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Synthesis of Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Final Report

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Scope of Work 8: Synthesis of Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Final Report

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Executive Summary

Coastal marsh loss is a significant issue globally, due in part to rising sea levels and high levels of coastal human activity. Marshes have natural mechanisms to allow them to adapt to rising sea levels, however, migration across the landscape is one of those mechanisms and is frequently in conflict with human use of the shoreline. Ensuring the persistence of marshes into the future requires an understanding of where marshes are likely to migrate under sea level rise and targeting those areas for conservation and preservation activities.

The goal of this project was to 1) compile existing datasets and information related to marsh migration under sea level rise-driven inundation due to forecasted climate change, topography of bay shorelines, shoreline condition (e.g., erosion rates, hardening, existing natural resources), existing wetland area and potential migration corridors, and other relevant data from around the Chesapeake Bay and 2) develop a methodology that synthesizes the information in a format that can be used to assist with marsh conservation and restoration decisions under multiple sea level rise scenarios.

A literature review of available marsh models demonstrated that marsh models tend to fall into 3 main categories, Landscape models, Site-specific models, and combination/cross-scale models. There are extensive datasets (>110) related to marsh migration considerations, including: Sea level rise forecasts for multiple stations throughout the Chesapeake Bay; subsidence rates throughout the Chesapeake Bay; topographic and topo-bathy surfaces and bank height; shoreline erosion rates and soil types; type and extent of shoreline alterations (e.g., bulkheads, revetments); locations of living shorelines, and distribution of natural resources (e.g., marshes, beaches, dunes). Evaluation of existing datasets in the Chesapeake Bay that can be used in marsh migration models indicated that the data necessary to run Landscape models is broadly available; however, the data necessary to run Site-specific and Combination/cross-scale models is limited in geographic and temporal scope.

In addition to datasets, there are five marsh migration models that have been run for areas in the Chesapeake Bay. These models were leveraged to develop a methodology to identify Marsh Migration Corridor Envelopes (MMCE) which stakeholders felt gave sufficient information to target conservation/preservation areas. Using existing model runs, this method could be reproduced (with some modification) throughout the Chesapeake Bay and in other areas throughout the United States. The exact suite of elevation-driven marsh migration models available varies by locations, but any suites of models could be substituted into the methodology since the point of the MMCE calculation is to mitigate the biases in any given model by including the results from multiple models. This method is faster and less expensive than running large scale marsh migration models. However, it should be considered only as a targeting tool. Before identified parcels are acquired, detailed analysis of the parcel characteristics and potentially some small-scale modeling should be done for the target area.

Introduction

Coastal marsh loss is a significant issue globally (Barbier et al. 2011) and has been accelerating over the past century with a total loss greater than 50% of the original tidal salt marsh habitat, due in part to human activity (Kennish 2001). In the Chesapeake Bay, studies have suggested marsh loss in various areas around the Bay (Wray et al. 1995, Stevenson et al. 2002, Kearney et al. 1998, Kearney et al. 2002, Tiner 1994, Mitchell et al. 2017). Research on the response of marshes to sea-level rise has typically focused on a limited number of discrete marshes, leading to conflicting results, with some studies suggesting that marshes are expanding under sea-level rise (Kirwan et al. 2016b) while other suggest marshes are fragmenting and losing extent (Beckett et al. 2016).

Marsh loss associated with sea level rise, erosion and human activity has been documented throughout the United States (e.g., DeLaune et al. 1994; Hartig et al. 2002; Bromberg and Bertness 2005; Mitchell et al. 2017). Sea-level rise in particular has been cited as a cause of on-going marsh loss in many estuaries, including the Chesapeake Bay (e.g., Stevenson et al. 1985, Wray et al. 1995, Beckett et al. 2016) and is considered to be an increasing threat in the future as sea level rise accelerates. Relative sea-level rise in the Chesapeake Bay since 1970 has averaged (across the Bay) around 5 mm/year (Ezer and Atkinson 2015, Boon and Mitchell 2015), which is commiserate with the maximum rate of accretion theoretically possible for marshes (Morris et al. 2016), suggesting that marshes are likely becoming stressed by increased inundation on a broad scale.

Sea level rise impacts the tidal marshes in two primary ways:

1. Sea level rise increases tidal inundation frequency, tidal flooding extent and shoreline erosion (due to increased water depth). Changing inundation drives marsh migration. Changes in inundation are reflected in the marsh extent and position on the landscape and the plant community composition.
2. Sea level rise changes the salinity distribution in the estuary, pushing brackish waters up into previously freshwater systems. Changes in salinity are reflected in the plant community composition.

The purpose of this project was to develop a methodology for using results from marsh migration models combined with social, landuse, and environmental data to inform marsh management, conservation, and restoration under sea level rise. There were five steps to achieve this goal: 1) Identify available data relevant to marsh migration modeling 2) Review the parameters, benefits, and limitations of marsh migration models, 3) Determine existing models that have been run within the Middle Peninsula, Virginia; 4) Using a few targeted areas, compare results across the models to determine how different model parameters and formulations may affect projected marsh migration pathways; 5) develop a methodology that combines model results with other landscape data to highlight considerations of marsh migration for restoration/conservation purposes.

A literature review of available marsh models (see Appendix 1) demonstrated that marsh models tend to fall into three main categories, Landscape models, Site-specific models, and combination/cross-scale models. Landscape-scale models often use fixed rates (e.g., erosion rates) during the entire simulation. Landscape scale models fall into two broad categories: topography-driven models (SLOPE, Evolution of Tidal Marsh) and elevation/process inclusive models (SLAMM, NOAA MM, Nicholas Institute). Both types of model are predominately driven by the land elevations, with marshes migrating in to appropriate elevations as sea level rises. In areas with broad, flat lands, marshes tend to expand as they migrate. In areas with steep slopes, marshes tend to become narrower, or completely disappear. Elevation/process inclusive models incorporate erosion and/or accretion rates to model marsh persistence. The differences between these models is minor when just looking at marsh migration, but maybe important if marsh persistence is also being modeled. Site-specific models are more mechanistic. They are employed to simulate responses for a specific site with a particular set of conditions and settings (MEM/CWEM), they contribute to our understanding of marsh persistence and change, however, they do not model migration. Combination and cross-scale models are an integrated approach that combines spatial dynamics of salt marshes and predicts the impacts of possible future sea-level conditions (Hydro-MEM, TMM). They require extensive data sets of hydrological, sedimentological, and biological data and often substitute fixed rates for missing data.

Evaluation of existing datasets in the Chesapeake Bay that can be used in marsh migration models indicated that the data necessary to run Landscape models is broadly available (see Appendix 2). Data of interest included, land elevation, land use, shoreline stabilization*, fetch & wave models, and social data**(note: *data may be dated; **data may be dated and scales vary). The data necessary to run site-specific and combination/cross-scale models are limited in geographic and temporal scope. These data include: erosion rates, sediment availability, marsh accretion rates, marsh plant composition, and plant biomass/productivity.

Data and Methods

Objectives

This project develops a methodology for using results from marsh migration models combined with social, landuse, and environmental data to inform marsh management, conservation, and restoration under sea level rise. The methodology is considered a targeting tool, for identifying areas of interest for further investigation. Given the resolution of some of the data and the constantly changing nature of the shoreline, any parcels targeted for conservation or restoration activities should include an on-site assessment of conditions and potentially high-resolution marsh model runs specific to the location.

The methodology was developed and tested in three locations on the Middle Peninsula of Virginia (Figure 1) using existing marsh migration models already run in those locations but is intended to be exportable to locations throughout the Chesapeake Bay. Five existing marsh models were combined into a single Marsh Migration Corridor Envelope (MMCE), which encompasses the potential area of current upland expected to become marsh under a select sea level rise scenario. The need for a multi-model approach to identifying marsh migration pathways was supported by the marsh migration comparison done during methodology development. Marsh models vary in model resolution, parameters included in the model, and data sources used for parameterization. Our analysis showed that there are not strong patterns between marsh model parameters and model results; two models can give similar results in one area and different results in another area, regardless of how they are parameterized. Since no marsh migration models have been extensively validated, both temporally and spatially, there is no *a priori* reason to assume that one model is more accurate than another. Therefore, the multi-model approach creates a MMCE, which is an inherent consideration of the uncertainty in the future marsh location for a given sea level rise scenario.

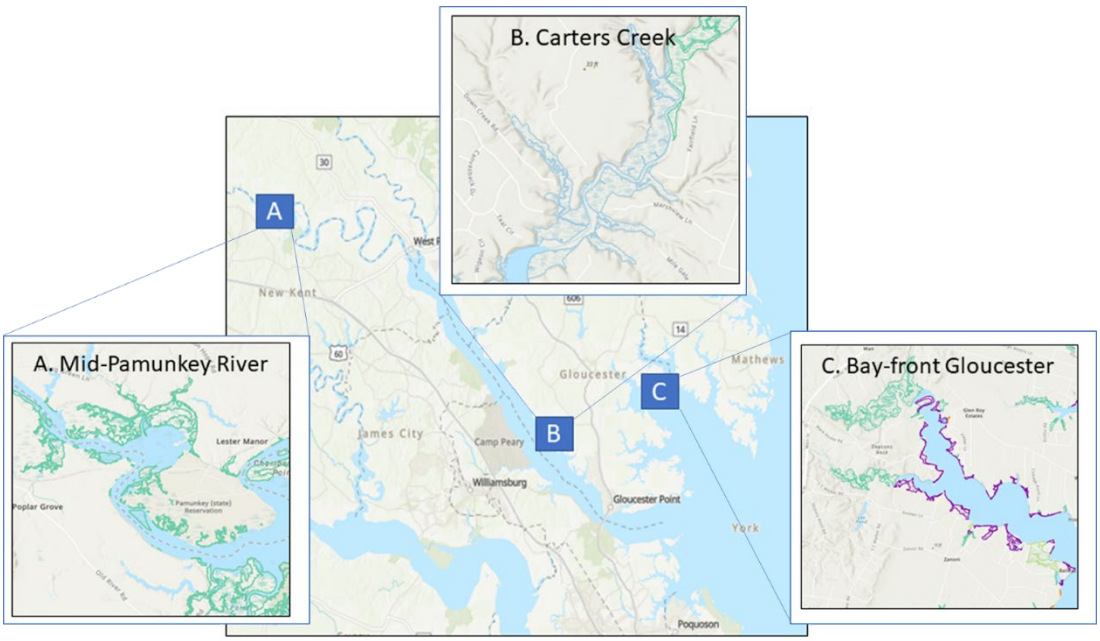


FIGURE 1 LOCATIONS OF TEST AREAS USED FOR METHODOLOGY DEVELOPMENT. THE TEST AREAS INCLUDE FRESHWATER RIVERINE MARSH (A), BRACKISH EMBAYED MARSH (B), AND HIGH-ENERGY SALINE MARSH (C).

Although this report used five existing model runs, future efforts could include other models within the marsh migration multi-model analysis framework (see Appendix 1: Literature Review for descriptions of available models) or re-runs of some of the tested models with updated parameters (see Appendix 2: Data Table for data that can be used to help parameterize marsh models).

Proposed targeting methodology

The overall recommended methodology is described here and shown in Figure 2, with details on the multi-model marsh migration portion in the section below.

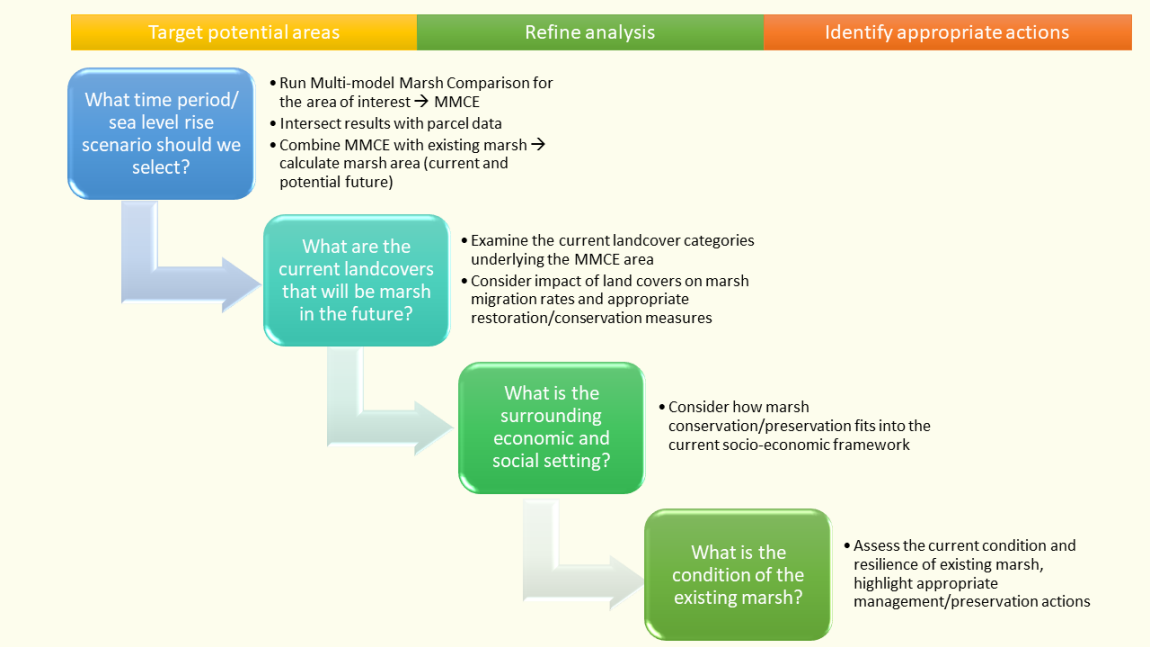


FIGURE 2 FLOW DIAGRAM OF PROPOSED METHODOLOGY FOR TARGETING PROPERTIES FOR MARSH CONSERVATION, PRESERVATION, AND MANAGEMENT.

1. Select the time period of interest and/or the expected sea level rise. Use this information to select the appropriate marsh migration model layers (for the methodology development we used 2 ft and 4 ft of sea level rise).
2. Run the Multi-model Marsh Comparison for the area of interest (as explained below) to determine the MMCE.
3. For each waterfront parcel, determine the value for marsh conservation as the area covered by the MMCE (land conservation target) plus the existing marsh (marsh management/restoration target) on the parcel (see Appendix 2: Data Table for current marsh information).
4. Using high-resolution landcover data (see Appendix 2: Data Table), examine the current landcover categories underlying the MMCE area. It is recommended that areas of impervious landcover be removed from the MMCE, since they will not convert to marsh without active removal of the impervious surface. However, if removal of impervious surfaces is a goal of the restoration/conservation plan, then they can be left within the MMCE.
5. Once parcels that are good conservation/restoration targets are identified, social and economic data of the surrounding area should be considered and brought into the decision framework.
6. When parcels are targeted for acquisition, a marsh quality assessment (such as the MarshRAM (Kutcher et al 2022)) can be used to assess the resilience of the existing marsh and target appropriate management techniques (such as filling ditches or adding thin-layer sediments).

Multi-model Marsh Comparison Methodology development and output

Marsh Models - Major Characteristics

The following marsh models were employed in the generation of the multi-model spatial layer (i.e., MMCE):

1. **SLAMM 5.0 – Sea Level Affecting Marshes Model**

This model was developed by Warren Pinnacle Consulting, Inc. It simulates dominant processes involved in wetland conversion under different SLR scenarios (inundation, erosion, accretion, soil saturation, and barrier island overwash). SLAMM uses a decision tree incorporating geometric and qualitative relationships to represent transfer among coastal classes. SLAMM is available as a raster coverage (30m pixel resolution) for select scenarios of sea level rise for the Chesapeake Bay.

2. **InVEST - Integrated Valuation of Ecosystem Services and Tradeoffs**

A modified InVEST model was run for the Coastal Protection and Blue Carbon for Eastern States project by the Nicolas Institute. InVEST is a suite of models used to map and value the goods and services from nature. InVEST models are based on production functions that define how changes in an ecosystem's structure and function are likely to affect the flows and values of ecosystem services across a land- or a seascape. In this model, water elevations rise uniformly across all areas. InVEST is available as a raster coverage (30m pixel resolution) for multiple elevations of sea level rise, up to 4 ft, for the Chesapeake Bay and the Mid-Atlantic coastal areas.

3. **NOAA – Sea Level Rise Viewer: Marsh Migration**

It maps sea level rise marsh migration using a process developed by the NOAA Office for Coastal Management. Model outputs show potential impacts to marsh environments from sea level rise for the Sea Level Rise Viewer. In this model water elevations rise relatively uniformly across all areas but the model attempts to account for some local and regional tidal variability. These data represent the potential distribution of each wetland type based on their elevation and how frequently they may be inundated under potential future SLR scenarios, from 0 to 10ft of SLR. The Sea Level Rise Viewer: Marsh Migration is available as a raster coverage(30m pixel resolution) for multiple elevations of sea level rise for the Chesapeake Bay and the United States.

4. **ETM – Evolution of Tidal Marsh**

The Evolution of Tidal Marsh Model was developed by the Center for Coastal Resources Management (CCRM), VIMS (Mitchell et al. 2020). This is a static model. Data layers represent the land that is encompassed by the average tidal range (2 ft) as sea level rises in the Virginia coastal region. In this model, water elevations rise uniformly across all areas. Data layers represent each 2-foot range of elevation incremented by 0.5 ft (e.g. 0-2 ft, 0.5-2.5 ft, 1-3 ft, etc.) with the current land cover that exists

in that range. ETM is available as a raster coverage (1m pixel resolution) for multiple elevations of sea level rise for the Virginia portion of the Chesapeake Bay.

5. TMM – Tidal Marsh Model

The Tidal Marsh Model (TMM) was developed by the CCRM, VIMS (Nunez et al. 2020), within the SCHISM framework (Semi-implicit Cross-scale Hydroscience Integrated System Model). This model performs hydrodynamic simulations. The TMM simulates marsh migration under the joint influence from tides, wind waves, sediment transport, precipitation, and sea level rise. The model accounts for shoreline bank erosion, upland erosion inputs at the upland-marsh edge, marsh vertical accretion through mineral sediment deposition, and marsh landward migration under changing sea levels with constraints from physical barriers (e.g. development, shoreline structures). ETM is available as a vector/raster coverage (variable resolution) for select scenarios of sea level rise for 2 creeks (Carter and Taskinas) in the York River tributary of the Chesapeake Bay.

Sea-level rise (SLR)/ Water level scenarios

For this study, two water levels were selected to allow for consistent comparison across models: 2 ft (0.6 m) and 4 ft (1.2) increase in MSL above the current tidal datum (Figure 3).

Model outputs based on water levels were compared rather than based on SLR scenarios since the scenarios differed between models, so selecting a given projection and/or year would result in inconsistent water level comparisons.

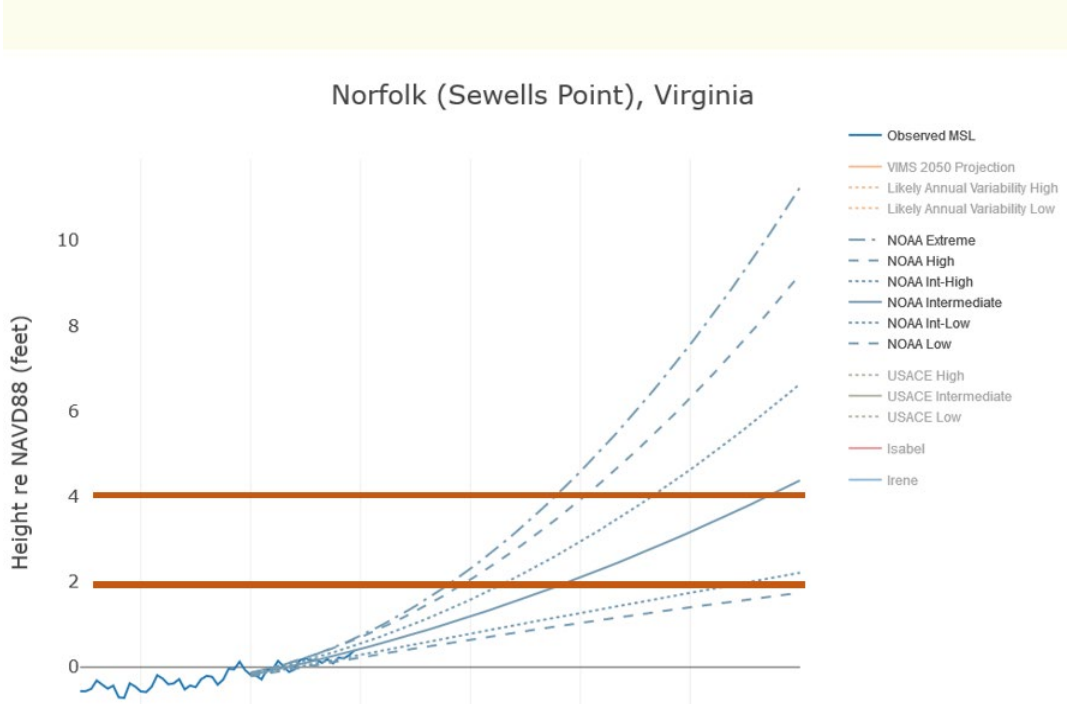


FIGURE 3 WATER LEVELS SELECTED TO CONDUCT THE MARSH MODEL COMPARISON

Generation of the Multi-model Layers

Model outputs were acquired from their respective web pages/platforms. Outputs come in different formats (i.e., raster and vector data). GIS software from ESRI (ArcGIS Pro 2.8) was used to perform the spatial analyses. Different geoprocessing tools were used to format model outputs to rasters, where necessary. Based on the two water levels selected for this study, two outputs from each model were selected from the array of all the simulation products. Model outputs were clipped to the three study areas. In order to focus the model comparison on the potential marsh migration areas, current marsh extent was removed using the Tidal Marsh Inventory developed by CCRM, VIMS, as a reference layer. Each model output (raster) contains a binary classification, reflecting marsh presence (1) or marsh absence (0). Individual rasters were overlaid to create a non-weighted summed raster. Each of the cells of this summed raster has the value that represents the sum of models that predict marsh presence at that specific location (pixel) (Figure 4). For example, a cell with a value of "5" means that the five models agree (i.e., five models predict that marshes will migrate to that specific location).

