, the Virginia Department of Forestry, Friends of the Rappahannock, and the Chesapeake Bay Foundation.

Three stakeholder meetings were held. The first, on May 13, 2021, was an informational webinar on the development of the regulations. The attendees from the first webinar were also offered an opportunity to be on a formal stakeholder advisory group for the development of the guidance following promulgation of the regulations.

The guidance stakeholder advisory group met two times, on October 7, 2021, and on April 20, 2022.

The goal of the stakeholder engagement was to vet the data and modeling approach undertaken by CCRM/VIMS and the content of the guidance developed collaboratively by DEQ, VCPC and CCRM/VIMS. As a result of this interaction with local governments and other stakeholders, a request for outreach and education is planned for Winter and Spring 2023.

Conclusion

Although requested by rural coastal local governments in Tidewater Virginia, this guidance document could be transferable to localities in other States that are currently experiencing, or will soon experience, similar challenges and do not have the resources to develop guidance of their own. The resulting guidance document specifies how projects that meet the requirements for review should be assessed for resiliency, defines the models that should be used for the assessment and identifies those allowable natural and nature-based practices and techniques to address recurrent coastal flooding.

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Berman, M., Mason, P., Nunez, K., & Tombleson, C. 2018. Implementing Sustainable Shoreline Management in Virginia: Assessing the Need for an Enforceable Policy. Virginia Institute of Marine Science, William & Mary. Final Report on W&M Scholarworks

NOAA. Hampton Roads' Sea Level Rise Adaptation Advances on Multiple Fronts (https://coast.noaa.gov/states/stories/sea-level-rise-adaptation-advances-on-multiple-fronts.html)

Reay, William G., and Erdle, Sandra Y. 2011. Sea Level Rise: Local Fact Sheet for the Middle Peninsula, Virginia. Virginia Institute of Marine Science, CBNERRVA, Gloucester Point, Virginia.

2050 Shoreline Position and Wetlands Location Modeling

Data Layers Created

The Center created three data layers for the project to provide information on the projected location (extent and position) of certain RPA features to inform resiliency assessments as required by CBPA legislation and regulation. The CBPA programmatic changes specified which of the sea level rise projections, NOAA 2017 Intermediate-High and the year to be modeled (2050) as those conditions to be addressed by the resiliency assessments. Based upon criteria set by the CBPA programmatic changes, specific models, or comparable models, are to be used in the resiliency assessment. To inform the required assessment, these three data layers were created and provided in AdaptVA.com:

1. **Potential 2050 Upland Interface Shoreline**
2. **Potential 2050 Wetlands (these are wetlands that meet the RPA criteria)**
3. **Opportunity for Wetlands Migration: Existing Turf Grass in Potential 2050 Wetland Areas**

Existing Data

Several existing base layers were used to model future RPA features. Those data are:

1. 2020 upland interface shoreline (CCRM)
2. National Wetlands Inventory (NWI) (Link to Fish and Wildlife National Wetlands Inventory website)
3. Tidal Marsh Inventory (TMI) (Link to VIMS, CCRM Comprehensive Coastal Inventory webpage).
4. High-resolution elevation layer (CBTBDEM, 2016)
5. High-resolution land cover data (Link to the Virginia Geographic Information Network webpage),

Model development

The project area was land adjacent to tidal waters within the Chesapeake Bay (CB) watershed in Virginia (Figure 2). This means lands within the Virginia Coastal Zone that border tidal waters. This study area was selected by DEQ and CCRM. Not included are lands within the coastal zone localities that are adjacent to free-flowing, unidirectional, non-tidal waters. These lands were not included due to the lack of any impacts indicated by 2050 NOAA intermediate-high sea level curve, or impacts indicated by the NOAA storm surge model. As these are two models specified for consideration in the CBPA climate resiliency assessment, these lands would not meet the criteria for requiring an assessment.