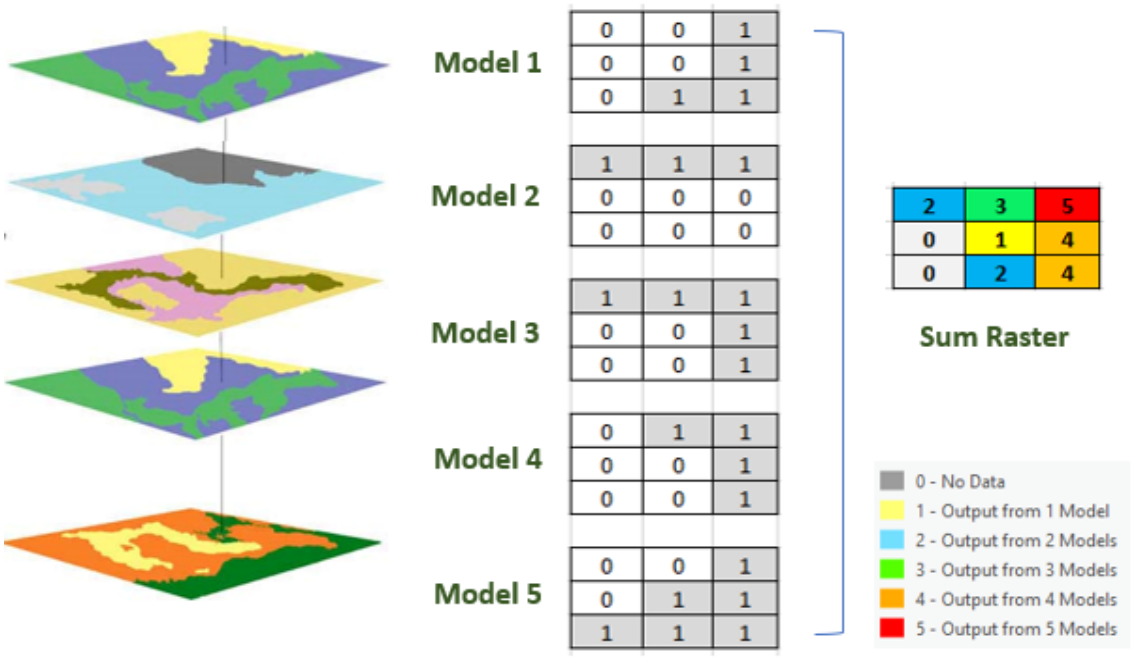


FIGURE 4 DIAGRAM SHOWING HOW THE SUMMED RASTER (MULTI-MODEL LAYER) VALUES ARE COMPUTED FROM THE INDIVIDUAL MODEL RASTERS.

The specifications of the ETM and the InVEST models allow projected marsh migration to occur in any type of land uses. In contrast, the code for the rest of the models only allows marsh migration in "natural" land use categories (i.e., excluding development). In order to cover different management scenarios, two different approaches were taken to conduct the model comparison:

- ***Example 1***: ETM and InVEST projected marsh migration area includes only the "**natural**" land use categories (i.e., excludes development).
- ***Example 2***: ETM and InVEST projected marsh migration area includes **all** the land use categories.

Each approach was conducted for both of the water levels selected for the study, resulting in the generation of four multi-model layers.

Results

Migrated marsh acreage from each model for the two different water levels and the two different scenarios are shown in the tables below. In the first scenario, the TMM and ETM are very similar in acreage (at Carter Creek), but in the second scenario the ETM has much higher acreage, showing the

EXAMPLE - 1		Area (acres)		
Scenario	Model	Pamunkey	Ware	Carter
2ft	SLAMM A1B	70.9	317.1	64.1
4ft	SLAMM 1pt5	66.2	354.8	63.8
2ft	**InVEST Int 2061**	**478.9**	**102.5**	**69.5**
4ft	**InVEST IntHigh 2075**	**185.3**	**179.9**	**96.4**
2ft	NOAA mm20	516.7	165.3	103.9
4ft	NOAA mm40	176.8	198.1	115.9
2ft	**ETM_2ft**	**91**	**88.9**	**26.3**
4ft	**ETM_4ft**	**107.3**	**133.2**	**29.2**
2ft	TMM Intermediate	n/a	n/a	24.9
4ft	TMM Extreme	n/a	n/a	27.5

TABLE 2 EXAMPLE 1: ETM AND INVEST PROJECTED MARSH MIGRATION AREA INCLUDES ONLY THE "NATURAL" LAND USE CATEGORIES (I.E., EXCLUDES DEVELOPMENT)

EXAMPLE - 2		Area (acres)		
Scenario	Model	Pamunkey	Ware	Carter
2ft	SLAMM A1B	70.9	317.1	64.1
4ft	SLAMM 1pt5	66.2	354.8	63.8
2ft	**InVEST Int 2061**	**480.8**	**103.1**	**69.5**
4ft	**InVEST IntHigh 2075**	**190.4**	**183.1**	**96.4**
2ft	NOAA mm20	516.7	165.3	103.9
4ft	NOAA mm40	176.8	198.1	115.9
2ft	**ETM_2ft**	**258.4**	**132.3**	**83.5**
4ft	**ETM_4ft**	**134.8**	**160.7**	**56.4**
2ft	TMM Intermediate	n/a	n/a	24.9
4ft	TMM Extreme	n/a	n/a	27.5

TABLE 1 EXAMPLE 2: ETM AND INVEST PROJECTED MARSH MIGRATION AREA INCLUDES "ALL" THE LAND USE CATEGORIES

impact of limiting landuse to natural categories. Since the TMM is not available for the Pamunkey or Ware sites, it cannot be compared to the other models at those sites.

SLAMM and InVEST are very similar acreages in Carter's Creek under 2 ft of sea level rise, but less similar under 4 ft of sea level rise. Interestingly, in the other two areas, SLAMM and InVEST give very different results under any scenario. The marsh migration areas for the InVEST model are derived from the NOAA model so we expected the model results to be quite similar, however, there are areas where they differ significantly. The InVEST model removed marshes that are not spatially connected to existing coastal marshes; if they are not connected to any marsh, those areas are not projected by the InVEST model. Therefore, major differences maybe prompted by the models' classifications of land use.

Study Areas

Results from each of the three study areas is shown below. The different colors indicate the level of agreement between marsh models. Grey areas indicate current marsh areas. All colored, non-grey areas together represent the potential future location of migrated marsh based on one or more of the models.

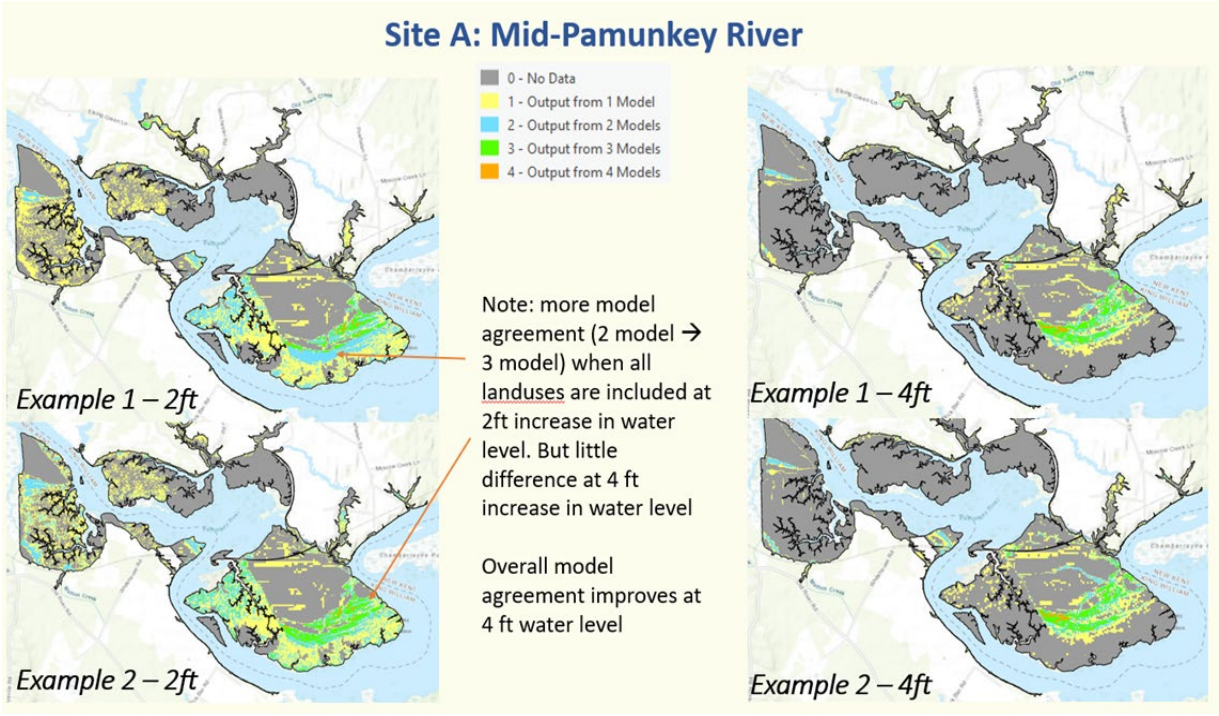


FIGURE 5 PAMUNKEY RIVER RESULTS. IT CAN BE OBSERVED THAT MORE MODEL AGREEMENT (2 MODELS -> 3 MODELS) WHEN ALL LAND USES ARE INCLUDED AT 2 FT INCREASE IN WATER LEVEL. HOWEVER, THERE IS LITTLE DIFFERENCE AT 4 FT INCREASE IN WATER LEVEL. OVERALL, MODEL AGREEMENT IMPROVES AT 4 FT WATER LEVEL

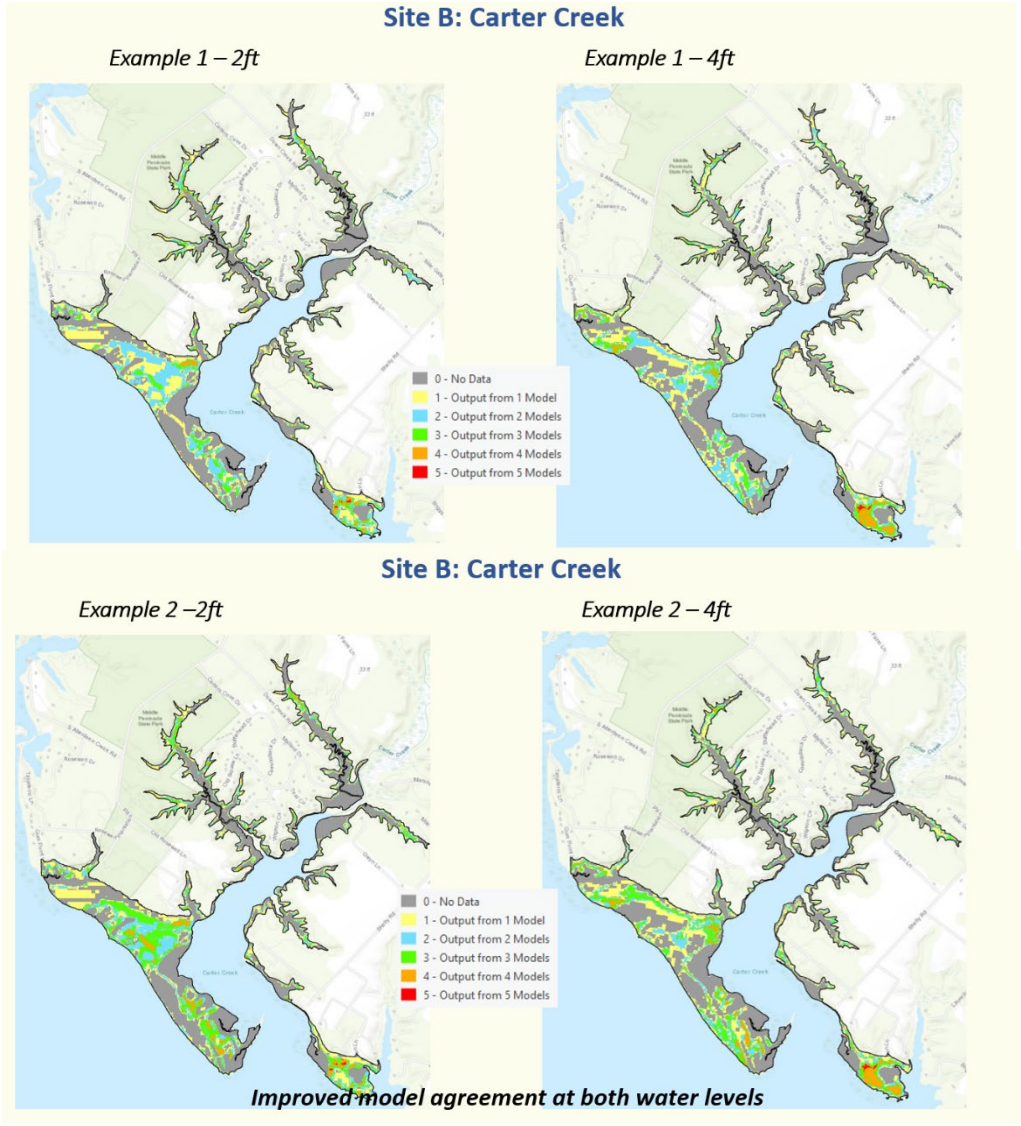
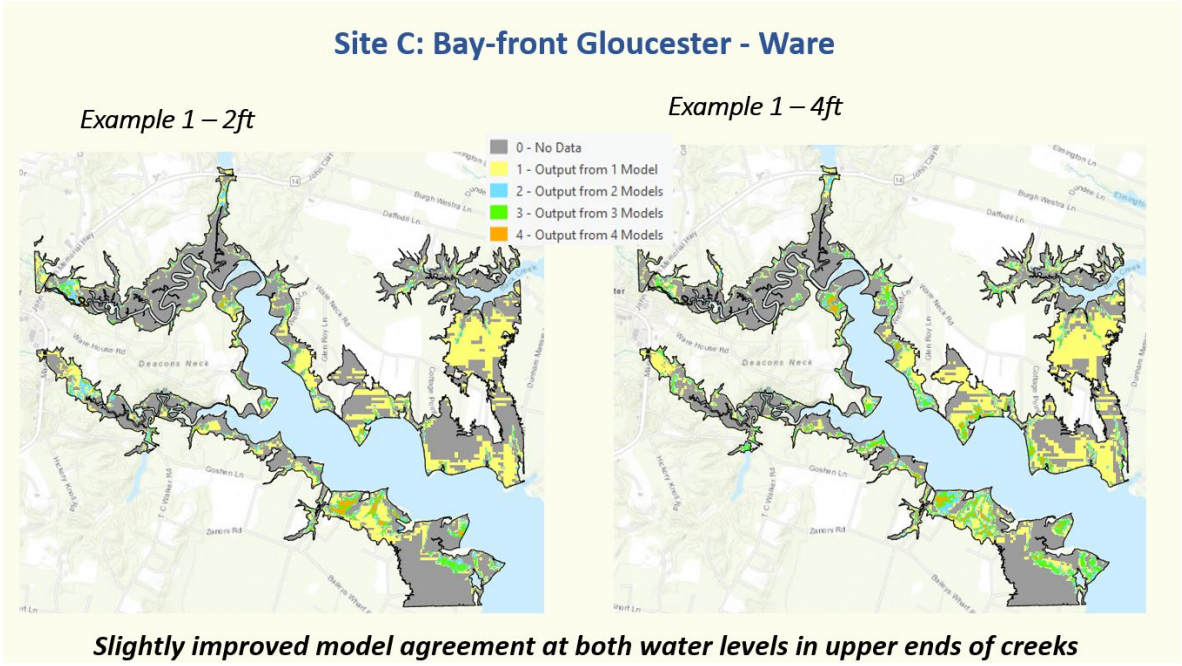


FIGURE 6 CARTERS CREEK RESULTS. IT CAN BE OBSERVED THAT MORE MODEL AGREEMENT (2 MODELS -> 3 MODELS) WHEN ALL LAND USES ARE INCLUDED AT 2 FT INCREASE IN WATER LEVEL. HOWEVER, THERE IS LITTLE DIFFERENCE AT 4 FT INCREASE IN WATER LEVEL. OVERALL, MODEL AGREEMENT IMPROVES AT 4 FT WATER LEVEL. THIS IS THE ONLY SITE WHERE THERE ARE RESULTS FROM THE FIVE MODELS DESCRIBED ABOVE.



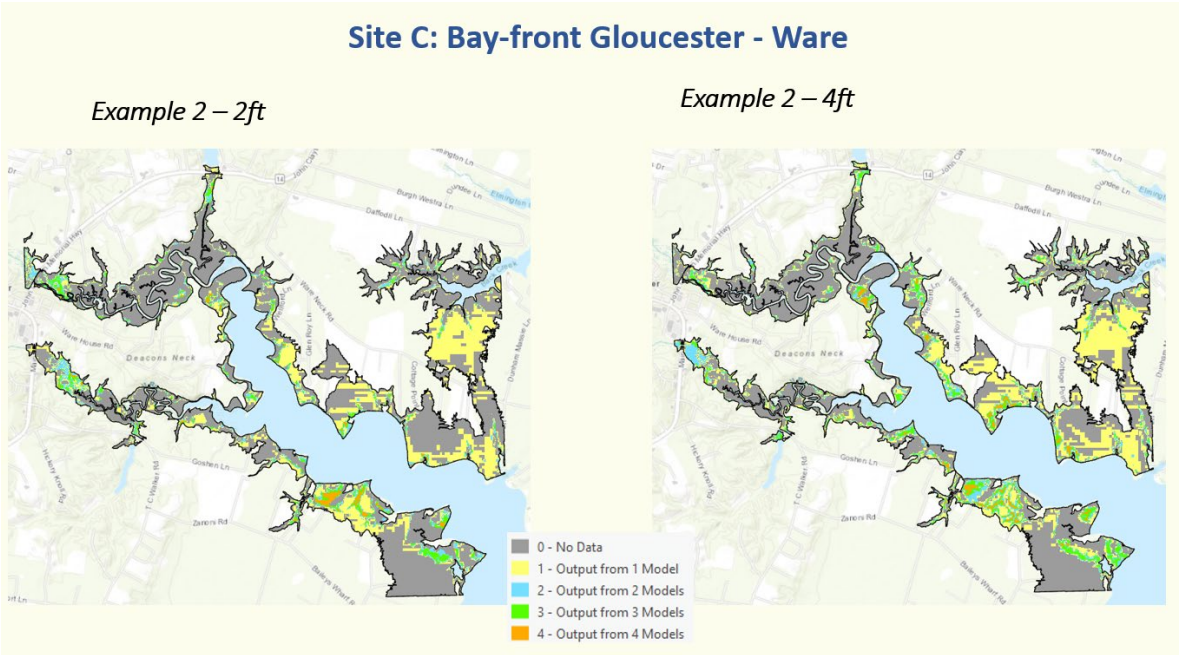


FIGURE 7 BAYFRONT RESULTS. ALL SIMULATIONS SHOW AN IMPROVED MODEL AGREEMENT AT BOTH WATER LEVELS.

Determining the Marsh Migration Corridor Envelope (MMCE)

Since no marsh migration models have been extensively validated, both temporally and spatially, there is no presumptive reason to assume that one model is more accurate than another. It was decided at

both the second stakeholder meeting and the steering committee meeting that using the entire envelope of potential marsh migration area (the sum of all models) was a preferable approach to using the areas with the greatest agreements between models (see figure 6). This area can then be geospatially joined to a parcel layer and the size of the MMCE on each parcel can be calculated. If done on a large geographic scale, the parcels can then be color-coded by the size of the MMCE on the parcel (e.g., less than 1 acre, greater than 1 acre, etc.). For example, in Figure 7, the MMCE would include yellow, blue, green, and orange areas, but not gray areas.

Summary

Transferability of the Method

This method should be broadly transferrable to any location with existing marsh migration models. How many marsh models are included in the MMCE calculation would depend greatly on the existing model runs or the existing data needed to do new model runs. The NOAA – Sea Level Rise Viewer: Marsh Migration model results are available around the continental United States; however, the other marsh models have more limited geographic scope. SLAMM 5.0 – Sea Level Affecting Marshes Model has been used in various locations along the coastline, but has not been systematically run for the entire United States. The InVEST - Integrated Valuation of Ecosystem Services and Tradeoffs model has been run for the Mid-Atlantic states. The TMM – Tidal Marsh Model has been run for the coastline of Virginia. The ETM – Evolution of Tidal Marsh has the most limited geographic scope, only having been run for two watersheds.

In the Chesapeake Bay, there should always be three available models (NOAA, SLAMM, and InVEST). Outside of the Chesapeake Bay, the suite of models used in this project would not be applicable. However, any suite of elevation-driven marsh migration models could be substituted into the methodology since the point of the MMCE calculation is to mitigate the biases in any given model by including the results from multiple models. Hydro-MEM and SLOPE have both been run for locations in the Gulf, and would be suitable substitutes. In an extreme circumstance, where only the NOAA – Sea Level Rise Viewer: Marsh Migration model was available, the logic framework (Figure 2) could still be applied without the calculation of a MMCE.

Limitations/Caveats

Marsh migration areas from the different models were surprisingly different, given that they were all run for the same sea level rise scenario and that they are all essentially driven by elevation differences. The model results differed in both areal totals and spatial distribution across the landscape. There are many nuances in each method that can contribute to model differences. Differences in model input structure are shown in Table 3 below; however, there are some nuances in how the models define current marsh that can contribute to differences. Some are straightforward to ascertain, while others are buried in the individual model methodology or application and not possible to determine. In addition, two of the models (InVEST and TMM) only allow marsh migration in areas with current marsh

(e.g., they forbid new marsh from forming in areas that are not physically connected to existing marsh as the tidal envelope moves across the landscape). These models should be considered conservative estimates for this reason, and the TMM did have small areas of marsh migration. However, the results show that the InVEST model had some of the highest areas of marsh migration of any model. This suggests that other factors (Table 3) may be more important determinants of the marsh migration area.

MODEL	Resolution (land cover)	Resolution (elevation)	Elevation source	Vertical datum	Marsh Source
SLAMM	30m x 30m	10m x 10m	CUDEM[1]	Mean Tide Level	NWI (1988 - 1992)
InVEST	30m x 30m	3m x 3m	CUDEM[1]	MHHW	VIMS TMI (Berman et al. 2016)
TMM	30m x 30m (C-CAP)	1m x 1m	CBTBDEM[2]	NAVD88	VIMS TMI (2016)
NOAA	30m x 30m (C-CAP)	*	CUDEM[1]	tidal datums	C-CAP
ETM	1m x 1m (VGIN)	1m x 1m (lidar)	CBTBDEM[2]	NAVD88	NWI and TMI

TABLE 3 COMPARISON OF MODEL INPUTS FOR DATA PARAMETERS AND SOURCES. * THESE DATA WERE DERIVED FROM THE MOST RECENT ELEVATION DATA AVAILABLE AT THE DATE OF PROCESSING THAT MET PROJECT SPECIFICATIONS, THE MOST RECENT VDATUM TIDAL MODEL DATA AVAILABLE AT THE DATA OF PROCESSING, AND 2011 CCAP LAND COVER DATA.

Results from the models clearly indicate that the resolution of the underlying data has a critical impact on the areas designated as being within the MMCE. Pixel size (resolution) for land cover is the same for most models, but elevation resolution differs (Table 3), explaining some of the differences. When areal values are calculated from raster data, the resolution affects the accuracy of the totals (Fig 8). For a polygon of interest, the smaller the pixel size, or closer the polygon is in size to the pixel size, the more accurate the calculations. Cumulating the differences in resolutions from multiple datasets may add to the discrepancies between model outputs.

[1] CUDEM—continuously updated digital elevation model from NOAA

[2] CBTBDEM—Chesapeake Bay topobathy digital elevation model from USGS

However, discrepancies seen from varying inputs may account for why areal totals differ, but even if the cumulative areal totals agree somewhat, the spatial overlap of the models may not. This is related to factors such as: water level alignment not being precise between models, differing resolution of underlying data, differing sources of underlying data, and the individual model parameters. For example: InVEST includes marsh accretion that might contribute to longevity of tidal swamp not seen in the other models, but the evidence is unclear since SLAMM also includes accretion but shows tidal swamp drowning at 2 ft water level. There are not strong patterns between marsh model parameters and migration results and difference between models are not consistent across locations, further confusing the issue

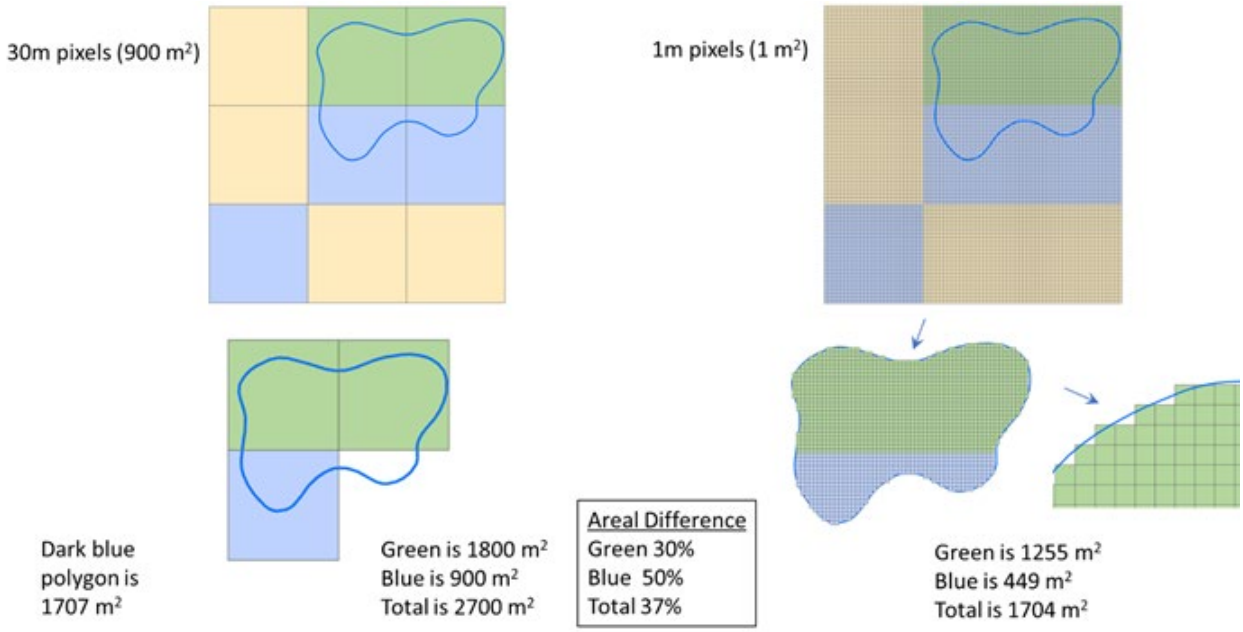


FIGURE 8 DIFFERING RESOLUTION OF RASTER DATASETS CAUSES INACCURACIES IN AREAL TOTALS. THE DARK BLUE POLYGON IS THE REGION OF INTEREST. A RESOLUTION OF 30M PIXELS CAUSES A 37% DIFFERENCE IN AREAL TOTAL VERSUS 1M PIXELS WHICH ONLY DIFFERS FROM THE BLUE POLYGON BY 1%

It is important to understand the sources of variation between the input data and the assumptions driving each model included in the MMCE creation. However, since there are advantages and disadvantages to each, there is no need to use and given characteristic as a screening tool for model inclusion. The strength of the MMCE methodology lies in the multi-model approach that allows a broad spectrum of assumptions to be included, without needing to verify one approach as "best".

Lessons Learned

Although there are limitations on the comparisons of the model, that highlight the uncertainty associated with forecasting of natural resources under sea level rise, stakeholders generally agreed that the information was useful. The method is fairly quick and inexpensive to run (compared with the running of new models) and is ideal to target large areas for conservation. Stakeholders commented

that areas always have to be ground-truthed anyway--when considering an area/parcel, you would want to walk the property and see if the model results make sense. This method is useful to help target the specific area to start exploring, and then more specific analysis might need to be done at the project design phase. The uncertainty was even considered to be an advantage under some circumstances, with one stakeholder commenting that saying "Your land is in a general area that is vulnerable to flooding" rather than "Your land will flood" is a much more productive conversation to have with a landowner.

Conclusion

The project developed a methodology for assessing marsh migration potential in a way that can be used to identify large areas for conservation and create a watershed-wide marsh restoration/mitigation plan. The methodology developed in this report is transferrable, repeatable, and stakeholders felt that it was useful for a variety of different uses. Some of the other suggested uses include: identifying areas where marshes may contribute to flood reduction, to assess future prospects and threats for federally listed threatened sensitive joint-vetch in tidal freshwater marshes, for funding grant applications on a variety of topics, and targeting BMP placement.

References

Barbier, E. B., S. D. Hacker, C. Kennedy, E. W. Koch, A.C. Stier, and B.R. Silliman. 2011. The value of estuarine and coastal ecosystem services. Ecological Monographs 81:169–193.

Beckett, L.H., Baldwin, A.H. and Kearney, M.S., 2016. Tidal marshes across a Chesapeake Bay subestuary are not keeping up with sea-level rise. PloS one, 11(7), p.e0159753.

Boon, J. D., & M. Mitchell 2015. Nonlinear change in sea-level observed at North American tide stations. Journal of Coastal Research, 31(6), 1295-1305.

Bromberg, K.D. and Bertness, M.D., 2005. Reconstructing New England salt marsh losses using historical maps. Estuaries, 28(6), pp.823-832.

DeLaune, R.D., Nyman, J.A. and Patrick Jr, W.H., 1994. Peat collapse, ponding and wetland loss in a rapidly submerging coastal marsh. Journal of Coastal Research, pp.1021-1030.

Ezer, T., Atkinson, L. P. 2015. Sea Level Rise in Virginia – Causes, Effects and Response. Virginia Journal of Science 66(3):355-369.

Hartig, E.K., Gornitz, V., Kolker, A., Mushacke, F. and Fallon, D., 2002. Anthropogenic and climate-change impacts on salt marshes of Jamaica Bay, New York City. Wetlands, 22(1), pp.71-89.

Kearney, M.S., Grace, R.E. and Stevenson, J.C., 1988. Marsh loss in Nanticoke Estuary, Chesapeake Bay. Geographical Review, pp.205-220.

Kearney, M.S., Rogers, A.S., Townshend, J.R., Rizzo, E., Stutzer, D., Stevenson, J.C. and Sundborg, K., 2002. Landsat imagery shows decline of coastal marshes in Chesapeake and Delaware Bays. Eos, Transactions American Geophysical Union, 83(16), pp.173-178.

Kennish, M. J. 2001. Coastal salt marsh systems in the US: a review of anthropogenic impacts. Journal of Coastal Research, 731-748.

Kirwan, M.L., Temmerman, S., Skeehan, E.E., Guntenspergen, G.R. and Fagherazzi, S., 2016b. Overestimation of marsh vulnerability to sea level rise. Nature Climate Change, 6(3), p.253.

Kutcher et al 2022. A rapid method to assess salt marsh condition and guide management decisions. *Ecological Indicators*, *138*, p.108841.

Mitchell, M, J. Herman, D. M. Bilkovic & C. Hershner (2017) Marsh persistence under sea-level rise is controlled by multiple, geologically variable stressors, Ecosystem Health and Sustainability, 3:10, 1379888, DOI: 10.1080/20964129.2017.1396009

Mitchell, M., Herman, J. and Hershner, C., 2020. Evolution of tidal marsh distribution under accelerating sea level rise. Wetlands, 40(6), pp.1789-1800.

Morris, J.T., Barber, D.C., Callaway, J.C., Chambers, R., Hagen, S.C., Hopkinson, C.S., Johnson, B.J., Megonigal, P., Neubauer, S.C., Troxler, T. and Wigand, C., 2016. Contributions of organic and inorganic matter to sediment volume and accretion in tidal wetlands at steady state. Earth's Future, 4(4), pp.110-121.

Nunez, K., Zhang, Y., Bilkovic, D.M., and C. Hershner. 2021. Coastal setting determines tidal marsh sustainability with accelerating sea-level rise. Ocean & Coastal Management, 214, 105898. https://doi.org/10.1016/j.ocecoaman.2021.105898.

Nunez, K., Zhang, Y., Herman, J., Reay, W., and C. Hershner (2020). A Multi-scale Approach for Simulating Tidal Marsh Evolution. Ocean Dynamics, 70(9), 1187–1209. https://doi.org/10.1007/s10236-020-01380-6

Stevenson, J.C., Kearney, M.S. and Pendleton, E.C., 1985. Sedimentation and erosion in a Chesapeake Bay brackish marsh system. Marine Geology, 67(3-4), pp.213-235.

Tiner, R. V. 1994. Recent Wetland Status and Trends in the Chesapeake Watershed (1982 to 1989): Executive Summary Report. Prepared by the U.S. Fish and Wildlife Service, Region 5, Hadley, MA, for the Chesapeake Bay Program, Annapolis, lvID. 12 pp.

Wray, Rachel Donham, Leatherman, Stephen, P., and Nicholls, Robert J., 1995, Historic and Future Land Loss for Upland and Marsh Islands in the Chesapeake Bay, Maryland, U.S.A., Journal of Coastal Research 11 (4):1195-1203.

Appendices

Appendix 1: Literature Review

Introduction

Coastal marsh loss is a significant issue globally (Barbier et al. 2011) and has been accelerating over the past century with a total loss greater than 50% of the original tidal salt marsh habitat, due in part to human activity (Kennish 2001). In the Chesapeake Bay, studies have suggested marsh loss in various areas around the Bay (Wray et al 1995, Stevenson et al 2002, Kearney et al 1998, Kearney et al 2002, Tiner 1994, Mitchell et al 2017, Nunez et al. 2021). Research on the response of marshes to sea-level rise has typically focused on a limited number of discrete marshes, leading to conflicting results, with some studies suggesting that marshes are expanding under sea-level rise (Kirwan et al. 2016b) while other suggest marshes are fragmenting and losing extent (Beckett et al. 2016). Both of these processes are likely occurring in the Chesapeake Bay, depending on local conditions surrounding the marsh. Research on the York River estuary marsh changes between the early 1970s and 2009, showed a loss of approximately 2,187,000 m^2, or ~2.7% of total marsh area from the original survey; however, marsh change varied by watershed, with some watersheds showing an increase (up to 11% gain) in marsh area while others showed losses (up to a 32% loss) in marsh area (Mitchell et al 2017).

Tidal marshes are highly productive ecosystems that provide a myriad of services to the human and aquatic system. Services include modification of wave climates to create habitat opportunities (Bruno 2000) and enhance shoreline stabilization (Shepard et al. 2011), provision of refuge habitat translating to enhanced fisheries (Minello et al. 2012), modifiers of nutrient loads from upland (Valiela & Cole 2002) and tidal (Deegan et al. 2007) sources, and a long-term carbon sink (Chmura 2003, Bridgham et al. 2006). Extensive marshes and marsh islands are important habitats for avian species (Wilson et al. 2009). Saltmarsh specialist species include: laughing gulls, Forster's terns, black rail, seaside sparrow, saltmarsh sharptailed sparrow (Erwin et al 2004). Salt marsh plants support high diversity and abundances of epifaunal invertebrate communities (Robertson and Weis 2005) Although tidal marshes support a low diversity of non-aquatic vertebrate species, the ones that they do support are dependent on their habitat (Greenberg et al. 2006). Due to their ecological importance marsh loss has the capacity to dramatically change coastal and estuarine functions and potentially impact global biogeochemical cycles (Coverdale et al 2014, Chmura 2013). In estuarine systems, their role in mediating water quality, both through sediment removal from tidal waters and precipitation-induced runoff and through the provision of habitat for filter feeding organisms, such as mussels, directly links the abundance of marsh systems to the overall health of the estuary. A 62% reduction in wetland areas has been found to result in a loss of 60% of its original capacity for

streamflow maintenance and a 35% reduction in surface water detention, nutrient transformation, sediment and particulate retention and provision of wildlife habitat (Tiner 2005).

One consequence of marsh loss is fragmentation leading to a loss of habitat connectivity. Habitat fragmentation in terrestrial and estuarine systems has been linked with shifts in biodiversity, loss of habitat-specific sensitive or functionally important species, and isolation of populations when connectivity is diminished (Kareiva and Wennergren 1995, Fahrig 2003, Thrush et al. 2008, Collinge 2009). Fragmentation also threatens marsh resilience under sea-level rise, as there is more exposure for erosion. Ecological concerns with shifts in marsh extent include both loss and redistribution of ecological services provided by marshes, particularly water quality and habitat functions. For both of these functions, location is often as important, if not more important, than total amount of marsh. Fragmentation and relocation risk disconnecting marsh service capacity from landscape-based needs and opportunities. The fragmentation of fringing marshes may particularly impact groundwater nutrient removal (Beck et al. 2017). In the Chesapeake Bay groundwater discharge of nutrients may be as high as 30% of surface inputs (Libelo et al., 1991), potentially making fringe marshes a critical mediator of estuary water quality.

Sea level rise in the Chesapeake Bay

The lower Chesapeake Bay is currently undergoing the highest rates of relative sea level rise along the Atlantic coast (Boon, 2012; Ezer et al. 2013; Sallenger et al., 2012; Kopp, 2013) and there is strong evidence that those rates are accelerating (Boon and Mitchell 2015, Boon et al. 2017). Relative sea level rise rates are derived from tide gauge records and incorporate all processes affecting water levels including sea level changes, ocean dynamics, and subsidence.

Marsh loss associated with sea level rise, erosion and human activity has been documented throughout the United States (e.g. DeLaune et al. 1994; Hartig et al. 2002; Bromberg and Bertness 2005; Mitchell et al. 2017; Nunez et al. 2021). Sea-level rise in particular has been cited as a cause of on-going marsh loss in many estuaries, including the Chesapeake Bay (e.g., Stevenson et al. 1985, Wray et al. 1995, Beckett et al. 2016) and is considered to be an increasing threat in the future as sea level rise accelerates. Relative sea-level rise in the Chesapeake Bay since 1970 has averaged (across the Bay) around 5 mm/year (Ezer and Atkinson 2015, Boon and Mitchell 2015), which is commiserate with the maximum rate of accretion theoretically possible for marshes (Morris et al. 2016), suggesting that marshes are likely becoming stressed by increased inundation on a broad scale.

Sea level rise impacts the tidal marshes in two primary ways:

1) Sea level rise increases tidal inundation frequency, tidal flooding extent and shoreline

erosion (due to increased water depth). Changing inundation drives marsh migration**.** Changes in inundation are reflected in the marsh extent and position on the landscape and the plant community composition.

2) Sea level rise changes the salinity distribution in the estuary, pushing brackish waters up into previously freshwater systems. Changes in salinity are reflected in the plant community composition.

As sea-level rises, it increases the depth of inundation on the marsh surface, which triggers responses in vegetation (Morris et al. 2002), sediment accumulation (Kirwan and Murry 2007), and erosion (Mariotti and Fagherazzi 2010). These responses are specific to plant species and marsh position (and may be related to associated fauna, such as ribbed mussel (Guekensia demissa) presence), leading to spatial variability of marsh in response to sea-level rise. In addition, subsidence can vary on small spatial scales (Cahoon 2015) causing marshes in neighboring sub-watersheds to experience different rates of relative sea-level rise. High rates of sea-level rise can lead to marsh drowning, but in areas with sufficient sediment supply and low elevation adjacent lands it can lead to marsh expansion.

Sea level rise rates for tide gauges in the Chesapeake Bay and lower tributaries can be found at https://tidesandcurrents.noaa.gov/. The USGS also maintains tide gauges in the upper tributaries; however, their records are not long enough to calculate sea level rise trends. Sea level rise trend calculation requires a minimum 50-year record to accurately capture sea level dynamics that can influence long term water level variation (Table 1). However, the length of record used in trend analysis can have a significant effect on the calculated trend with longer records yielding lower trends due to recent accelerations in sea level rise (Boon and Mitchell 2015). The impact of this artifact of tidal record analysis can been seen in the trends presented at https://tidesandcurrents.noaa.gov/sltrends/sltrends.html. Boon (2012) suggests that trends calculated since 1969 provide an optimum balance of length of record and modern processes. Due to the complications inherent in water level records, it is recommended that peer-reviewed trend methods be used for trend calculations. Sources for the Chesapeake Bay that utilize a standard length of record include Boon and Mitchell 2015; Boon et al 2018 and associated Sea Level Report Cards, Ezer and Atkinson 2015. These sources suggest relatively minor variability in sea level rise rates around the Bay.

Tide gauge trends should not be extrapolated beyond ~ 30 years into the future (Boon and Mitchell 2015). Beyond that point (e.g., projections out to 2080, 2100 or beyond), global climate model (GCM) based scenarios are more appropriate. The most current scenarios are from Sweet et al. (2017) and can be accessed at https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html.

Scenarios are available for limited tide gauge stations (see Table 1), but given the low variability in sea level rise rates around the Bay, should be sufficient for modeling purposes.

TABLE 4. TIDE GAUGES IN THE CHESAPEAKE BAY AND THEIR LENGTH OF RECORD. NOTE THAT SOME RECORDS, ALTHOUGH LONG ENOUGH TO ALLOW FOR TREND ANALYSIS MAY BE MISSING PARTS OF THEIR RECORDS WHICH COULD AFFECT TREND ANALYSIS. *INSTALLATION UPDATED OR ALTERED AT SOME POINT **CAN BE COMBINED WITH WATER LEVELS FROM DISCONTINUED GLOUCESTER POINT TIDE GAUGE FOR LONGER RECORD FOR TREND ANALYSIS ***LONG TERM PROJECTIONS BASED ON GCM AVAILABLE

Gauge name	*Date installed*	*> 50 years?*
*Money Point, VA - Station ID: 8639348****	Dec 17, 1997	almost
*Sewells Point, VA - Station ID: 8638610****	Jul 01, 1927*	yes
*Yorktown USCG Training Center, VA - Station ID: 8637689****	Jan 22, 2004**	yes**
*CBBT, Chesapeake Channel, VA - Station ID: 8638901****	Oct 15, 2016	no
*Kiptopeke, VA - Station ID: 8632200****	Aug 22, 1951	yes
Wachapreague, VA - Station ID: 8631044	Jun 28, 1978*	almost
Windmill Point, VA - Station ID: 8636580	Jun 24, 1970*	yes
Lewisetta, VA - Station ID: 8635750	Oct 20, 1970*	yes
Dahlgren, VA - Station ID: 8635027	Apr 09, 1970*	yes
*Washington, DC - Station ID: 8594900****	Nov 10, 1924*	yes
*Solomons Island, MD - Station ID: 8577330****	Nov 05, 1937	yes
Bishops Head, MD - Station ID: 8571421	Mar 22, 2005	no
*Cambridge, MD - Station ID: 8571892****	Oct 21, 1980*	no
*Annapolis, MD - Station ID: 8575512****	Sep 14, 1978*	almost
*Baltimore, Fort McHenry, Patapsco River, MD - Station ID: 8574680****	Jul 01, 1902	yes
Tolchester Beach, MD - Station ID: 8573364	Jun 24, 1971	yes
Chesapeake City, MD - Station ID: 8573927	Nov 15, 1972*	almost

Other climate change impacts

Although this review primarily focuses on marsh migration, it is worth noting that changes in the elevation of the marsh surface also contribute to overall marsh extent by either maintaining elevation (leading to marsh persistence) or losing elevation (leading to marsh drowning) Some of these processes, such as accretion rates, can be affected by changes in temperature, precipitation, and CO_2. These processes can impact marsh accretion in variable directions and magnitudes (Figure 2). Increases in CO_2 increase plant productivity, particularly in C3 plants (Drake 2014). This can lead to higher rates of organic accretion. Increased temperature can also result in an increase in respiration rates, which can cause declines in productivity and can cause organic matter in the sediment to break down more quickly, both of which lead to decreased organic matter accretion.

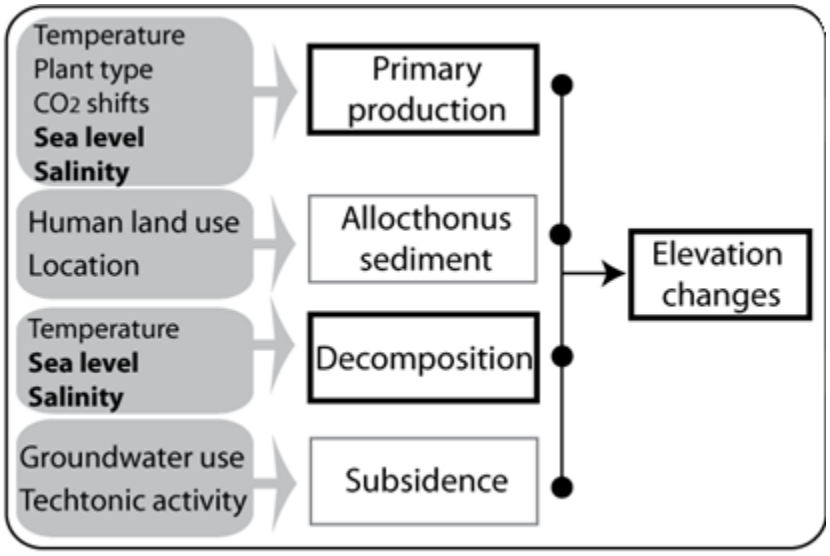


FIGURE 9. DIAGRAM SHOWING THE DRIVERS OF CHANGES IN MARSH ELEVATION. BOLDED DRIVERS ARE RELATED TO SEA LEVEL RISE.