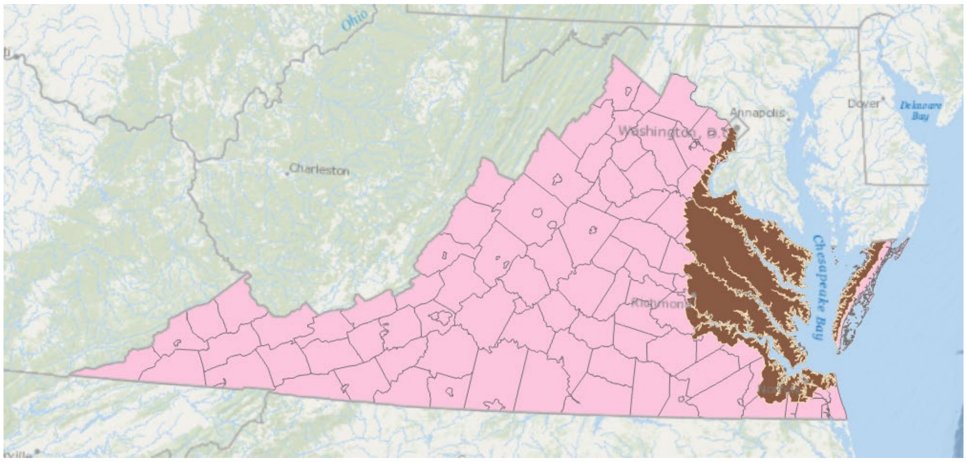

Figure 2. Map of the study area. Includes lands within the Virginia Coastal Zone adjacent to tidal waters where impacts from sea level rise and storm flooding are expected according to projections.

A Geographic Information System (GIS) model was used to identify the projected location of the 2050 shoreline and RPA features, specifically tidal and non-tidal adjacent wetlands as needed for site assessments according to CBPA regulations and guidance. We used multiple data layers to model potential future Resource Protection Area (RPA) features (listed in previous section). This section details the GIS methodology for creating the 2050 features.

Potential 2050 Upland Interface Shoreline

The upland interface shoreline represents the boundary between the tidal water and upland. Where tidal marshes exist, it is the upland edge of the tidal marsh; where marshes do not exist, it is the landward edge of the water. The first step was to create a projected upland interface shoreline location for the year 2050 using the NOAA 2017 Intermediate High Sea level curve [Sweet et. al, 2017]. The NOAA study predicts for the year 2050, for Chesapeake Bay, Virginia, Mean Sea Level (MSL) is 0.6m elevation and Mean High Water (MHW) is 0.9m. This elevation was verified using the sea level rise data from AdaptVA for mean high water. A high-resolution elevation layer (CBTBDEM, 2016) for Virginia was used to determine the future 2050 upland interface shoreline.

To determine the 2050 Upland Shoreline Interface, the current shoreline (CCRM 2020 upland interface shoreline) was treated in two ways:

1. For locations along the current shoreline where no wetlands are present, the 2050 MHW line (0.9m) is calculated as the future 2050 upland interface shoreline.
2. For locations where wetlands currently exist, the future 2050 upland interface shoreline was based on the jurisdictional delineation of the upland limit of vegetated tidal wetlands (defined as 1.5 times the mean tide range) and was calculated to lie at 1.5m elevation. The average tidal range in Chesapeake Bay is 2 feet (0.6 m), which was multiplied by 1.5 and then added to the projected 2050 MSL elevation of 0.6m. Note that the regulation states that the average tidal range times 1.5 should be added to MLW. By adding it to MSL instead makes the output conservatively inclusive, that is the results are incorporating possible uncertainties in future shoreline location based on the projected sea level rise curve (Fig. 3), as well as inaccuracies from pre-existing GIS datasets, and artifacts from the GIS methodology for translating information inland from the shoreline.

In addition, MSL is the lower limit of tidal elevation at which marsh vegetation can persist representing the area of vegetated tidal wetlands.

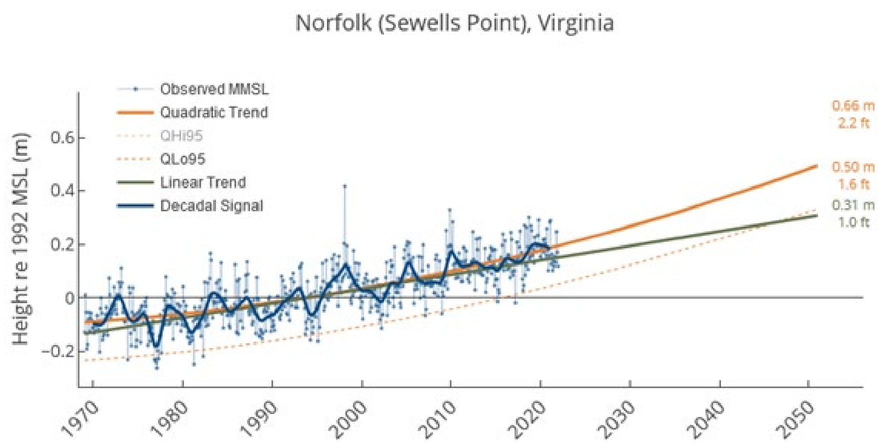

Figure 3. Graph from Sea Level Rise Report Card showing uncertainty in sea level rise projections. [*Link to the VIMS Sea Level Report Cards webpage*]

Modelling future wetlands and RPA features

The definition of wetlands was based on the Chesapeake Bay Preservation Act which states they are those tidal wetlands, and those non-tidal wetlands that are connected by surface flow and contiguous to tidal wetlands or water bodies of state waters. This does not include current or future non-tidal isolated wetlands, such as those seen in NWI (National Wetlands Inventory). To estimate where future CBPA wetlands will occur, requires a multi-step process in GIS. It was first determined where along the tidal wetlands occur, then this information was migrated inland to estimate what land surfaces would be included. To start, the current shoreline was divided into 10m segments with a midpoint generated for each segment (Fig. 4).

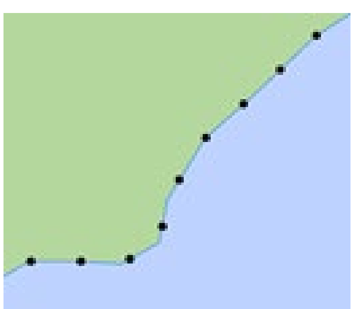

Figure 4. The black dots represent the midpoints of 10m segments along the shoreline. Initial step in building Thiessen polygons to model wetlands migration.

Thiessen polygons were generated from these shoreline mid points. Each of these Thiessen polygons defines an area of influence around a point, so that any location inside the polygon is closer to that point than any of the other points. This technique divides the land surface into regions (polygons) associated with each point along the shoreline and includes land up to 1.5m in elevation (Fig. 5).

Figure 5. The pink sections are Thiessen polygons associated with each 10m shoreline segment based on the midpoints (black dots).

This method enables us to determine which land area may be potential future wetlands and which will not, based on the NOAA 2017 Intermediate High sea level curve.

Next, two identical Thiessen polygon layers were made; with one generated up to 0.9m elevation and the second to 1.5m elevation, to allow for separate treatment of shoreline segments without wetlands and shoreline segments with tidal wetlands, respectively (as discussed in the previous section). All polygons in these layers represent land elevations from the current shoreline up to their respective boundary (i.e., 0.9m or 1.5m). With this information, we can then proceed to select land areas that will be considered future wetlands by choosing wetland and Thiessen polygons that fit the RPA wetland criteria.

Potential 2050 Wetlands

Areas likely to become CBPA wetlands in 2050 fulfill two criteria: 1) they are adjacent to existing (2020) tidal wetlands, and 2) they lie within the projected 2050 intertidal zone (i.e., less than 1.5m elevation). Six layers were created using a series of selections to identify all wetland and Thiessen polygons that meet these criteria. Some polygons were selected more than once, and all duplicates were removed during merging of these six layers into the final layer for Potential 2050 Wetlands.

1. Tidal wetland polygons that touch the current shoreline. This selection captures current wetlands that may be future wetlands. In addition, it includes the projected 2050 intertidal zone.
2. Thiessen polygons for 0.9 m elevation that touch the shoreline. This selection translates the current shoreline without wetlands to its projected 2050 future MHW location.
3. Wetland polygons that touch the 0.9m Thiessen polygons in step 2. This selection includes wetlands that do not touch the current shoreline but will touch the 2050 shoreline.
4. Thiessen polygons for 1.5 m elevation that touch wetlands that touch the shoreline. This selection includes areas that are adjacent to tidal wetlands.
5. Extra 1.5m Thiessen polygons that touch LIDAR-generated streams that touch 1.5m Thiessen polygons in step 4. This step selects areas for non-tidal adjacent connected by surface flow. This selection compensates for some areas where the Thiessen polygons created unnaturally shaped boundaries on the land surface, which is a result of the GIS methodology.
6. Wetlands that touch the 1.5m Thiessen polygons in steps 4 and 5. This selection fulfills the RPA criteria of those non-tidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies of state waters.

Note that in areas where existing datasets (generated by other agencies) have unexpected discrepancies, the source data were not altered.