Critical drivers of marsh migration

Tidal marsh extents are defined by the interaction of landscape elevations and tidal regime (Figure 2). As sea levels rise and the maximum extent of tidal inundation reaches higher elevations, tidal marshes can migrate inland to maintain their place in the tidal frame. In areas with low coastal elevations, tidal marshes can expand or maintain their size as they move across the landscape, resulting in a potential future gain of tidal marshes (e.g., Kirwan et al. 2016, Carr et al. 2020). However, in areas with higher elevations or where migration paths are blocked by shoreline structures or impervious surfaces, marsh loss has been documented (Torio and Chmura 2013, Mitchell et al. 2017, Nunez et al. 2021). Tidal marshes along shorelines with high banks, stabilized shorelines and marsh islands have limited migration potential and are at particular risk of reduction under sea level rise (Fagherazzi et al. 2019; Molino et al. 2021). Although elevation is the primary control on marsh migration potential, as marshes migrate inland they also conflict with development, particularly impervious surfaces.

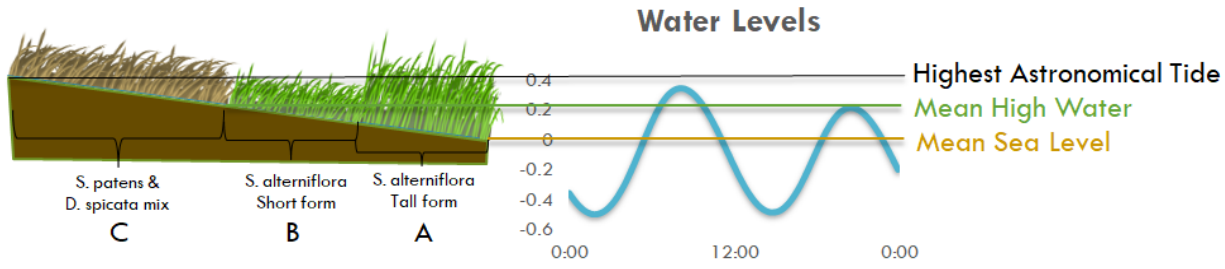


FIGURE 10. RELATIONSHIP BETWEEN WATER LEVELS AND TIDAL MARSH ELEVATIONS.

Marshes position and extent in the landscape is controlled through three basic mechanisms: migration, erosion and progradation (Figure 3). In this review, we will focus on migration; however, it is important to note that, along with marsh migration, erosion (and sometimes accretion) can influence marsh persistence.

The rate at which these mechanisms drive change is determined by a variety of factors: Migration rates are tightly tied to sea-level rise, but also respond to human activities, such as shoreline hardening. Erosion rates are driven by wave energy (a function of fetch, nearshore bathymetry, boating activity or adjacent shoreline stabilization), which increase with sea-level rise due to increased nearshore water depths (Leatherman et al., 2000).

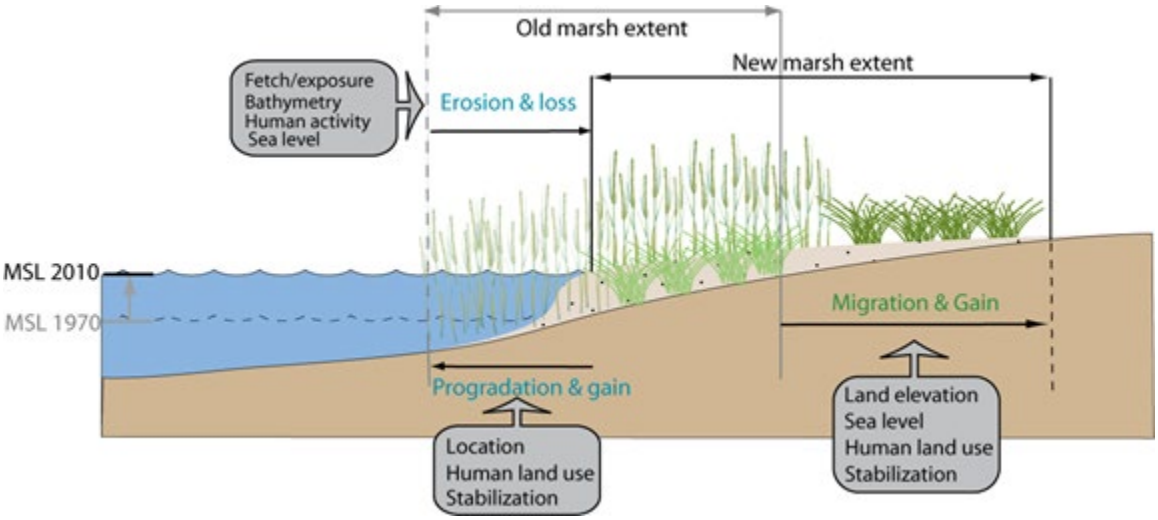


FIGURE 11. MECHANISTIC DRIVERS OF MARSH CHANGE. MECHANISMS IN GREY BOXES EXACERBATE OR MITIGATE THE EFFECTS OF MARSH CHANGE DRIVERS. FROM MITCHELL 2018.

Land elevation is the dominant factor controlling marsh migration potential although it is moderated by development (which is the most important factor controlling marsh change in the partitioning analysis). Areas with low elevation lands immediately adjacent to wetlands show

signs of marsh gain through migration, with marsh gain in the lower estuary primarily seen in extensive marshes as migration into interior forested hummocks, and along the river shoreline as migration into low-lying riparian uplands. The conversion of forest hummocks to marsh is expected to continue with sea-level rise, but represents only a small area of potential future gain relative to upland migration.

Data availability for this factor: High resolution, lidar-derived, topographic and topy-bathy surfaces are available for the Chesapeake Bay region.

Land use is a critical moderator of marsh migration. Impervious surfaces are unsuitable for marshes to migrate into and agricultural areas may be protected from marsh migration through drainage, filling, or levee creation. This conflict is likely to increase in importance since coastal zones are not only more densely populated than inland areas but also show a trend of increasing population growth and urbanization (Neumann et al. 2015). Within the coastal zone, populations tend to be clustered in the lowest elevation areas (Small and Nicholls 2003), which are prime areas for marsh migration. Development patterns in urbanizing areas are a controlling factor in habitat loss (Bierwagen et al. 2010), and in coastal areas will be critical to the persistence of tidal marsh ecosystems.

Ecological thresholds studies suggest that levels of development between 10-25% can impact ecosystem system functions (e.g. Wang et al. 1997; Limburg and Schmidt 1990; Paul and Meyer 2001; DeLuca et al. 2004; Brooks et al. 2006; King et al. 2005; Bilkovic et al. 2006; Lussier et al. 2006) and previous work has shown accelerated loss of marshes with greater than 15% development (Mitchell et al. 2017).

Data availability for this factor: High resolution landuse and landcover surfaces are available for the Chesapeake Bay. One of these datasets has been developed by the Virginia Geographic Information Network (VGIN). This is a statewide 1-meter digital land classification. This information is served in raster and vector data formats. Another land use coverage that can be used for this region is provided by NOAA through the Coastal Change Analysis Program (C-CAP). This dataset is generated from the analysis of multiple dates of remotely sensed imagery. The resolution of this layer is 30m. In addition, the Chesapeake Conservancy, U.S. Geological Survey, and University of Vermont Spatial Analysis Lab, with funding from the Chesapeake Bay Program (CBP), have produced a 1-meter resolution land cover and land use datasets for the Chesapeake Bay watershed regional area (over 250,000 km2). The generation of the CBP 1-meter land cover data involves the identification and classification of image objects derived from aerial imagery (National Agriculture Imagery Program, NAIP), above-ground height information derived from LIDAR, and other ancillary data.

Slope at the marsh-upland interface is an important factor determining the likelihood and the rate of marsh transgression (Fagherazzi et al. 2019; Molino et al., 2021). Low-lying areas with low slopes are inundated more frequently and for longer periods (Hussein and Rabenhorst, 2001). Moreover, along with decreased slope, there is a reduction in drainage area, which lowers the amount of freshwater input to the system (Hussein, 2009).

Shoreline stabilization is another critical moderator of marsh migration potential. Shoreline stabilization landward of the marsh, such as bulkheads and riprap revetments, block upland migration and potentially reduce sediment availability by trapping sediment landward of the bulkhead (Douglass and Pickel 1999, Griggs 2005). Once sea level rise has overcome the height of the shoreline stabilization, marshes should re-establish on the landward side, assuming there are no other barriers. Shoreline hardening currently occurs on 14% of the U.S. coastline (Gittman et al. 2015) and in the Chesapeake Bay, approximately 18% of all tidal shorelines are already hardened (Bilkovic and Mitchell, 2017).

Data availability for this factor: There are high resolution shoreline stabilization datasets for much of the Chesapeake Bay. However, shoreline stabilization can alter on short time scales and in some areas the survey supporting the datasets are dated.

Marsh form (shape) can influence the impact marsh migration has on marsh extent. In a York River study, marsh losses by area were highest in extensive marshes, particularly marsh islands, (Mitchell et al 2017). Both fringing marshes and marsh islands have limited potential for migration in this estuary, so loss to erosion cannot be counterbalanced in the long term (e.g., Schile et al 2014). Embayed marshes were particularly resilient, with small embayed marshes persisting at the tops of creeks where long extents of fringe marsh have been lost.

Data availability for this factor: Marsh form is not well documented for marshes throughout the Chesapeake Bay.

Erosion rates are predicted to increase with sea level rise, exacerbating marsh loss (Leatherman et al. 2000). Erosion rates are highly variable along Chesapeake Bay shorelines, even sometimes within close geographic proximity. Although relatively stable over the recent past (Kirwan et al. 2016b), erosion rates are predicted to increase with accelerating sea level rise, potentially resulting in huge coastal losses (Leatherman et al. 2000; Mariotti and Fagherazzi 2010). On average, Bayfront locality shorefronts experience low to moderate erosion on 30% of their shorelines (Milligan et al. 2012). Exceptions are heavily stabilized shorelines such as those in Norfolk where the locality shorelines appear stable due to the prevalence of shoreline structures. Bayfront marshes are considered one of the more stable Bay shoreline environments, eroding at 0.54 – 0.66 m/yr, depending on the underlying substrate (Rosen 1980). Rates on the tributaries are generally lower (e.g., York River marshes are eroding at 0.21 m/yr; Byrne and

Anderson, 1978) and erosion in the creeks is generally negligible, except when there is significant boat wake activity.

Data availability for this factor: Shoreline erosion rates are available for some Chesapeake Bay shorelines. They are generally lacking in low fetch creeks and not consistently classified across state boundaries.

Sediment availability is a key driver of marsh accretion, allowing marshes to maintain their extent under sea level rise. Although it is a different process from marsh migration, it is a complementary process and frequently included in marsh migration models.

Sediment for marsh accretion can come from either the watershed (originating in the upstream or downstream of the marsh, depending on hydrodynamics) or from adjacent lands, particularly eroding bluffs or marshes. Without sufficient sediment supply, marshes can begin to pond, leading to fragmentation and permanent loss (Mariotti 2016).

Sea level rise causes non-linear changes in hydrodynamics, leading to changes in sediment transport and ecological processes (Passeri et al. 2015), which will affect the signal of change in shoreline systems. This non-linearity means that signals of change may be muted until sea level rise acceleration passes a critical threshold. Marshes (as measured by extent) appear to show a threshold effect related to sediment supply in relation to sea level (Kirwan et al. 2010). Up to some inundation frequency, marshes will accrete sediment to keep pace with sea level (i.e. no discernable signal) and beyond that frequency should begin to drown. Therefore, the effect of accelerating sea level will not be apparent until it has crossed the threshold. This effect will be more evident in microtidal systems, such as the Chesapeake Bay, because the changes in sea level will be a larger proportion of the tidal range (Friedrichs and Perry 2001).

Marsh accretion is a factor of both in situ organic production rates and allochthonous sediment retention. It is the hardest variable to project into the future, since climatic shifts can affect plant productivity (e.g. C3 plant production under increased CO2; Drake 2014) and sediment supply (e.g. sediment erosion under increased precipitation intensity; Williams et al. 2017). Marsh plant production rates are highly variable, but a geographically expansive survey suggests that there is a theoretical limit to sediment accretion of 5mm/yr (Morris et al. 2016). Sea level rise has exceeded this rate in the Chesapeake Bay over the past 30 years (5.86 mm/yr at the mouth of the Bay; Ezer and Atkinson 2015) and is predicted to accelerate (Boon and Mitchell 2015). During the same time period, sediment loads to the Bay (a potential source of allochthonous sediment contribution to marshes) have declined due to management actions (Gellis et al. 2004). Explicit TSS reduction goals for the Bay (http://www.epa.gov/chesapeake-baytmdl) are designed to continue aggressive sediment management into the future. These reductions in sediment supply

coupled with the predicted acceleration in sea level rise will stress marsh accretion processes. Even in areas with high sediment supply, rates of RSLR above 10.2 mm/yr are predicted to be unsustainable for marshes (Morris et al. 2002). Under current rates of acceleration (0.119 mm/yr2; Boon et al. 2017), RSLR in the Bay will exceed those values within 60 years. However, previous studies in the Chesapeake Bay have shown a time lag between the time sea level rise rates exceeded local accretion rates and the subsequent marsh loss (Kearney et al. 2002) that may mean tidal marsh loss in the next couple decades is controlled more by erosion rates than sea level drowning.

Data availability for this factor: There are datasets of water quality reflecting sediment availability. The connection between the measured parameters (e.g., total suspended solids) and marsh sediment availability is not well established.

Marsh migration models

Due to the increased need to evaluate tidal marsh vulnerability in the light of changing environments, different models have been developed to predict marsh spatial extent and future distribution as well as to assist resource managers and habitat restoration practitioners in their decision-making process. Current models are constrained by the limitations of the two commonly used modeling approaches: landscape-scale models and site-specific models.

Landscape-scale Models

Landscape-scale models often use fixed rates (e.g., erosion rates) during the entire simulation. Landscape scale models fall into two broad categories: topography-driven models and elevation/process driven models.

The first category of models considers only the effect of elevation on marsh migration and generally ignores accretion and erosion. Examples of these models are the Sea Level Over Proportional Elevation (SLOPE) model (Doyle et al. 2010), and the Evolution of Tidal Marsh modeling (Mitchell et al. 2020). These models can be run at high resolution, provided that there is a high-resolution elevation dataset available for the region. They are good for identifying upland areas where marshes are likely to migrate and weaker on estimating overall marsh area. When estimating overall marsh area, these models are most appropriate for areas where high sea level rise rates limit the importance of accretion processes and drive migration rates that outpace typical erosion rates. In large scale model runs, where process rates cannot be reasonable estimated for the whole area, these models can be useful.

The second category of model simulates general trends in marsh area over large areas (as long as the process rates can be reasonably estimated), and typically run at a relatively coarse resolution. For that reason, these types of models are not suitable for site-specific research and management

uses because scaling down the results to local levels is not feasible, thereby limiting their accuracy and usefulness to local applications. Examples of these models include NOAA's Coastal Services Center's Marsh Migration Model and the EPA-funded Sea Level Affecting Marshes Model, (SLAMM). Since these models are generally similar, only SLAMM is described in detail here as an example. SLAMM simulates the principal processes involved in wetland conversions and shoreline modifications during long-term sea-level rise. Input file requirements (Figure 4 for the model include elevation, slope, National Wetland Inventory (NWI), dike, and impervious surface areas). The model incorporates IPCC projections as well as fixed rates of sea-level rise. The National Elevation Dataset (NED) is applied as a principal source of elevation. NED data usually do not have the vertical resolution required for accurate predictions of marsh elevations. To solve some of these problems, SLAMM computes wetland elevations based on National Wetlands Inventory (NWI) categories. Marsh elevation ranges may be estimated as a function of tidal ranges or may be input by the user if site-specific data are available. In SLAMM 6.7 users can enter the elevation of the levees or dikes to determine when a dike is overtopped.

The processes considered within the SLAMM v.6.7 (latest version) are inundation, erosion, overwash, saturation, salinity, and accretion. SLR is offset by accretion and sedimentation. There are three options for specifying accretion rates within SLAMM: 1) use average or site-specific values for each wetland category, 2) use spatially varying values for each wetland category, and 3) specify accretion as a time-varying function of cell elevation, wetland type, salinity, and distance to channel. Regarding the erosion process, SLAMM computes exposure to wave action in two ways. In the simplest approach, if the fetch is greater than 9 km, the model assumes

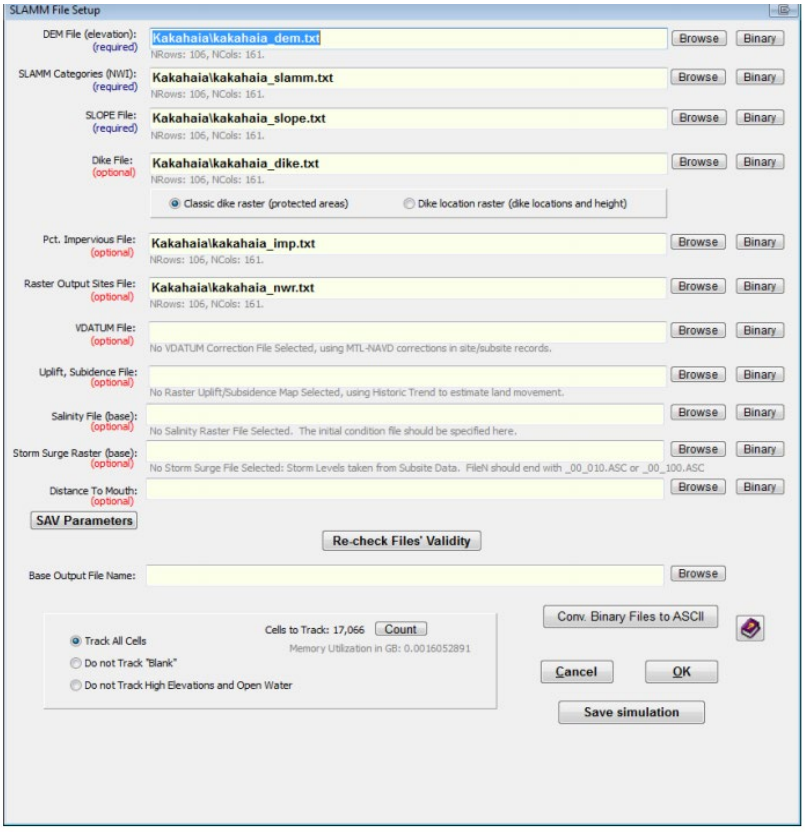


FIGURE 12. SLAMM FILE SETUP INTERFACE (FROM SLAMM 6.7 BETA USER'S MANUAL)

erosion will occur at a user-specified rate. Based on a combination of professional judgment and literature review, the default erosion rates in the model (fixed values) are assumed and set to 2.0 meters per year for marshes (emergent tidal wetlands), 1.0 meter per year for swamps (forested tidal wetlands), and 0.5 meter per year for tidal flats In SLAMM 6.7, marsh erosion can be calculated as a proportional to calculated wave power, which is a function of dominant wind directions, observed wind speeds, fetch, and water depths (Warren Pinnacle Consulting, Inc.,2021).

Site-specific Models

Site-specific models are more mechanistic. They are employed to simulate responses for a specific site with a particular set of conditions and settings. For example, the Marsh Equilibrium Model (MEM) (Morris et al. 2002) is a zero-dimensional model that simulates change in marsh surface elevation with SLR as a function of in situ biomass production and deposition of suspended sediment. The online version (Figure 5) of the model allows users to conduct experiments and to simulate sedimentation and sediment organic matter profiles in any tidal marsh.

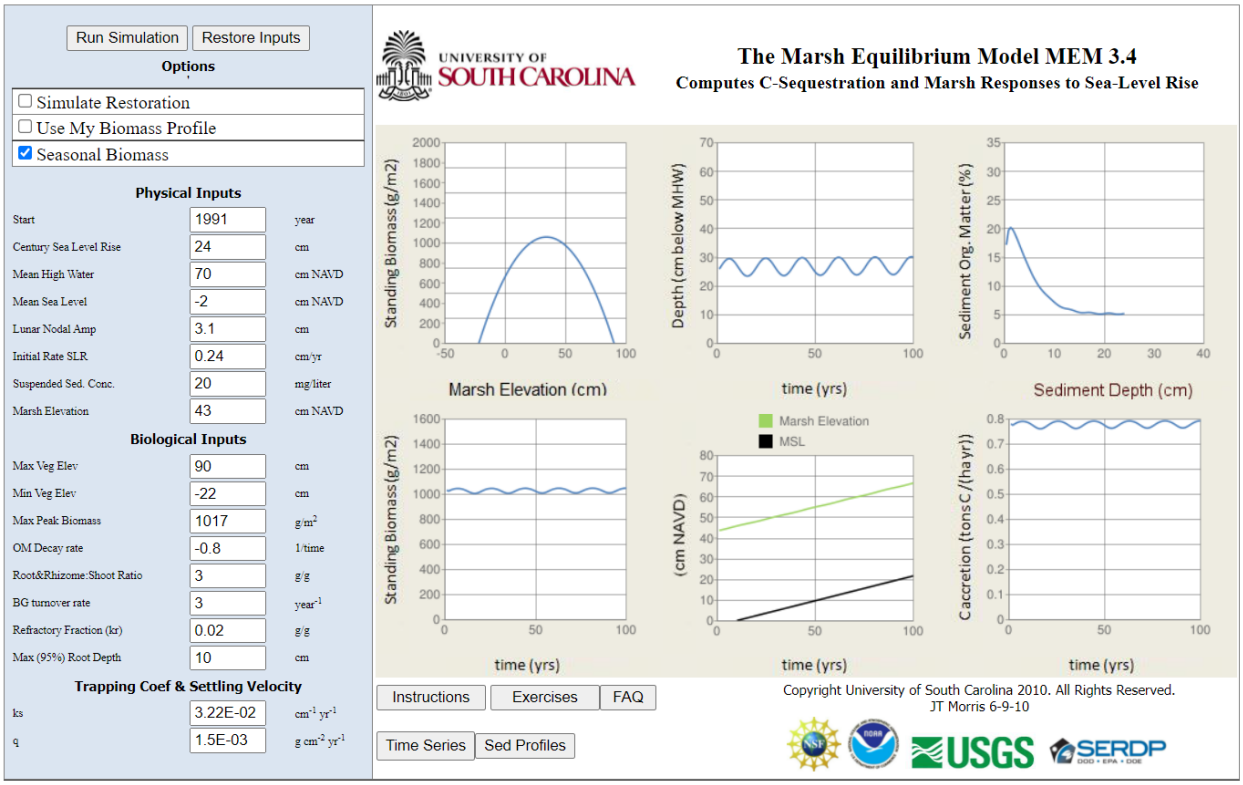


FIGURE 13.THE MEM USER INTERFACE DASHBOARD. CREDIT: JAMES T. MORRIS, UNIVERSITY OF SOUTH CAROLINA.