Opportunity for Wetlands Migration: Existing Turf Grass in Potential 2050 Wetland Areas

Using the Potential 2050 RPA Wetlands layer (from previous section) combined with a high-resolution land cover dataset (from 2016), areas with turf grass were selected. The resulting layer shows areas for potential wetlands in 2050 which might not become wetlands (i.e., there will be a wetlands loss), assuming turf grass areas will be managed to prevent marsh migration. Remediation would need to occur for wetlands to form. These areas are mapped to identify potential restoration targets as those lands falling within the modeled 2050 wetlands extent that are not natural cover or impervious surface (infrastructure).

Visualization: Data Service

The data outputs from the modeling are served on the Tools tab of Adaptva.com. The Adaptva mapper layout was modified to add a table of contents heading labeled “Chesapeake Bay Preservation Act”. Two of the date layers are found under this new sub-heading. The third data layer is found under the Protection/Restoration heading.

The Adaptva interactive mapper is found under the Tools tab on the main page. Figure 6 shows a screen capture highlighting the addition of a new Chesapeake Bay Preservation Act subheading under Shoreline Management. This same subheading has a previously modeled CBPA features buffer mapped for a NOAA funded project “Increasing use of natural and nature-based features to build resilience to storm-driven flooding”. Two of the data layers are found under this sub-heading, Potential 2050 Wetlands and Potential 2050 upland shoreline (Figure 7 and 8).

Figure 6. Adaptva Interactive Mapper showing new Chesapeake Bay Preservation Act sub-heading in Table of Contents under Shoreline Management.

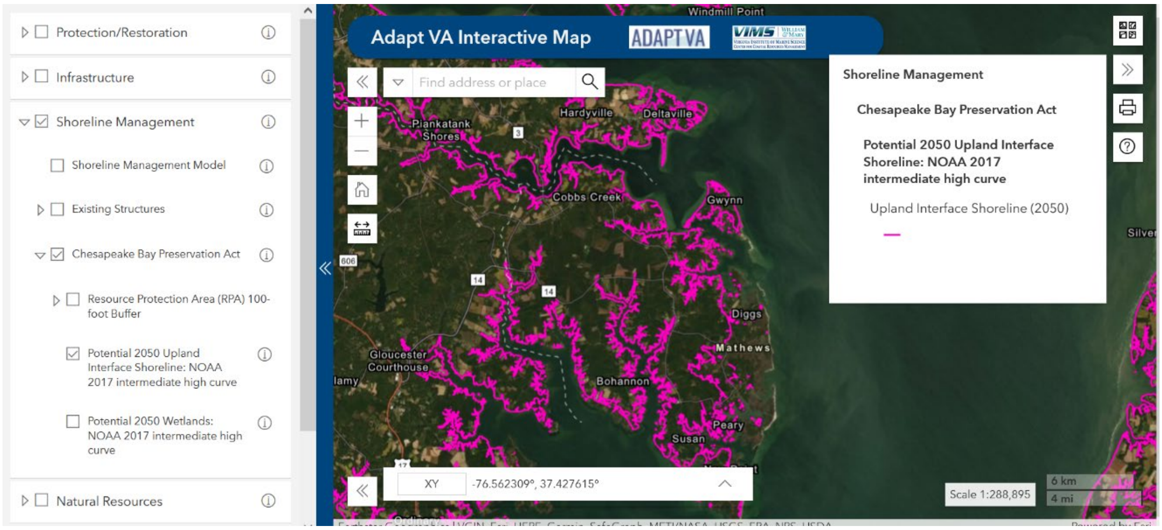

Figure 7. Adaptva Interactive Mapper. Chesapeake Bay Preservation Act Heading checked on and Potential 2050 Upland Interface Shoreline turned on and shown in the legend