The latest version of MEM is called the Coastal Wetland Equilibrium Model, CWEM 9. This version incorporates in the simulations the ability to grow intertidal trees like mangroves.

Like the landscape models, site-specific models have scaling limitations as well. Using results from an individual site to make long-term projections at larger spatial extents is challenging due to the broad range of geomorphic settings across landscapes (Titus et al. 2009). Moreover, shoreline structures that interfere with the natural migration of marshes as a response to sea-level rise are not considered in these approaches.

Combination of Different Approaches

In recent years, several studies that used landscape-scale models incorporated different dynamic approaches to particularly evaluate marsh vertical accretion. For example, Clough et al. (2016) used SLAMM to evaluate the potential effect of SLR on the marshes along the New York coast using a 5-m horizontal resolution. To improve model results, the authors combined SLAMM data with a mechanistic approach to estimate marsh vertical accretion by applying MEM (at a site-specific level). In addition, Alizad et al. (2016) developed and applied a spatially explicit model called Hydro-MEM in the Timucuan salt marsh, located along the lower St. Johns River (Florida). This integrated approach combines spatial dynamics of salt marshes and predicts the impacts of possible future sea-level conditions. Inputs needed to run the Hydro-MEM are shown in Figure 6. In this case, MEM, a zero-dimensional model, is coupled with the hydrodynamic model ADCIRC (ADvanced CIRCulation Model) (Luettich and Westerink 2006) to create a dynamic 2-dimensional marsh model. Even though the approach refines the simulation of some processes, the resolution in that study is

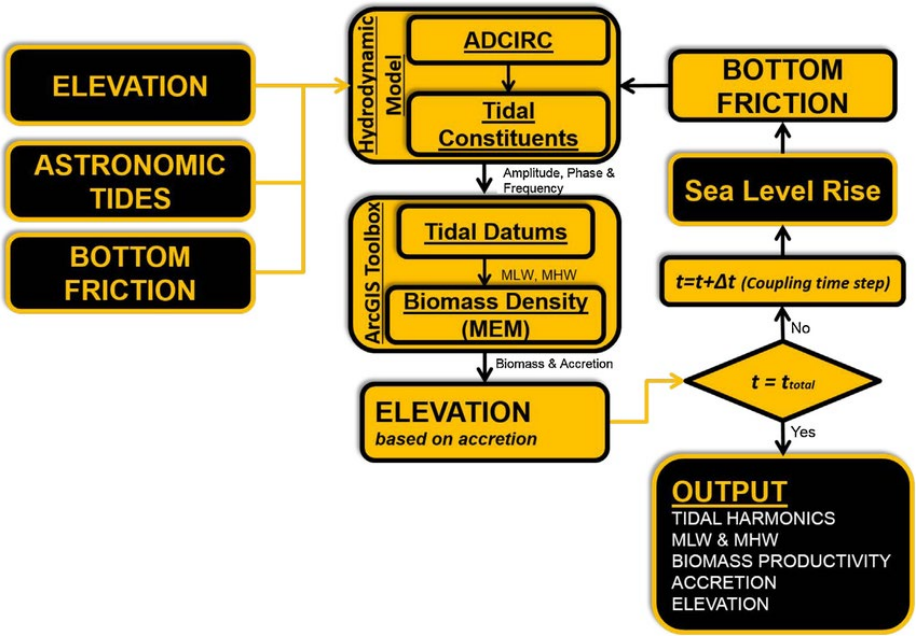


FIGURE 14. HYDRO-MEM MODEL FLOWCHART. THE BLACK BOXES SHOW THE PARAMETERS THAT ARE NOT BEING CHANGED. YELLOW BOXES REPRESENT THE PARAMETERS THAT ARE BEING MODIFIED THROUGH SIMULATION. INITIAL CONDITIONS ARE REPRESENTED BY THE BLACK BOXES ON THE LEFT (FROM ALIZAD ET AL. 2016).

very limited due to the inherent stability constraints in the circulation model (Zhang et al. 2019).

Moreover, several numerical models have been proposed to determine salt marsh survival under different scenarios of SLR (e.g., Temmerman et al. 2003; Van Proosdij et al. 2006; D'Alpaos et al. 2007; Mariotti et al. 2010; Kirwan et al. 2016). These models attempt to quantify the evolution of salt marshes under different physical and ecological drivers. In many of these models, the sediment transport dynamics of salt marsh evolution are highly simplified, representing only the starting point for the system.

Cross-scale Models

Even though current marsh models are valuable tools to address particular questions, there is still a need to model marshes over a broad geographic extent, but with the spatially explicit resolution currently available only from site-specific marsh evolution studies. Nunez et al. (2020) developed a new cross-scale approach to modeling marsh evolution. The Tidal Marsh Model (TMM) has been developed within the SCHISM (Semi-implicit Cross-scale Hydroscience Integrated System Model) framework (www.schism.wiki; Zhang et al. 2016). SCHISM (Figure 7) is a next-generation hydrodynamic modeling system developed for riverine, estuarine, coastal, and ocean applications. Some of the unique features the TMM includes are dynamic rates (most importantly, erosion rates and sediment deposition rates), cross-scale simulations, and incorporation of anthropogenic stressors, which allow it to overcome many limitations that current marsh models present. The initial version of TMM integrates the physical and human components needed to simulate and assess the evolution and persistence of tidal marshes under different SLR scenarios. Major inputs needed to run TMM are: spatial location of marshes, marsh plant data (physical characteristics), elevation data (DEM), bathymetry, riparian land use, shoreline structures, bottom sediment type, total suspended sediments, river input, tides, atmospheric forcing (available: North American Regional Reanalysis (NARR)). The TMM effectively interpolates site-specific information across critical conditions, creating the capacity to assess marsh vulnerability under present and potential future conditions. The TMM simulates marsh migration under the joint influence of tides, wind waves, sediment transport (including loading from upland erosion), shoreline structures, land use, and precipitation. TMM utilizes inundation frequency based on the water surface level predicted by the modeling system to drive inundation and horizontal marsh migration. This new approach accounts for shoreline changes, marsh accretion through mineral sediment deposition, upland erosion inputs at the marsh edge (derived from the Revised Universal Soil Loss Equation—RUSLE) (Renard et al. 1991), and marsh-upland transgression under a changing sea level with constraints from physical barriers (e.g., shoreline erosion control structures). Shoreline hardening structures that protect upland property from erosion (e.g., seawalls, revetments, and bulkheads) act not only as barriers for marshes to migrate inland but also represent barriers for sediment exchange between the marsh

habitat and the upland. In the model, these structures are treated as impenetrable barriers for sediment transport (but can be topped by water).

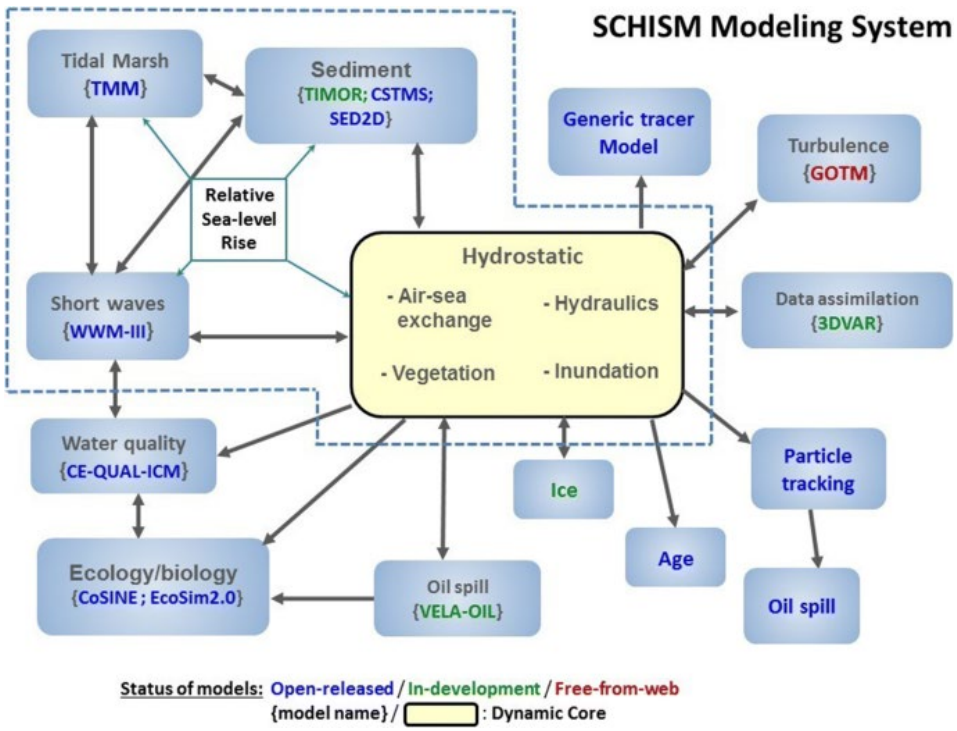


FIGURE 15. SCHISM MODELING SYSTEM. THE DASHED BOX INDICATES THE TMM AND KEY SUPPORTING COMPONENTS. THE HYDROSTATIC CORE SERVES AS THE FOUNDATION OF THE SYSTEM TO PROVIDE HYDRODYNAMIC VARIABLES TO OTHER MODELS AS WELL AS TO FACILITATE EXCHANGE OF VARIABLES BETWEEN MODELS IN A PARALLEL SOFTWARE ENVIRONMENT (FROM NUNEZ ET AL. 2020)

Takeaway

Major differences among marsh model approaches can be attributed to the processes simulated and the spatial scale. Due to the local geomorphic, hydrologic and biotic variation, it is recommended to apply a marsh model where the spatial extent is limited to an area where high-resolution and site-specific-relevant data are available. Nevertheless, it is important to understand that efforts to maximize details as well as to increase the degree of freedom might result in excessive parameterization, increased model uncertainty, and error propagation (Anderson 2005; Hood et al. 2006; Nunez et al. 2020). Hence, for a proper selection of model application, it is imperative to clearly define in advance the type of research and management questions that the model simulations are to address. Moreover, it is critical to have the necessary data to support parameterization. In the case of a heterogeneous system (i.e., with multiple

geomorphic settings), end users need to evaluate the overall purpose and application of the model, the resolution of the outputs, as well as the amount of error that they are willing to accept.

References

Alizad K, Hagen SC, Morris JT, Bacopoulos P, Bilskie MV, Weishampel JF, Medeiros SC (2016) A coupled, two-dimensional hydrodynamic-marsh model with biological feedback. Ecol Model 327:29–43. https://doi.org/10.1016/j.ecolmodel.2016.01.013.

Anderson T. 2005. Plankton functional type modeling: Running before we can walk? Journal of Plankton Research 27(11):1073–1081. https://doi.org/10.1093/plankt/fbm024

Barbier, E. B., S. D. Hacker, C. Kennedy, E. W. Koch, A.C. Stier, and B.R. Silliman. 2011. The value of estuarine and coastal ecosystem services. Ecological Monographs 81:169–193.

Beck, A., R.M. Chambers, M.M. Mitchell, D.M. Bilkovic. 2017. Evaluation of living shoreline marshes as a tool for reducing nitrogen pollution in coastal system. In Living Shorelines: The Science and Management of Nature-based Coastal Protection. (Eds: Bilkovic, D. M., M. Mitchell, J. Toft, M. La Peyre) Taylor & Francis Group and CRC Press; CRC Press Marine Science Series.

Beckett, L.H., Baldwin, A.H. and Kearney, M.S., 2016. Tidal marshes across a Chesapeake Bay subestuary are not keeping up with sea-level rise. PloS one, 11(7), p.e0159753.

Bierwagen, B.G., Theobald, D.M., Pyke, C.R., Choate, A., Groth, P., Thomas, J.V. and Morefield, P., 2010. National housing and impervious surface scenarios for integrated climate impact assessments. Proceedings of the National Academy of Sciences, 107(49), pp.20887-20892.

Bilkovic, D. M. and M.M. Mitchell. 2017. Designing living shoreline salt marsh ecosystems to promote coastal resilience. In Living Shorelines: The Science and Management of Nature-based Coastal Protection. (Eds: Bilkovic, D. M., M. Mitchell, J. Toft, M. La Peyre) Taylor & Francis Group and CRC Press; CRC Press Marine Science Series.

Bilkovic, D.M., M. Roggero, C. H. Hershner and K. H. Havens. 2006. Influence of Land Use on Macrobenthic Communities in Nearshore Estuarine Habitats. Estuaries and Coasts.

Boon, J. D. 2012. Evidence of sea-level acceleration at US and Canadian tide stations, Atlantic Coast, North America. Journal of Coastal Research, 28(6), 1437-1445.

Boon, J. D., & M. Mitchell 2015. Nonlinear change in sea-level observed at North American tide stations. Journal of Coastal Research, 31(6), 1295-1305.

Boon, J. D., Mitchell, M., Loftis, J. D., & Malmquist, D. M. (2018) Anthropocene Sea Level Change: A History of Recent Trends Observed in the U.S. East, Gulf, and West Coast Regions. Special Report in Applied Marine Science and Ocean Engineering (SRAMSOE) No. 467. Virginia Institute of Marine Science, College of William and Mary. https://doi.org/10.21220/V5T17T

Bridgham, S.D., Megonigal, J.P., Keller, J.K., Bliss, N.B. and Trettin, C., 2006. The carbon balance of North American wetlands. Wetlands, 26(4), pp.889-916.

Bromberg, K.D. and Bertness, M.D., 2005. Reconstructing New England salt marsh losses using historical maps. Estuaries, 28(6), pp.823-832.

Brooks, R.P., D.H. Wardrop, K.W. Thornton, D. Whigham, C. Hershner, M.M. Brinson and J.S. Shortle, eds. 2006. Integration of ecological and socioeconomic indicators for estuaries and watersheds of the Atlantic Slope. Final Report to U.S. Environmental Protection Agency STAR Program, Agreement R-82868401, Washington, DC. Prepared by the Atlantic Slope Consortium, University Park, PA. 96pp.+ attachments (CD).

Bruno, J. F. 2000. Facilitation of cobble beach plant communities through habitat modification by Spartina alterniflora. Ecology, 81(5), 1179-1192.

Byrne, R.J. and Anderson, G.L., 1978. Shoreline erosion in tidewater Virginia. Special Report in Applied Marine Science and Ocean Engineering No. 111, Virginia Institute of Marine Science, Gloucester Pt, VA, 102p.

Cahoon, D. R. 2015. Estimating relative sea-level rise and submergence potential at a coastal wetland. Estuaries and Coasts, 38(3), 1077-1084.

Carr, J., Guntenspergen, G., and Kirwan, M. 2020. Modeling marsh-forest boundary transgression in response to storms and sea-level rise. Geophys. Res. Lett. 47:e2020GL088998. doi: 10.1029/2020GL088998

Chmura, G.L., Anisfeld, S.C., Cahoon, D.R. and Lynch, J.C., 2003. Global carbon sequestration in tidal, saline wetland soils. Global biogeochemical cycles, 17(4).

Chmura, G.L., 2013. What do we need to assess the sustainability of the tidal salt marsh carbon sink? Ocean & coastal management, 83, pp.25-31.

Clough J, Polaczyk A, Popato M (2016) Modeling the potential effects of sea-level rise on the coast of New York: integrating mechanistic accretion and stochastic uncertainty. Environ Model Softw 84: 349–362

Collinge, S.K. 2009. Ecology of Fragmented Landscapes. The Johns Hopkins University Press. 360p.

Coverdale TC, Brisson CP, Young EW, Yin SF, Donnelly JP, Bertness MD. 2014. Indirect Human Impacts Reverse Centuries of Carbon Sequestration and Salt Marsh Accretion. PLoS ONE 9(3): e93296. doi:10.1371/journal.pone.0093296

D'Alpaos A, Lanzoni S, Marani M, Rinaldo A (2007) Landscape evolution in tidal embayments: modeling the interplay of erosion sedimentation and vegetation dynamics. J Geophys Res 112:F01008. https://doi.org/10.1029/2006JF000537

Deegan, L., J. Bowen, D. Drake, J. Fleeger, C. Friedrichs, K. Galvan, J. Hobbie, C. Hopkins, D. Johnson, J. Johnson, L. LeMay, E. Miller, B. Peterson, C. Picard, S. Sheldon, M. Sutherland, J. Vallino and R. Warren. 2007. Susceptibility of salt marshes to nutrient enrichment and predator removal. Ecological Applications 17(5):S42-S63.

DeLaune, R.D., Nyman, J.A. and Patrick Jr, W.H., 1994. Peat collapse, ponding and wetland loss in a rapidly submerging coastal marsh. Journal of Coastal Research, pp.1021-1030.

DeLuca, W. V., C. E. Studds, L. L. Rockwood, and P. P. Marra. 2004. Influence of land use on the integrity of marsh bird communities of the Chesapeake Bay, USA. Wetlands 24:837-847.

Douglass, S.L. and B.H. Pickel. 1999. "The Tide Doesn't Go Out Anymore"—The Effect of Bulkheads on Urban Bay Shorelines. University of South Alabama, Civil Engineering and Marine Sciences Departments, Mobile. [Online] Available at: http://www.southalabama.edu/cesrp/Tide.htm [January 25, 2006].

Doyle TW, Krauss KW, Conner WH, From AS (2010). Predicting the retreat and migration of tidal forests along the northern Gulf of Mexico under sea-level rise. Forest Ecology and Management, 259(4):770-777

Drake, B.G., 2014. Rising sea level, temperature, and precipitation impact plant and ecosystem responses to elevated CO 2 on a Chesapeake Bay wetland: Review of a 28-year study. Global change biology, 20(11), pp.3329-3343.

Erwin, R.M., Sanders, G.M. and Prosser, D.J., 2004. Changes in lagoonal marsh morphology at selected northeastern Atlantic coast sites of significance to migratory waterbirds. Wetlands, 24(4), pp.891-903.

Ezer, T. 2013. Sea level rise, spatially uneven and temporally unsteady: Why the US East Coast, the global tide gauge record, and the global altimeter data show different trends. Geophysical Research Letters, 40(20), 5439-5444.

Ezer, T., Atkinson, L. P. 2015. Sea Level Rise in Virginia – Causes, Effects and Response. Virginia Journal of Science 66(3):355-369.

Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. Annual Review of Ecology Evolution and Systematics 34(1):487–515.

Friedrichs, C.T. and Perry, J.E., 2001. Tidal salt marsh morphodynamics: a synthesis. Journal of Coastal Research, pp.7-37.

Gittman, R.K., Fodrie, F.J., Popowich, A.M., Keller, D.A., Bruno, J.F., Currin, C.A., Peterson, C.H. and Piehler, M.F., 2015. Engineering away our natural defenses: an analysis of shoreline hardening in the US. Frontiers in Ecology and the Environment, 13(6), pp.301-307.

Griggs, G.B. 2005. The impacts of coastal armoring. Shore Beach. 73(1): 13-22.

Greenberg, R., Maldonado, J.E., Droege, S.A.M. and McDonald, M.V., 2006. Tidal marshes: a global perspective on the evolution and conservation of their terrestrial vertebrates. BioScience, 56(8), pp.675-685.

Hartig, E.K., Gornitz, V., Kolker, A., Mushacke, F. and Fallon, D., 2002. Anthropogenic and climate-change impacts on salt marshes of Jamaica Bay, New York City. Wetlands, 22(1), pp.71-89.

Hood R, Laws EA, Armstrong RA, Bates NR, Brown CW, Carlson CA, Chai F, Doney SC, Falkowski PG, Feely RA, Friedrichs MA, Landry MR, Moore JK, Nelson DM, Richardson TL, Salihoglu B, Schartau M, Toole DA, Wiggertk JD. 2006. Pelagic functional group modeling: progress, challenges and prospects. Deep Sea Research Part II: Topical Studies in Oceanography 53(5):459–512. https://doi.org/10.1016/j.dsr2.2006.01.025

Hussein, A. H., and Rabenhorst, M. C. (2001). Modeling the Impact of Tidal Inundation on Submerging Coastal Landscapes of the Chesapeake Bay. Soil Sci. Soc. Am. J. 65, 932–941. doi:10.2136/sssaj2001.653932x

Hussein, A. H. (2009). Modeling of Sea-Level Rise and Deforestation in Submerging Coastal Ultisols of Chesapeake Bay. Soil Sci. Soc. Am. J. 73, 185–196. doi:10.2136/sssaj2006.0436

Kareiva, P. and U. Wennergren. 1995. Connecting landscape patterns to ecosystem and population processes. Nature 373:299–302.

Kearney, M.S., Grace, R.E. and Stevenson, J.C., 1988. Marsh loss in Nanticoke Estuary, Chesapeake Bay. Geographical Review, pp.205-220.

Kearney, M.S., Rogers, A.S., Townshend, J.R., Rizzo, E., Stutzer, D., Stevenson, J.C. and Sundborg, K., 2002. Landsat imagery shows decline of coastal marshes in Chesapeake and Delaware Bays. Eos, Transactions American Geophysical Union, 83(16), pp.173-178.

Kennish, M. J. 2001. Coastal salt marsh systems in the US: a review of anthropogenic impacts. Journal of Coastal Research, 731-748.

Kirwan, M.L. and Murray, A.B., 2007. A coupled geomorphic and ecological model of tidal marsh evolution. Proceedings of the National Academy of Sciences, 104(15), pp.6118-6122.

Kirwan, M.L., Guntenspergen, G.R., D'Alpaos, A., Morris, J.T., Mudd, S.M. and Temmerman, S., 2010. Limits on the adaptability of coastal marshes to rising sea level. Geophysical Research Letters, 37(23).

Kirwan M, Walters DC, Reay WG, Carr JA (2016a) Sea level driven marsh expansion in a coupled model of marsh erosion and migration. Geophys Res Lett 43:4366–4373. https://doi.org/10.1002/2016GL068507

Kirwan, M.L., Temmerman, S., Skeehan, E.E., Guntenspergen, G.R. and Fagherazzi, S., 2016b. Overestimation of marsh vulnerability to sea level rise. Nature Climate Change, 6(3), p.253.

Kopp, R.E., 2013. Does the mid-Atlantic United States sea level acceleration hotspot reflect ocean dynamic variability? Geophysical Research Letters, 40(15), pp.3981-3985.

Leatherman, S.P., Zhang, K. and Douglas, B.C., 2000. Sea level rise shown to drive coastal erosion. Eos, Transactions American Geophysical Union, 81(6), pp.55-57.

Libelo, L., MacIntyre, W.G. and Johnson, G.H., 1991. Groundwater nutrient discharge to the Chesapeake Bay: Effects of nearshore land use practices. New Perspectives in the Chesapeake Bay System: A Research and Management Partnership. JA Mihursky and A. Chaney (eds). Chesapeake Research Consortium. Pub, 137, pp.4-6.

Limburg, K. E., and R. E. Schmidt. 1990. Patterns of fish spawning in Hudson River tributaries: response to an urban gradient? Ecology 71:1238-1245.

Luettich RA, Westerink JJ (2006) ADCIRC: A (parallel) Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters, Users Manual for Version 51. http://adcirc.org/home/documentation/users-manual-v51/

Lussier, S.M., R.W. Enser, S,N, Dasilva, and M. Charpentier. 2006. Effects of habitat disturbance from residential development on breeding bird communities in riparian corridors. Environ. Manage. 38(3): 504-521.

Mariotti, G., 2016. Revisiting salt marsh resilience to sea level rise: Are ponds responsible for permanent land loss? Journal of Geophysical Research: Earth Surface, 121(7), pp.1391-1407.

Mariotti, G., and S. Fagherazzi. 2010. A numerical model for the coupled long-term evolution of salt marshes and tidal flats, J. Geophys. Res., 115, F01004, doi:10.1029/2009JF001326.

Mariotti G, Fagherazzi S, Wiberg PL, McGlathery KJ, Carniello L, Defina A (2010) Influence of storm surges and sea level on shallow tidal basin erosive processes. J Geophys Res 115:C11012. https://doi.org/10.1029/2009JC005892

Milligan, D. A., Wilcox, C., Cox, M. C., & Hardaway, C. S. (2012) Shoreline Evolution Update: 1937/38-2009 End Point Rate Calculations Counties of Accomack, Gloucester, and York Cities of Newport News, Norfolk, and Poquoson. Virginia Institute of Marine Science, College of William and Mary. https://doi.org/10.21220/V5213G

Minello, T. J., Rozas, L. P., & Baker, R. 2012. Geographic variability in salt marsh flooding patterns may affect nursery value for fishery species. Estuaries and Coasts, 35(2), 501-514.

Mitchell, M, "Impacts of Sea Level Rise on Tidal Wetland Extent and Distribution" (2018). Dissertations, Theses, and Masters Projects. Paper 1530192833. http://dx.doi.org/10.25773/v5-5s6z-v827

Mitchell, M., Herman, J. and Hershner, C., 2020. Evolution of tidal marsh distribution under accelerating sea level rise. Wetlands, 40(6), pp.1789-1800.

Mitchell, M, J. Herman, D. M. Bilkovic & C. Hershner (2017) Marsh persistence under sea-level rise is controlled by multiple, geologically variable stressors, Ecosystem Health and Sustainability, 3:10, 1379888, DOI: 10.1080/20964129.2017.1396009

Molino, G. D., Z. Defne, A. L. Aretxabaleta, N. K. Ganju, and J. A. Carr. 2021. Quantifying slopes as a driver of Forest to marsh conversion using geospatial techniques: Application to Chesapeake Bay coastal-plain, United States. Front. Environ. Sci. 9: 1–13. doi:10.3389/fenvs.2021.616319

Morris, J.T., Barber, D.C., Callaway, J.C., Chambers, R., Hagen, S.C., Hopkinson, C.S., Johnson, B.J., Megonigal, P., Neubauer, S.C., Troxler, T. and Wigand, C., 2016. Contributions of organic and inorganic matter to sediment volume and accretion in tidal wetlands at steady state. Earth's Future, 4(4), pp.110-121.

Morris JT, Sundareshwar PV, Nietch CT, Kjerfve B, Cahoon DR (2002) Responses of coastal wetlands to rising sea level. Ecology 83(10): 2869–2877. https://doi.org/10.1890/0012-9658(2002)083[2869:ROCWTR]2.0.CO;2

Neumann, B., Vafeidis, A.T., Zimmermann, J. and Nicholls, R.J., 2015. Future coastal population growth and exposure to sea-level rise and coastal flooding-a global assessment. PloS one, 10(3), p.e0118571.

Nunez, K., Zhang, Y., Bilkovic, D.M., and C. Hershner (2021). Coastal setting determines tidal marsh sustainability with accelerating sea-level rise. Ocean & Coastal Management, 214, 105898. https://doi.org/10.1016/j.ocecoaman.2021.105898.

Nunez, K., Zhang, Y.J., Herman, J., Reay, W., Hershner, C. (2020) A multi-scale approach for simulating tidal marsh evolution. Ocean Dynamics 70:1187–1209. https://doi.org/10.1007/s10236-020-01380-6

Paul, M. J. and J. L. Meyer. 2001. Streams in the urban landscape. Annual Review of Ecology and Systematics 32:333-365.

Passeri, D.L., Hagen, S.C., Medeiros, S.C., Bilskie, M.V., Alizad, K. and Wang, D., 2015. The dynamic effects of sea level rise on low-gradient coastal landscapes: A review. Earth's Future, 3(6), pp.159-181.

Renard KG, Foster GR, Weesies GA, Porter JP (1991) RUSLE: revised universal soil loss equation. J Soil Water Conserv 46:30–33

Robertson, T.L., Weis, J.S., 2005. A comparison of epifaunal communities associated with the stems of salt marsh grasses Phragmites australis and Spartina alterniflora. Wetlands 25: 1-7.

Rosen, P.S., 1980. Erosion susceptibility of the Virginia Chesapeake Bay shoreline. Marine Geology, 34(1-2), pp.45-59.

Sallenger Jr, A. H., Doran, K. S., & Howd, P. A. 2012. Hotspot of accelerated sea-level rise on the Atlantic coast of North America. Nature Climate Change, 2(12), 884-888

Schile LM, Callaway JC, Morris JT, Stralberg D, Parker VT, Kelly M. 2014. Modeling Tidal Marsh Distribution with Sea-Level Rise: Evaluating the Role of Vegetation, Sediment, and Upland Habitat in Marsh Resiliency. PLoS ONE 9(2): e88760. doi:10.1371/journal.pone.0088760

Shepard CC, C.M. Crain, M.W. Beck. 2011. The Protective Role of Coastal Marshes: A Systematic Review and Meta-analysis. PLoS ONE 6(11): e27374. doi:10.1371/journal.pone.0027374

Small, C. and Nicholls, R.J., 2003. A global analysis of human settlement in coastal zones. Journal of coastal research, pp.584-599.

Stevenson, J.C., Kearney, M.S. and Pendleton, E.C., 1985. Sedimentation and erosion in a Chesapeake Bay brackish marsh system. Marine Geology, 67(3-4), pp.213-235.

Sweet, W.W.V., Kopp, R., Weaver, C.P., Obeysekera, J.T.B., Horton, R.M., Thieler, E.R. and Zervas, C.E., 2017. Global and regional sea level rise scenarios for the United States.

Temmerman S, Goers G, Wartel S, Meire P (2003) Spatial and temporal factors controlling short-term sedimentation in a salt and freshwater tidal marsh, Scheldt Estuary, Belgium, SW Netherlands, earth surf. Process Landforms 28:739–755. https://doi.org/10.1002/esp.495

Tiner, R. \V. 1994. Recent Wetland Status and Trends in the Chesapeake Watershed (1982 to 1989): Executive Swnrnary Report. Prepared by the U.S. Fish and Wildlife Service, Region 5, Hadley, MA, for the Chesapeake Bay Program, Annapolis, lvID. 12 pp.

Tiner, R.W., 2005. Assessing cumulative loss of wetland functions in the Nanticoke River watershed using enhanced National Wetlands Inventory data. Wetlands, 25(2), pp.405-419.

Thrush, S.F., J. Halliday, J.E. Hewitt, and A.M. Lohrer. 2008. The effects of habitat loss, fragmentation, and community homogenization on resilience in estuaries. Ecological applications 18(1):12–21.

Torio, D.D. and Chmura, G.L., 2013. Assessing coastal squeeze of tidal wetlands. Journal of Coastal Research, 29(5), pp.1049-1061.

Valiela I. and M.L. Cole. 2002. Comparative evidence that salt marshes and mangroves may protect seagrass meadows from land-derived nitrogen loads. Ecosystems 5: 92–102.

Van Proosdij D, Davidson-Arnott RGD, Ollerhead J (2006) Controls on spatial patterns of sediment deposition across a macro-tidal salt marsh surface over single tidal cycles. Estuar Coast Shelf Sci 69: 64–86. https://doi.org/10.1016/j.ecss.2006.04.022

Wang, L., J. Lyons and P. Kanehl. 1997. Influences of watershed land use on habitat quality and biotic integrity in Wisconsin streams. Fisheries 22:6-12.

Warren Pinnacle Consulting, Inc. 2008. Sea-level rise Affects Marshes Model (SLAMM). http://www.warrenpinnacle.com/prof/SLAMM/SLAMM_Model_Overview.html

Williams MR, Bhatt G, Filoso S, Yactayo G (2017) Stream Restoration Performance & Its Contribution to the Chesapeake Bay TMDL: Challenges Posed by Climate Change in Urban Areas. Estuaries & Coasts, 40(5):1227-1246

Wilson, M.D., Watts, B.D. and Brinker, D.F., 2009. Status review of Chesapeake Bay marsh lands and breeding marsh birds.

Wray, Rachel Donham, Leatherman, Stephen, P., and Nicholls, Robert J., 1995, Historic and Future Land Loss for Upland and Marsh Islands in the Chesapeake Bay, Maryland, U.S.A., Journal of Coastal Research 11 (4):1195-1203.

Zhang YJ, Ye F, Stanley EV, Grashorn S (2016) Seamless cross-scale modeling with SCHISM. Ocean Model 102:64–81. https://doi.org/ 10.1016/j.ocemod.2016.05.002

Zhang Y, Gerdts N, Ateljevich E, Nam K (2019) Simulating vegetation effects on flows in 3D using an unstructured grid model: model development and validation. Ocean Dyn 70:213–230. https://doi.org/10.1007/s10236-019-01333-8

Appendix 2: Data table

Topics	Category	Data Name	Data Link	Data Source	Data Type	Date Range of Data	Resolution	Covered Geography	Available online?	Citation
Assessments of Marsh Resilience	Tidal Marsh Resilience	Tidal Marsh Resilience to Sea Level Rise	https://coast.noaa.gov/digitalcoast/data/marshresilience.html	NOAA - Digital Coast	GIS Data	2016	12-digit watersheds	Coastal watersheds - Nationwide	Yes	NOAA Office for Coastal Management, National Estuarine Research Reserve System (2021). https://coast.noaa.gov/digitalcoast/data/marshresilience.html
Assessments of Marsh Resilience	Vertical accretion and elevation change rates	Paper: Overestimation of marsh vulnerability to sea level rise	https://www.nature.com/articles/nclimate2909	Journal - Nature Climate Change	Peer-reviewed article	2016	Not Applicable	United States, Canada, United Kingdom, France, and Spain	Yes	Kirwan, M., Temmerman, S., Skeehan, E. et al. Overestimation of marsh vulnerability to sea level rise. Nature Climate Change 6, 253–260 (2016). https://doi.org/10.1038/nclimate2909
Assessments of Marsh Resilience	Marsh Migration	NOAA Digital Coast - Sea Level Rise Viewer	https://coast.noaa.gov/digitalcoast/tools/slr.html	NOAA	GIS Data	2015	DEM: 3 meters	National	Yes	NOAA Office for Coastal Management. Sea Level Rise Viewer
Assessments of Marsh Resilience	Coastal Wetlands	An Unvegetated to Vegetated Ratio (UVVR) for coastal wetlands of the Conterminous United States (2014-2018)	https://www.sciencebase.gov/catalog/item/5fa18656d34e198cb793cba5	USGS	GIS Data	2014-2018	Unknown	Atlantic Coast	Yes	Couvillion, B.R., Ganju, N.K., and Defne, Z., 2021, An Unvegetated to Vegetated Ratio (UVVR) for coastal wetlands of the Conterminous United States (2014-2018): U.S. Geological Survey data release, https://doi.org/10.5066/P97DQXZP.
Assessments of Marsh Resilience	Coastal Wetlands	TNC Coastal Resilience Map portal	https://maps.coastalresilience.org/virginia/#/living.	The Nature Conservancy	Map Viewer	Varies	Unknown	Virginia's Eastern Shore	Yes	Not Provided
Conserved Lands	Targeted Ecological Areas	Watershed Resources Registry - Targeted Ecological Areas	http://mdewin64.mde.state.md.us/ECollaboration/SearchPortal.aspx	Maryland Department of the Environment	Online map viewer; GIS Data	Unknown	NA	Maryland	Yes	Watershed Resources Registry (2021). Targeted Ecological Areas. Maryland Department of the Environment.
Conserved Lands	Conserved Lands	Virginia Conservation Lands Database	https://www.dcr.virginia.gov/natural-heritage/cldownload	Virginia Department of Conservation and Recreation (VA DCR), Division of Natural Heritage	GIS Data	1998-Sept 2020. The database is constantly being edited and updated.	NA	Virginia	Yes	Conservation Lands Database (2020). Virginia Department of Conservation and Recreation, Division of Natural Heritage.
Conserved Lands	Forest Conservation Lands	Forest Conservation Value	https://www.dcr.virginia.gov/natural-heritage/vaconvisforest	Virginia Department of Conservation and Recreation (DCR) and Virginia Department of Forestry (VDOF)	GIS Data	2020	Unknown	Virginia	Yes	Biasiolli, K., J. Pugh, and M. Santucci. 2020. Forest Conservation Value Model, 2020 Edition. Virginia Department of Forestry, Charlottesville, VA, USA.
Conserved Lands	Natural Areas	Delaware Natural Areas	https://data.delaware.gov/Energy-and-Environment/Delaware-Natural-Areas/9pe9-z9z2	Delaware Department of Natural Resources and Environmental Control (DNREC)	GIS Data	1978-present; updated August 5, 2021	NA	Delaware	Yes (Requires Username and Password)	Delaware Natural Areas (2021).Data. Delaware Dept of Natural Resources and Environmental Control (DNREC).https://data.delaware.gov/dataset/Natural-Areas/sryx-uafh
Conserved Lands	Land and Water Conservation Fund Investments	Delaware Land and Water Conservation Fund	https://opendata.firstmap.delaware.gov/datasets/delaware-land-and-water-conservation-fund/explore?location=39.128170%2C-75.417300%2C9.00	State of Delaware	GIS Data	Updated to October 23, 2020	NA	Delaware	Yes	Delaware Land and Water Conservation Fund (2020). Data. State of Delaware. https://opendata.firstmap.delaware.gov/datasets/delaware-land-and-water-conservation-fund/explore?location=39.128170%2C-75.417300%2C9.00
Conserved Lands	Nature Preserves	Delaware Nature Preserves	https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-nature-preserves/about	Delaware Department of Natural Resources and Environmental Control Division of Parks and Recreation	GIS Data	Updated August 5, 2021	NA	Delaware	Yes	Delaware Nature Preserves (2020). Data. Delaware Department of Natural Resources and Environmental Control Division of Parks and Recreation. https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-nature-preserves/about or https://data.delaware

Conserved Lands	Public Protected Lands	Delaware Public Protected Lands	https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-public-protected-lands/about	Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Parks and Recreation	Online map viewer; GIS Data	updated to June 27, 2019	NA	Delaware	Yes	Delaware Public Protected Lands (2019). Data. Delaware Department of Natural Resources and Environmental Control, Division of Parks and Recreation. https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-public-protected-lands/about
Conserved Lands	Biodiversity Conservation Network	Biodiversity Conservation Network - Watershed Resources Registry -	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Online map viewer; GIS Data	Unknown	NA	Maryland	Yes	Biodiversity Conservation Network (2021). Data. Watershed Resources Registry. Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on
Conserved Lands	MD Critical Areas	MD Critical Areas - Watershed Resources Registry	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Online map viewer; GIS Data	Unknown	NA	Maryland	Yes	Maryland Critical Areas (2021). Map viewer and Data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map
Conserved Lands	Protected Lands	Protected Lands - Watershed Resources Registry	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Online map viewer; GIS Data	Varies	NA	Maryland	Yes	Protected Lands (2021). Map viewer and data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on
Conserved Lands	Conserved Lands	The GreenPrint Map	https://geodata.md.gov/greenprint/	Maryland Department of Natural Resources (DNR)	Online Map Viewer	updated to Dec 2018	NA	Maryland	Yes	Not Provided
Data Infrastructure to Assess Marsh Resilience	Coastal Wetlands	Chesapeake Bay Sentinel Site Cooperative Data & Infrastructure Inventory	http://chesapeakebayssc.org/wp-content/uploads/2018/08/CBSSC_DataInfrastructureSummaryReport_FINAL.pdf	NOAA/ Maryland Sea Grant/ MD DNR	Report	May 2017	NA	Sentinel Sites around the Chesapeake Bay	Yes	Cahoon, Don, D.J. Reed, A.S. Kolker, M.M. Brinson, "Coastal Wetland Sustainability", Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region, Chapter 4, U.S. Climate Change Science Program, Synthesis and Assessment Product 4.1. 2009. Wilkins, Sarah & A, Phelps "Chesapeake Bay Sentinel Site Cooperative Data & Infrastructure Inventory Summary Report" Maryland Sea Grant. 2017.
Distribution of Natural Resources	Salt Marsh	Maryland Salt Marsh - Salt Marsh	https://data.imap.maryland.gov/datasets/maryland::maryland-salt-marsh-salt-marsh/about	MD-DNR	GIS Data	1988-1995	Unknown	Maryland	Yes	MD iMAP Data Catalog (DOIT)
Distribution of Natural Resources	Wetlands	National Wetlands Inventory (NWI)	https://www.fws.gov/wetlands/data/data-download.html	U.S. Fish and Wildlife Service	Online map viewer; GIS Data	1977- 2017, Continuously being improved and new data added on a biannual basis	Data intended for use with base maps or imagery at a scale of 1:12,000 or smaller.	National	Yes	National Wetlands Inventory (NWI) (2021). Data. U.S. Fish and Wildlife Service, Washington, D.C.https://www.fws.gov/wetlands/data/data-download.html.
Distribution of Natural Resources	Beaches	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/index.php

Distribution of Natural Resources	Dunes	Lidar-derived beach morphology (dune crest, dune toe, and shoreline) for U.S sandy coastlines	https://coastal.er.usgs.gov/data-release/doi-F7GF0S0Z/	USGS	Tabular Data	1998-2020	Varies	Virginia, Maryland, Delaware	Yes	Doran, K.S., Long, J.W., Birchler, J.J., Brenner, O.T., Hardy, M.W., Morgan, K.L.M, Stockdon, H.F., and Torres, M.L., 2017, Lidar-derived beach morphology (dune crest, dune toe, and shoreline) for U.S. sandy coastlines (ver. 4.0, October 2020): U.S. Geolo
Distribution of Natural Resources	Natural and Nature-Based Features (NNBFs)	Coastal Natural and Nature-Based Features (NNBFs) Ranked: Co-Benefits for Coastal Buildings and Target Areas for the Creation	https://doi.org/10.25773/d8pv-gb12	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	2021	Varies	Coastal Virginia - Lands at less than 10-feet	Yes	Mason, Pamela; Hendricks, Jessica; and Herman, Julie, "Coastal Natural and Nature-Based Features (NNBFs) Ranked: Co-Benefits for Coastal Buildings and Target Areas for the Creation of New or Restoration of NNBFs in Coastal Virginia"
Distribution of Natural Resources	Maritime Forest	Coastal Maritime Forests in Virginia – Delineation and Distribution	https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=1708&context=reports	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	Report with map	2007	2 Feet	Virginia	Yes	Berman, M., & Berquist, H. (2007) Coastal Maritime Forests in Virginia – Delineation and Distribution. Virginia Institute of Marine Science, William & Mary. https://doi.org/10.21220/V5Q71P
Distribution of Natural Resources	Wetlands	Delaware Wetlands	https://enterprise.firstmap.delaware.gov/arcgis/rest/services/Hydrology/DE_Wetlands/FeatureServer/6	Delaware Department of Natural Resources and Environmental Control (DNREC)	GIS Data	Updated to June 21, 2021	NA	Coastal Delaware	Yes	Delaware Wetlands (2021). Vector Polygon Data. Delaware Department of Natural Resources and Environmental Control. https://enterprise.firstmap.delaware.gov/arcgis/rest/services/Hydrology/DE_Wet
Distribution of Natural Resources	Tidal Wetlands	Delaware Regulated Tidal Wetlands Index	https://dnrec.alpha.delaware.gov/water/wetlands-subaqueous/state-regulated-wetlands/	Delaware Dept of Natural Resources and Environmental Control (DNREC)	Online Map viewer; downloadable aerial photos	Varies	NA	Coastal Delaware	Yes	State Regulated Wetlands Map Index (2021). Web map. Delaware.gov. https://dnrec.alpha.delaware.gov/water/wetlands-subaqueous/state-regulated-wetlands/
Distribution of Natural Resources	Wetlands	Virginia Wetlands Catalog	https://www.dcr.virginia.gov/download-files-registration?2015-04-21-20-46-35-315247-ey8	Virginia Department of Conservation and Recreation, Division of Natural Heritage	GIS Data	2014	Varies	Virginia	Yes	Weber, J. T. and J. F. Bulluck 2014. Virginia Wetlands Catalog: An inventory of Wetlands and Potential Wetlands with Prioritization Summaries for Conservation and Restoration Purposes by Parcel, Subwatershed, and Wetland Boundaries. Natural Heritage Techn
Distribution of Natural Resources	Beaches	No Build Line - Bay	https://firstmap-delaware.opendata.arcgis.com/datasets/delaware::no-build-points-bay/about	Delaware Department of Natural Resources and Environmental Control (DNREC)	GIS Data	Updated to May 1, 2020	NA	Coastal Delaware	Yes	No Build Line - Bay (2020). Data. Delaware Department of Natural Resources and Environmental Control (DNREC).https://firstmap-delaware.opendata.arcgis.com/datasets/Delaware::no-build-points-bay/about
Distribution of Natural Resources	Barrier Islands	Virginia Eastern Shore Coastal Resilience Tool - Historic Shoreline Change Database	maps.coastalresilience.org/virginia	These shoreline data were developed "in-house" or came from well-known repositories of shoreline data, including the University of Virginia, the United States Geological	Online map viewer; GIS Data	1849-2014	Multiple spatial and temporal scales	Virginia Barrier Islands	Yes	Virginia Eastern Shore Coastal Resilience Tool, Historic Shoreline Change Database (2014). University of Virginia, et al. https://maps.coastalresilience.org/virginia.