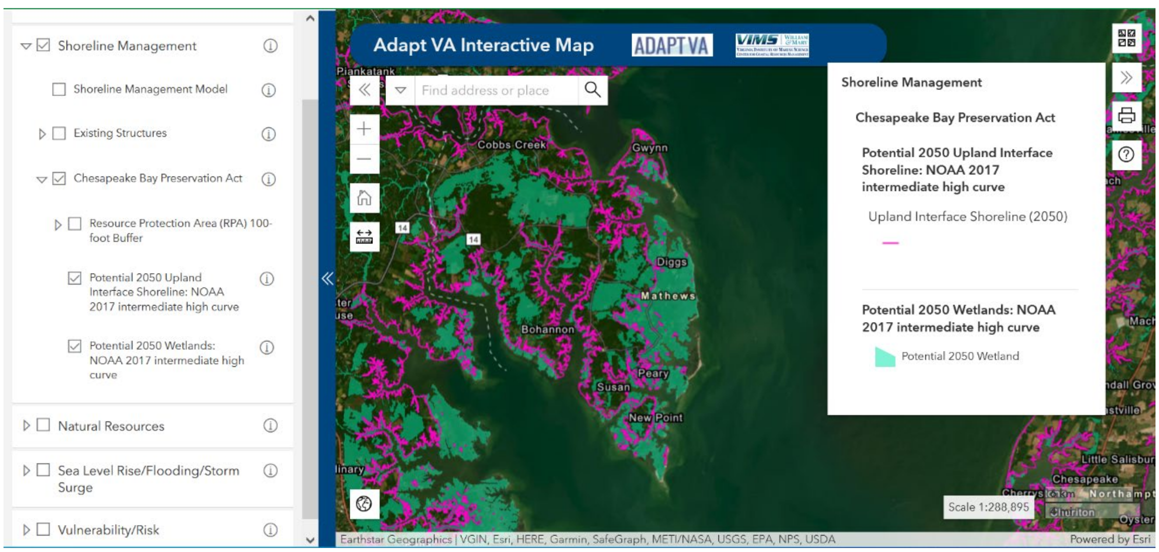

Figure 8. Adaptva Interactive Mapper. Chesapeake Bay Preservation Act Heading checked on and both Potential 2050 Upland Interface and Potential 2050 wetlands checked on and shown in legend.

The restoration opportunities identified as turf grass within the potential 2050 wetlands are found under the Protection/ Restoration heading in the mapper. These turf areas within the projected tidal marsh migration footprint can highlight the opportunities for marsh migration (Figure 9). However, if these turf (lawn) areas are protected from future sea level rise and marsh migration, they can be an indication of future wetlands prevented by management actions.

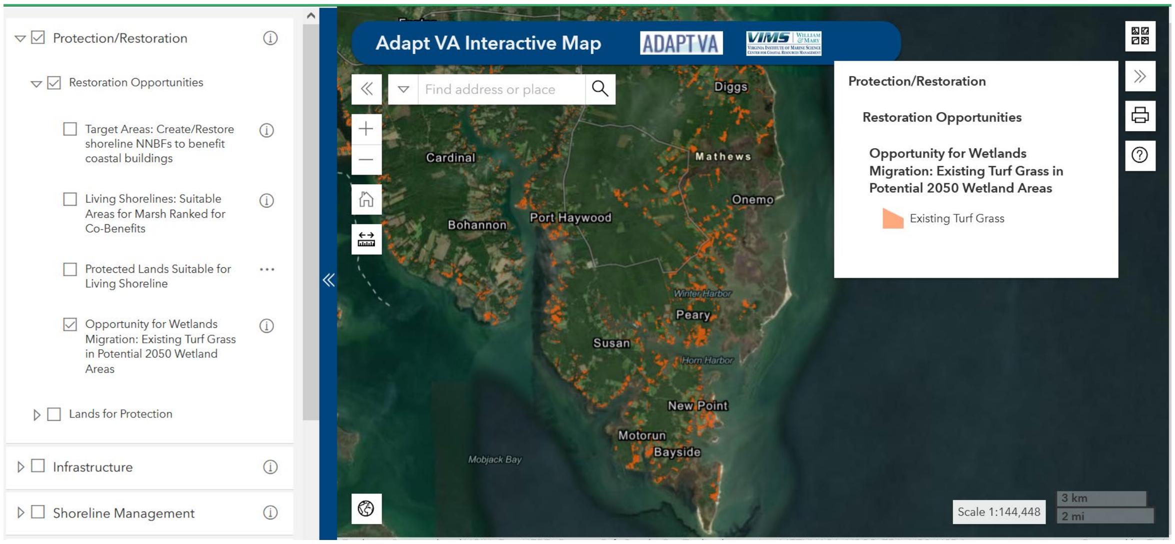

Figure 9. AdaptVa Interactive Mapper. The highlighted areas are current turf grass that, if protected from sea level rise, will not become tidal marsh even though these lands are identified as Potential 2050 wetlands.

Citations

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