Distribution of Natural Resources	Beaches	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002-2021	Scale 1:1,000	Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php
Distribution of Natural Resources	Rivers and Streams	National Hydrography Dataset (NHD)	https://www.usgs.gov/core-science-systems/ngp/national-hydrography/national-hydrography-dataset?qt-science_support_page_related_con=0	USGS	GIS Data	Varies	1:24,000 (some states 1:36,360)	National	Yes	Not Provided
Distribution of Natural Resources	Wetlands	MD DNR Wetlands - Watershed Resources Registry	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Online map viewer; GIS Data	Updated to 4/5/1995	NA	Maryland	Yes	MD DNR Wetlands (1995). Map viewer and Data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on
Distribution of Natural Resources	Wetlands	Wetlands Special State Concern - Watershed Resources Registry	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Online map viewer; GIS Data	Updated to August 2017	NA	Maryland	Yes	Wetlands Special State Concern (2017). Map viewer and data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on
Distribution of Natural Resources	Dunes	Chesapeake Bay Dune Systems: Monitoring	https://www.vims.edu/GreyLit/VIMS/Shoreline%20Evol%20Reports/CBDuneSystems2005.pdf	Shoreline Studies Program (SSP), Virginia Institute of Marine Science (VIMS)	Report	2005	Not Applicable	Chesapeake Bay	Yes	Milligan, D.A., Hardaway, Jr., C.S., Thomas, G. R., Varnell, L.M., Barnard, T. Reay, W., Comer, T. R., Wilcox, C.A., 2005. Chesapeake Bay Dune Systems: Monitoring Final Report. Virginia Institute of Marine Science, College of William & Mary, Gloucester
Distribution of Natural Resources	Tree Fringe	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/virginia/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/virginia/index.php

Distribution of Natural Resources	Beaches Above High Water	Beaches Above High Water	https://gaia.vcu.edu/GemsMap/?extent=-8622879.4296%2C4433048.7104%2C-8405492.5212%2C4530582.3585%2C102100&s	Shoreline Studies Program (SSP), Virginia Institute of Marine Science (VIMS)	Map viewer; Tabular Data	2005-2006	NA	Coastal Virginia	Yes	Virginia's Non-jurisdictional Beach Assessment (2006). Virginia Institute of Marine Science Shoreline Studies Program.
Distribution of Natural Resources	Wetlands	Maryland Wetlands (National Wetlands Inventory)	https://data.imap.maryland.gov/datasets/maryland::maryland-wetlands-wetlands-national-wetlands-inventory/about	Maryland Department of Natural Resources (MD DNR - Maryland.gov)	GIS Data	September 27, 2017	NA	Maryland	Yes	Not Provided
Distribution of Natural Resources	Submerged Aquatic Vegetation	Submerged Aquatic Vegetation 2019	https://geodata.md.gov/imap/rest/services/Biota/MD_SubmergedAquaticVegetation/MapServer	Maryland Department of Natural Resources (MD DNR), Maryland Coastal Atlas	Online map viewer; GIS Data	2019	NA	Chesapeake Bay and Chincoteague	Yes	Submerged Aquatic Vegetation (2019). Data. Maryland Department of Natural Resources. https://geodata.md.gov/imap/rest/services/Biota/MD_SubmergedAquaticVeget
Distribution of Natural Resources	Tidal Marsh/Phragmites Australis Inventory	Virginia Shoreline & Tidal Marsh Inventory (2010-2016)	https://www.vims.edu/ccrm/research/inventory/virginia/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marinca Science (VIMS)	GIS Data	2010-2019	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/rese
Distribution of Natural Resources	Phragmites	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002-2021	1: 12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php
Distribution of Natural Resources	Marsh Buffer	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002-2021	1:12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php
Distribution of Natural Resources	Bank Cover	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia	GIS Data	Locality based series from 2002-2021	1:12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of
Distribution of Natural Resources	Bank Cover	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management. 2019. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from https://www.vims.e
Distribution of Natural Resources	Marsh, Beach, Phragmites	Delaware Shoreline Inventory - National Estuarine Research Reserve Sites	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine	GIS Data, online viewer, summary tables	2007	1:12,000	Delaware (Appoquinimink River, Blackbird Creek, St Jones River)	Yes	Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory:
Distribution of Natural Resources	Phragmites	Invasive Phragmites Experiment	https://serc.si.edu/gcrew/phragmitesdata	SERC Global Change Research Wetland	Tabular Data	2011-2019	Unknown	Edgewater, MD	Yes	Not Provided
Distribution of Natural Resources	Tidal Wetlands	TNC Coastal Resilience Map portal	https://maps.coastalresilience.org/virginia/#/future	The Nature Conservancy	Map Viewer	Future	Unknown	Virginia's Eastern Shore	Yes	Not Provided
Ditches Crossing Wetlands	Tax ditches	Eastern Shore Regional GIS Cooperative (ESRGC) Tax Ditches and PDAs (public drainage	https://www.esrgc.org/data/taxditch	Eastern Shore Regional GIS Cooperative (ESRGC)	GIS Data	2004	Unknown	Maryland - Lower Eastern Shore	Yes	Not Provided

Economic and Social Community Characteristics	Environmental Justice	EJSCREEN: Environmental Justice Screening and Mapping Tool	https://ejscreen.epa.gov/mapper/ - https://www.epa.gov/ejscreen/download-ejscreen-data	EPA	Online map viewer; GIS Data; Tabular Data	2015	Not Applicable	National	Yes	EPA Environmental Justice Screening and Mapping Tool (EJSCREEN). https://www.epa.gov/ejscreen/what-ejscreen
Economic and Social Community Characteristics	Environmental Justice	CB EJ SCREEN	https://gis.chesapeakebay.net/cbpejscreen/	Chesapeake Bay Program Chesapeake Research Consortium	Map Viewer	2016	NA	Chesapeake Bay	Yes	EJ Screen Chesapeake is a collaborative project of the CBP Diversity Workgroup and other Workgroups and staff of the Chesapeake Bay Program Office.
Economic and Social Community Characteristics	Physical Vulnerability	Physical Vulnerability Index (PVI)	https://scholarworks.wm.edu/data/441/	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	2015	Census tract	Coastal Virginia	Yes	Nunez, Karinna; Mitchell, Molly; and Renaud, Alexander, "Physical Vulnerability Index" (2021). Data. William & Mary. https://doi.org/10.25773/hz0r-jx50
Groundwater Information	Groundwater Flow	USGS Groundwater Data for the United States	https://waterdata.usgs.gov/va/nwis/gw	USGS National Water Information System: Web Interface	Tabular Data	2007-present (for historic observation datasets)	Unknown	National (and by state and territory)	Yes	Not Provided
Groundwater Information	Groundwater Tables	Depth to Water Table	https://www.usgs.gov/faqs/how-can-i-find-depth-water-table-a-specific-location?qt-news_science_products=0	USGS	Tabular Data	Varies	Unknown	National	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Land Cover Projections	ICLUS (Integrated Climate and Land-Use Scenarios) Land Cover data for SSP2 and SSP3 socioeconomic scenarios. SSP2 (Shared	https://www.epa.gov/gcx/iclus-fourth-national-climate-assessment	EPA	GIS Data	2018	Unknown	National	Yes	U.S. EPA. Updates to the Demographic and Spatial Allocation Models to Produce Integrated Climate and Land Use Scenarios (ICLUS) (Version 2) (External Review Draft). U.S. Environmental Protection Agency, Washington, DC,
Landuse/Landcover (Current and Projected)	Land Cover Projections	Conterminous United States Landscape Projections from 1992 to 2100	https://www.sciencebase.gov/catalog/item/5b86c2f9e4b0702d0e826f6d	USGS	GIS Data	4 IPCC SRES scenarios from 1992 to 2100	250 meter pixel	National	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Land Cover Hindcast	Landuse and Landcover Backcasting from 1938 to 1992	https://www.sciencebase.gov/catalog/item/59d3c73de4b05fe04cc3d1d1	USGS	GIS Data	1938-1992	250 meter pixel	National	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Roads	Tiger/Line Data	https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html	US Census Bureau	GIS Data	1992, 2000, 2006 to 2020	Unknown	National	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Roads	Virginia Road Centerlines	https://vgin.maps.arcgis.com/home/item.html?id=cd9bed71346d4476e8a08d3685cb36ae	Virginia Geographic Information Network (VGIN)	GIS Data	Updated Quarterly	Unknown	Virginia	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Roads	Open Street Map	https://www.openstreetmap.org/	Open Street Map (OSM)	Map Viewer; GIS Data	Varies	1:5000 or smaller	World	Yes	Not Provided

Landuse/Landcover (Current and Projected)	Buildings	Building Footprint	https://vgin.maps.arcgis.com/home/item.html?id=994d0afa44c046498f97746137 1ce9a	Virginia Geographic Information Network (VGIN)	GIS Data	Updated Quarterly	Unknown	Virginia	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Roads	Maryland Roads Centerlines - Comprehensive	https://data-maryland.opendata.arcgis.com/pages/mdot-data	Maryland Department of Transportation (MDOT)	GIS Data	2019; updated annually	Unknown	Maryland	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Current Land Cover	Virginia Land Cover Dataset	https://vgin.maps.arcgis.com/home/item.html?id=d3d51bb5431a4d26a313f586c7c2c848	VGIN (Virginia Geographic Information Network)	GIS Data	2016	1 meter pixel	Virginia	Yes	Virginia Geographic Information Network (VGIN), Department of Conservation & Recreation (DCR), Department of Environmental Quality (DEQ), Virginia Department of Forestry (VDOF), Tidal Marsh Inventory (TMI), National
Landuse/Landcover (Current and Projected)	Current Land Cover	National Land Cover Database (NLCD)	https://www.mrlc.gov/data?f%5B0%5D=category%3Aland%20cover&f%5B1%5D=region%3Aconus	Multi-Resolution Land Characteristics (MRLC) Consortium	GIS Data	Varies	30 meter pixel	National	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Current Land Cover	C-CAP (Coastal Change and Analysis Program) Regional Land Cover and Change	https://coast.noaa.gov/digitalcoast/data/ccapregional.html	NOAA	GIS Data	Varies	30 meter pixel	Coastal Areas of the United States	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Current Land Cover	Chesapeake Bay High-Resolution Land Cover Project	https://www.chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/	Chesapeake Conservancy Conservation Innovation Center	GIS Data	2016	1 meter pixel	Chesapeake Bay watershed including New York, Pennsylvania, West Virginia, Maryland, Delaware, Washington DC, Virginia	Yes	Not Provided
Landuse/Landcover (Current and Projected)	Riparian Land Use	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management. 2019. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of
Landuse/Landcover (Current and Projected)	Riparian Land Use	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002-2021	1: 12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php
Landuse/LandCover (Current and Projected)	Riparian Land Use	Delaware Shoreline Inventory - Rehoboth Bay	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	2012	1:12,000	Delaware - Rehoboth Bay	Yes	Berman, M., Killeen, S., Hershner, C., Nunez, K., Reay, K., Angstadt, K., Rudnicky, T., Schatt, D., & Stanhope, D. (2013) Rehoboth Bay, Delaware Shoreline Inventory Report Methods and Guidelines. Special Report in Applied Marine Science and Ocean Engine

Landuse/Landcover (Current and Projected)	Riparian Land Use	Delaware Shoreline Inventory - Indian River Watershed	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data, online viewer, summary tables	2005	1:12,000	Delaware - Indian River Watershed	Yes	O'Brien, D.L., Jacobs, A., Berman, M.R., Rudnicky, T., McLaughlin, E., Howard, A., 2007. Refinement and validation of a multi-level assessment method for Mid-Atlantic tidal wetlands. Center for Coastal Resources Management, Virginia
Projected Marsh Migration Patterns	Marsh migration Data	Migration of the Tidal Marsh Range Under Sea Level Rise for Coastal Virginia, with Land Cover Data	https://doi.org/10.25773/sz4n-k694	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	2021	Unknown	Coastal Virginia	Yes	Herman, Julie and Mitchell, Molly, "Migration of the Tidal Marsh Range Under Sea Level Rise for Coastal Virginia, with Land Cover Data" (2021). Data. William & Mary.
Projected Marsh Migration Patterns	Marsh Migration Zones	Marsh Migration Zones, Northeast U.S	https://nalcc.databasin.org/datasets/14de01cdcd0b4243b04fce3165cf873c/	Northeast Conservation Planning Atlas	GIS Data	2017	NA	Northeast U.S.	Yes	Kevin Ruddock(Principal Investigator), North Atlantic Landscape Conservation Cooperative(administrator), 2017-05-16(creation), 2018-02-09(lastUpdate), 2017-03-22(Publication), Marsh Migration Zones, Northeast U.S.
Sea Level Rise	Empirical Projections	Sea level report cards - Chesapeake Bay	https://www.vims.edu/bayinfo/bay_slrc/index.php	Virginia Institute of Marine Science (VIMS)	Graphs and charts	2019	5 stations in the Bay	Chesapeake Bay	Yes	Boon, J., Mitchell, M., Malmquist, M. Sea Level Report Cards Chesapeake Bay. Website. https://www.vims.edu/bayinfo/bay_slrc/index.php
Sea Level Rise	GCM Projections	Sea Level Rise Viewer	https://coast.noaa.gov/htdata/Inundation/SLR/SLRdata/VA/VA_Eastern Shore_slr_data_dist.zip; https://coast.noaa.gov/	NOAA	GIS Data	2007-2009	NOAA gauges	National	Yes	NOAA Office for Coastal Management. Digital Coast. Sea Level Rise Viewer. Website. https://coast.noaa.gov/digitalcoast/tools/slr.html
Sea Level Rise	GCM Projections	Sea-Level Change Curve Calculator	https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html	US Army Corps of Engineers and NOAA	Webtool with graphs and charts	2013-2017	NOAA gauges	National	Yes	USACE. Sea-Level Change Curve Calculator (Version 2021.12). Website. https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html
Sea Level Rise	GCM projections	Sea-level Rise: Projections for Maryland 2018	https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html	MD Sea Level Rise Working Group and NOAA	Webtool with graphs and charts	2018	NOAA gauges	Maryland	Yes	Boesch, D.F., W.C. Boicourt, R.I. Cullather, T. Ezer, G.E. Galloway, Jr., Z.P. Johnson, K.H. Kilbourne, M.L. Kirwan, R.E. Kopp, S. Land, M. Li, W. Nardin, C.K. Sommerfield, W.V. Sweet. 2018. Sea-level Rise: Projections for Maryland 2018, 27 pp. University
Shoreline Erosion	Fetch	CCRM Exposure Model	NA	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	2018	25 meters	Coastal Virginia	No	Center for Coastal Resources Management. 2018. Shoreline Management Model, version 5. Center for Coastal Resources Management, Virginia Institute of Marine Science,
Shoreline Erosion	Bank Height	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/virginia/index.php	Center for Coastal Resources Management (CCRM), Virginia	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management. 2019. Virginia Shoreline Inventory Database. Center for Coastal
Shoreline Erosion	Erosion Rates	Shoreline Evolution Database	https://www.vims.edu/research/departments/physical/programs/ssp/shoreline_evolution/index.php	Shoreline Studies Program (SSP), Virginia Institute of Marine Science (VIMS)	Map Viewer	2009	Unknown	Coastal Virginia	Yes	Hardaway, Jr., C.S., Milligan, D.A., & Wilcox, C.A. (2020). Shoreline Evolution GIS Database 1937-2017. Retrieved from VIMS, Shoreline Studies Program website www.vims.edu
Shoreline Erosion	Erosion Rates	Maryland Shoreline Changes - Baseline Changes	https://data.kmap.maryland.gov/datasets/maryland::maryland-shoreline-changes-baseline/about	Maryland Geological Survey	Map Viewer; GIS Data; Tabular Data	Varies	Unknown	Coastal Maryland	Yes	Not Provided

Shoreline Erosion	Erosion Rates	Maryland Shoreline Changes - Legacy Shoreline	https://data.imap.maryland.gov/datasets/b7dec9418668473c82002ee28e280eae_3/about	Maryland Geological Survey	Map Viewer; GIS Data; Tabular Data	Varies	Unknown	Coastal Maryland	Yes	Not Provided
Shoreline Erosion	Soil Data	Web Soil Survey	https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm	NRCS (USDA)	Map Viewer; GIS Data; Tabular Data	Varies	Varies	National	Yes	Not Provided
Shoreline Erosion	Sediment Loading	Recommendations of the Expert Panel to Define Removal Rates for Shoreline	https://www.chesapeakebay.net/channel_files/21151/attachment_c--uuww_shoreline_manag	Urban Stormwater Work Group, Chesapeake Bay Partnership	Report	2010	Not Applicable	Maryland and Virginia	Yes	Cerco, Carl F., Sung-Chan Kim, and Mark R. Noel. 2010. The 2010 Chesapeake Bay Eutrophication Model: A report to the US EPA CBPO and to the USACE Baltimore
Shoreline Erosion	Bank Height	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002-2021	1:12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php
Shoreline Erosion	Bank Height	Delaware Shoreline Inventory - Rehoboth	https://www.vims.edu/ccrm/research/inventor	Center for Coastal Resources Management	GIS Data	2012	1:12,000	Delaware - Rehoboth Bay	Yes	Berman, M., Killeen, S., Hershner, C., Nunez, K., Reay, K., Angstadt, K.,
Shoreline Erosion	Bank Height	Delaware Shoreline Inventory - National Estuarine Research Reserve Sites	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine	GIS Data, online viewer, summary tables	2007	1:12,000	Delaware (Appoquinimink River, Blackbird Creek, St Jones River)	Yes	Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory:
Subsidence Rates	Subsidence-Bay wide	Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region	http://dx.doi.org/10.3133/cir1392	USGS	Report with Map	2013	Coarse but varies by data source	Chesapeake Bay	Yes	Eggleston, Jack, and Pope, Jason, 2013, Land subsidence and relative sea-level rise in the southern Chesapeake Bay region: U.S. Geological Survey Circular 1392, 30 p., http://dx.doi.org/10.3133/cir1392
Subsidence Rates	Subsidence	Toward Sustained Monitoring of Subsidence at the Coast Using InSAR and GPS: An Application in Hampton Roads, Virginia	https://digitalcommons.odu.edu/ccpo_data/1/	Geophysical Research Letters	Open access publication	2020	30 meter	Hampton Roads, VA	Yes	Buzzanga, B., Bekaert, D. P. S.,Hamlington, B. D., & Sangha, S. S.(2020). Toward sustained monitoring of subsidence at the coast using Insured GPS: An application in Hampton Roads, Virginia. Geophysical Research Letters, 47, e2020GL090013. https://doi.org
Surface Elevation Table Distribution	Coastal Wetlands	Chesapeake Bay Sentinel Site Cooperative SET Inventory	http://chesapeakebayss.org/maps/	Maryland Sea Grant/NOAA	Map Viewer and GIS Data	Varies	NA	Chesapeake Bay and coastal bays	Yes	Not Provided
Suspended Sediments	Sediment	Input and Predictions from a suspended-sediment SPARROW model CBSS V2 in the Chesapeake Bay watershed	https://data-chesbay.opendata.arcgis.com/datasets/input-and-predictions-from-a-suspended-sediment-sparrow-model-cbss-v2-	USGS	GIS Data	2002	NA	Chesapeake Bay	Yes	Brakebill, J.W., Ator, S.W., and Sekellick, A. J., 2019. Input and predictions from a suspended-sediment SPARROW model CBSS_V2 in the Chesapeake Bay watershed: U.S. Geological Survey data release

Suspended Sediments	Turbidity	Virginia Estuarine and Coastal Observing System (VECOS)	http://vecos.vims.edu/	Chesapeake Bay National Estuarine Research Reserve (CBNERR)	Tabular Data	Varies	Unknown	Virginia Chesapeake Bay and Tributaries	Yes	Not Provided
Suspended Sediments	TSS (Total Suspended Solids)	Chesapeake Bay Program Monitoring Data Includes Chesapeake Bay Program Water Quality Database (1984-present)	https://www.chesapeakebay.net/what/data	Chesapeake Bay Program	Tabular Data	Varies	Unknown	Chesapeake Bay	Yes	Not Provided
Topographic and Topobathy Data	Bathymetric Data	Topobathymetric Lidar	https://data.noaa.gov/onestop/	NOAA	GIS Data	Varies	Varies	National	Yes	Not Provided
Topographic and Topobathy Data	Elevation Data	Topographic Lidar	https://prd-tnm.s3.amazonaws.com/LidarExplorer/index.html	USGS	GIS Data	Varies	Varies	National	Yes	Not Provided
Type and Extent of Shoreline Alterations	Living Shorelines	VMRC Habitat Management Permits and Applications	https://webapps.mrc.virginia.gov/public/habitat/	Virginia Marine Resources Commission (VMRC)	Online web viewer	1970 to present	Not Applicable	Virginia	Yes	Virginia Marine Resources Commission (VMRC). 2021. Habitat Management Permits and Applications. Virginia Marine Resources Commission, Newport News, Virginia.
Type and Extent of Shoreline Alterations	Living Shorelines	CCRM Shoreline Permit Database	NA	Center for Coastal Resources Management (CCRM) at the Virginia Institute of Marine Science (VIMS)	Tabular Data	1970-present	Not Applicable	Coastal Virginia	No	Center for Coastal Resources Management (CCRM). 2020. Shoreline Permit Database. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.
Type and Extent of Shoreline Alterations	Living Shorelines	MDE Wetland and Waterways Permits - Watershed Resources Registry	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Online map viewer; GIS Data	Varies	Not Applicable	Maryland	Yes	Not Provided
Type and Extent of Shoreline Alterations	Living Shorelines	A Tour of Living Shorelines in Delaware	https://dnrec.maps.arcgis.com/apps/Mapjournal/index.html?appid=371a244682084370a78d0a54c5edb27a	Delaware Living Shorelines Committee	Story Map	Projects constructed around 2014-2016	Not Applicable	Coastal Delaware	Yes	A Tour of Living Shorelines in Delaware (2016). Story Map. Delaware Living Shorelines Committee. https://dnrec.maps.arcgis.com/apps/Mapjournal/index.html?appid=371a244682084370a78d0a54c5edb27a.
Type and Extent of Shoreline Alterations	Living Shorelines	Watershed Resources Registry - MDE Wetland and Waterways Permits	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Map viewer; export Tabular Data	Unknown	NA	Maryland	Yes	MDE Wetland and Waterways Permits (2021). Watershed Resources Registry Map Viewer. Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

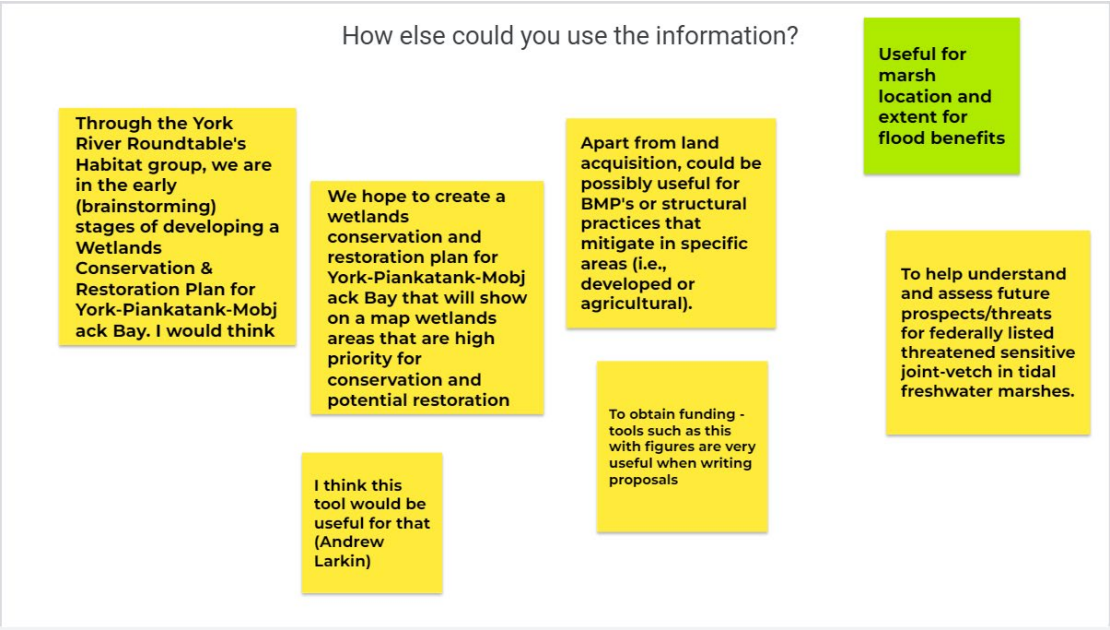
Type and Extent of Shoreline Alterations	Living Shorelines	Living Shorelines - Beaches & Dunes	https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=92e2148aa11e4216e21012ae1b2413e3%20	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	Story Map	2018; updated 2020	Not Applicable	Coastal Virginia	Yes	Center for Coastal Resources Management (2020). Story Map. Living Shorelines: Beaches and Dunes. Virginia Institute of Marine Science. https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=92e2148aa11e4216a21012ae1b2413e3%20
Type and Extent of Shoreline Alterations	Living Shorelines	Living Shorelines: Marshes and Oysters	https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=0132309272c44ffeb61cac08ae07798f	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	Story Map	2018; updated 2020	Not Applicable	Coastal Virginia	Yes	Center for Coastal Resources Management (2020). Story Map. Living Shorelines: Beaches and Dunes. Virginia Institute of Marine Science. https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=0132309272c44ffeb61cac08ae07798f
Type and Extent of Shoreline Alterations	Living Shorelines	SAGE Searchable Project Database	http://sagecoast.org/info/sagesearch.html	SAGE (Systems Approach to Geomorphic Engineering)	Searchable Online Database	Updated to 2016	NA	Atlantic Coast	Yes	Not Provided
Type and Extent of Shoreline Alterations	Hardened Shoreline	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/virginia/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	Center for Coastal Resources Management. 2021. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from https://www.vims.e
Type and Extent of Shoreline Alterations	Hardened Shoreline	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data	Locality based series 2002-2006	Scale 1:12,000	Coastal Maryland	Yes	Center for Coastal Resources Management. 2021. Maryland Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from http://https://www
Type and Extent of Shoreline Alterations	Hardened Shoreline	Delaware Shoreline Inventory - Indian River Watershed	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	Online Viewer; GIS Data; Summary Tables	Series of phases beginning in 2005	1:12,000	Delaware - Indian River Watershed	Yes	O'Brien, D.L., Jacobs, A., Berman, M.R., Rudnicky, T., McLaughlin, E., Howard, A., 2007. Refinement and validation of a multi-level assessment method for Mid-Atlantic tidal wetlands. Center for Coastal Resources Management, Virginia Institute of Marine Sc
Type and Extent of Shoreline Alterations	Hardened Shoreline	CCRM Shoreline Permit Database	NA	Center for Coastal Resources (CCRM), Virginia Institute of Marine Science (VIMS)	Tabular Data	1970-present	NA	Coastal Virginia	No	Center for Coastal Resources Management (CCRM). 2017. Shoreline Permit Database. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.
Type and Extent of Shoreline Alterations	Hardened Shoreline	VMRC Habitat Management Permits and Applications	https://webapps.mrc.virginia.gov/public/habitat/	Virginia Marine Resource Commission (VMRC)	Online viewer with tabular data download option	Approximately 1970 to present	Not Applicable	Virginia	Yes	Virginia Marine Resources Commission (VMRC). 2021. Habitat Management Permits and Applications. Virginia Marine Resources Commission, Newport News, Virginia.
Type and Extent of Shoreline Alterations	Shoreline Defense Structure Permits	VIMS Shoreline Permit Records Website Database	http://ccrm.vims.edu/perms/newpermits.html	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS); Virginia Marine Resources Commission (VMRC)	Searchable online database	1971-2015	Not Applicable	Coastal Virginia	Yes	VIMS Shoreline Permit Records Website Database (2015). Website database. Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science. William & Mary, Gloucester Point, VA.

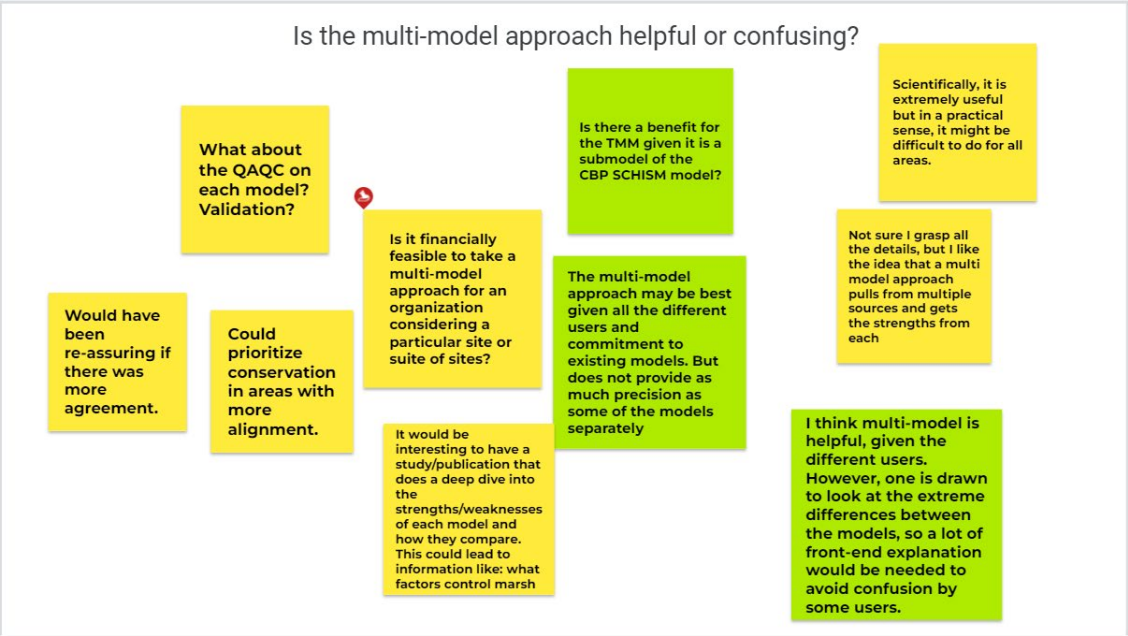
Type and Extent of Shoreline Alterations	Hardened Shoreline	Delaware Permit Search	http://www.nav.dnrec.delaware.gov/den3/Search/PermitSearch.aspx	Delaware Dept of Natural Resources and Environmental Control	Searchable Records	Varies	NA	Delaware	Yes	Permit Search (2021). Permit Search Website. Delaware.gov. http://www.nav.dnrec.delaware.gov/den3/Search/PermitSearch.aspx?issueStartDate=&issueEndDate=&expirationStartDate=&expirationEndDate=&type=30&status=F&pitypeid=89
Type and Extent of Shoreline Alterations	Hardened Shoreline	Delaware Shoreline Inventory - National Estuarine Research Reserve Sites	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)	GIS Data, online viewer, summary tables	2007	1:12,000	Delaware (Appoquinimink River, Blackbird Creek, St Jones River)	Yes	Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory: Rehoboth Bay, SRAMSOE #435, Comprehensive Coastal Inventory Program, Center for Coastal Resources Ma
Type and Extent of Shoreline Alterations	Hardened Shoreline	Delaware Shoreline Inventory - Rehoboth Bay	https://www.vims.edu/ccrm/research/inventory/delaware/index.php	Center for Coastal Zone Management (CCRM), Virginia Institute of Marine Science (VIMS), William & Mary	GIS Data, online viewer, summary tables	2012	1:12,000	Delaware - Rehoboth Bay	Yes	Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory: Rehoboth Bay, SRAMSOE #435, Comprehensive Coastal Inventory Program, Center for Coastal Resources Ma
Type and Extent of Shoreline Alterations	Hardened Shoreline	MDE Wetland Waterways Permits - Watershed Resources Registry	https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on	Maryland Department of the Environment	Map Viewer and GIS Data	Varies	NA	Maryland	Yes	MDE Wetland Waterway Permits (2021). Map viewer and GIS data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on
Type and Extent of Shoreline Alterations	Beach Nourishment	National Beach Nourishment Viewer	https://beachnourishment.wcu.edu/oneState?state=VA	NOAA Office for Coastal Management, Program for the Study of Developed Shoreline	Online viewer (table, chart and map); Tabular Data	1923-2019	Unknown	National	Yes	Not Provided
Type and Extent of Shoreline Alterations	Beach Nourishment	National Beach Nourishment Database	https://glm2.aptim.com/ASBPANationwideRenou	NOAA, American Shore and Beach Preservation	Map Viewer; GIS Data	1951-2020	Unknown	National	Yes	Elko, N., Briggs, T.R., Benedet, L., Robertson, W., Thomson, G., Webb,
Type and Extent of Shoreline Alterations	Hardened Shoreline	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia	GIS Data	Locality based series from 2002 - 2006	Scale 1:12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of
Type and Extent of Shoreline Alterations	Access Structures	Maryland Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/maryland/index.php	Center for Coastal Resources Management (CCRM), Virginia	GIS Data	Locality based series from 2002-2021	1:12,000	Coastal Maryland	Yes	Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of
Type and Extent of Shoreline Alterations	Living Shorelines	Virginia Shoreline Inventory	https://www.vims.edu/ccrm/research/inventory/index.php	Center for Coastal Resources Management (CCRM), Virginia	GIS Data	Locality based series from 2002 - 2021	Scale 1:1,000	Coastal Virginia	Yes	enter for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of
Type and Extent of Shoreline Alterations	Living Shorelines	TNC Coastal Resilience Map portal	https://maps.coastalresilience.org/virginia/#/living	The Nature Conservancy	Map Viewer	Varies	Unknown	Virginia's Eastern Shore	Yes	Not Provided

Appendix 3: Stakeholder meeting outputs

Additional comments:

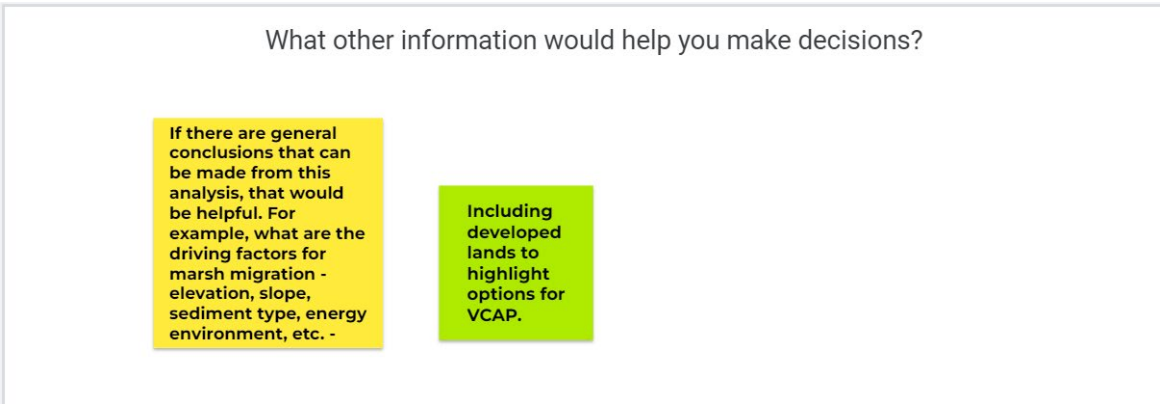
- The multi-model approach may be best given all the different users and commitment to existing models but does not provide as much precision as some of the models separately.
- Although the multi-model approach may be less precise, we don't know which of the models is "right", so there is no reason to consider it less accurate.





Additional Comments:

- I do like the Multi model approach and have used that quite a bit in my own work, one thing I wonder if you know about these models is has there been work done to show whether the models are actually doing well and in what different environments they may or may not do well.
- Is there a benefit of the TMM, given it is a sub-model of the CBP SCHISM model?



Appendix 4: Metadata sheets

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Assessments of Marsh Resilience

Category Tidal Marsh Resilience

Data Name: **Tidal Marsh Resilience to Sea Level Rise**

Data Source: NOAA - Digital Coast

Data Type: GIS Data **Resolution:** 12-digit watersheds

Geography Covered: Coastal watersheds - Nationwide

Date Range of Data 2016

Overview:

Welcome to DEN's new map selection page. From here you will be able to select from a growing list of maps to help you find the information you are looking for. Each map has a short description explaining what specific type of data it holds. This will help in narrowing down the types of sites available on each map to allow for easier and more targeted searching.

Methodology:

Metadata: marsh_resilience_slr_national_2010.xml

Available online? Yes

Data Link: https://coast.noaa.gov/digitalcoast/data/marshresilience.html

Citation:

NOAA Office for Coastal Management, National Estuarine Research Reserve System (2021). https://coast.noaa.gov/digitalcoast/data/marshresilience.html

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Assessments of Marsh Resilience

Category Vertical accretion and elevation change rates

Data Name: **Paper: Overestimation of marsh vulnerability to sea level rise**

Data Source: Journal - Nature Climate Change

Data Type: Peer-reviewed article **Resolution:** Not Applicable

Geography Covered: United States, Canada, United Kingdom, France, and Spain

Date Range of Data 2016

Overview:

179 unique measurements of accretion or elevation change from the US, Canada, the UK, France and Spain. Meta-analysis suggests that the mean rate of elevation change for high elevation marshes is 3.0 mm yr−1, and 6.9 mm yr−1 for low-elevation.

Methodology:

Meta-analysis

Available online? Yes

Data Link: https://www.nature.com/articles/nclimate2909

Citation:

Kirwan, M., Temmerman, S., Skeehan, E. et al. Overestimation of marsh vulnerability to sea level rise. Nature Climate Change 6, 253–260 (2016). https://doi.org/10.1038/nclimate2909

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Assessments of Marsh Resilience

Category Marsh Migration

Data Name: **NOAA Digital Coast - Sea Level Rise Viewer**

Data Source: NOAA

Data Type: GIS Data

Resolution: DEM: 3 meters

Geography Covered: National

Date Range of Data 2015

Overview:

Web mapping tool to visualize impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). Photo simulations of how future flooding might impact water depth, connectivity, flood frequency, wetland loss and migration.

Methodology:

https://coast.noaa.gov/data/digitalcoast/pdf/slr-inundation-methods.pdf

Available online? Yes

Data Link: https://coast.noaa.gov/digitalcoast/tools/slr.html

Citation:

NOAA Office for Coastal Management. Sea Level Rise Viewer

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Data Infrastructure to Assess Marsh Resilience

Category Coastal Wetlands

Data Name: **Chesapeake Bay Sentinel Site Cooperative Data & Infrastructure Inventory**

Data Source: NOAA/ Maryland Sea Grant/ MD DNR

Data Type: Report **Resolution:** NA

Geography Covered: Sentinel Sites around the Chesapeake Bay

Date Range of Data May 2017

Overview:

Each Chesapeake Bay Sentinel site collects long-term data on marsh elevations, water levels, water quality,emergent vegetation and weather.

Methodology:

Emergent Vegetation Scientists measure plant traits such as height, percent cover, stem density and biomass to understand how wetland vegetation responds to changing sea levels. Vegetation is often seen as a key indicator of marsh health and integrity. All of the founding sentinel sites within the Cooperative have emergent vegetation plots. Exact number of plots were not captured by the inventory, only estimations were provided. Each sentinel site contains between 60 and 200 plots; totaling more than 1,200 vegetation plots. Vegetation monitoring has a long history with monitoring dating back to 1987 at SERC and 1999 at the VCRLTER. The sampling frequency and aspects measured varies across the sites, as highlighted by Table 11. Table 11. Sampling Frequency of emergent vegetation and aspects measured Uses of Emergent Vegetation Data In order to understand the management implications of emergent vegetation data, sentinel sites were asked to list up to 5 past, current, or intended uses of emergent vegetation data. Table 12 outlines these uses. The most common use, as indicated by the survey results, is in the identification of shifts in the vulnerability of species composition due to changes in sea level.

Available online? Yes

Data Link: http://chesapeakebayssc.org/wp-content/uploads/2018/08/CBSSC_DataInfrastructureSummaryReport_FINAL.pdf

Citation:

Cahoon, Don, D.J. Reed, A.S. Kolker, M.M. Brinson, “Coastal Wetland Sustainability”, Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region, Chapter 4, U.S. Climate Change Science Program, Synthesis and Assessment Product 4.1. 2009. Wilkins, Sarah & A, Phelps "Chesapeake Bay Sentinel Site Cooperative Data & Infrastructure Inventory Summary Report" Maryland Sea Grant. 2017.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Assessments of Marsh Resilience

Category Coastal Wetlands

Data Name: **An Unvegetated to Vegetated Ratio (UVVR) for coastal wetlands of the Conterminous United States (2014-2018)**

Data Source: USGS

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Atlantic Coast

Date Range of Data 2014-2018

Overview:

These datasets are provided as objective and consistent means to help evaluating geomorphic status and vulnerability of coastal wetlands at a national scale. Specifically, the unvegetated to vegetated marsh ratio (UVVR) is useful for establishing vegetative cover status and for tracking changes in the status of salt marshes at the national scale annually.

Methodology:

This USGS Data Release represents geospatial data sets which were created to produce an Unvegetated to Vegetated Ratio (UVVR) for coastal wetlands of the conterminous United States (2014-2018). The following listed image products were generated 1) Annual spatial datasets (rasters) from 2014 to 2018 each containing 4 bands (Band 1: Unvegetated land fraction; Band 2: Vegetated land fraction; Band 3: Water fraction; Band 4: UVVR clipped into 3 coastal regions (Atlantic (ATL) Gulf of Mexico (GOM) and Pacific (PAC). 2) Calibration/Validation Datasets - datasets which were used in the calibration and validation of the above datasets 3) Mean of masked, multiyear composite - Mean vegetated fraction in coastal wetlands in each region 4) Standard deviation of masked, multiyear composite - Standard deviation of the vegetated fraction in coastal wetlands in each region 5) Unvegetated to Vegetated Ratio (UVVR) based on masked, multiyear composite - Unvegetated to Vegetated Ratio in coastal wetlands in each region The data release was produced in compliance with the new 'open data' requirements as a way to make the scientific products associated with USGS research efforts and publications available to the public.

Available online? Yes

Data Link: https://www.sciencebase.gov/catalog/item/5fa18656d34e198cb793cba5

Citation:

Couvillion, B.R., Ganju, N.K., and Defne, Z., 2021, An Unvegetated to Vegetated Ratio (UVVR) for coastal wetlands of the Conterminous United States (2014-2018): U.S. Geological Survey data release, https://doi.org/10.5066/P97DQXZP.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Targeted Ecological Areas

Data Name: **Watershed Resources Registry - Targeted Ecological Areas**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Unknown

Overview:

Targeted Ecological Areas (TEAs) are lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR) for natural resource protection. These areas represent the most ecologically valuable areas in the State: they are the "best of the best." Targeted Ecological Areas (TEA) are preferred for conservation funding through Stateside Program Open Space. This version updates the 2008 TEA layer. Lands that were developed, as identified by the Maryland Department of Planning (2010) were removed from the TEA layer since developed lands are not preferred for Stateside Program Open Space funding. Additionally, lands that are in the 0 foot to 2 foot inundation zone based on the 2011 SLAMM (Maryland Sea-Level Affecting Marshes Model) study performed for all 16 coastal counties and Baltimore City since these areas are not preferred for Stateside Program Open Space funding.

Methodology:

The first step in updating TEAs was to create an ecological baseline composed of several ecological databases and updates of the original databases. The componets include the updated Green Infrastructure Assessment (circa 2010) which identifies large, contiguous blocks (hubs) of significant forests and wetlands and their connecting corridors, the rare species and wildlife habitat component, the aquatic life hotspots component, the water quality protection component identifies sensitive lands such as forests, wetlands, and steep slopes, the coastal ecosystems component (areas important for sustaining coastal and tidal ecosystems and also identifies land areas important for sustaining spawning and nursery areas for important commercial and recreational fisheries), and the climate change adaptation component identifies areas important for sustaining wetlands ecosystems that are changing and moving landward in response to sea level rise. From the ecological baseline, areas that ranked as most important for each of the components were merged to create the Targeted Ecological Areas.

Available online? Yes

Data Link: http://mdewin64.mde.state.md.us/ECollaboration/SearchPortal.aspx

Citation:

Watershed Resources Registry (2021). Targeted Ecological Areas. Maryland Department of the Environment.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Conserved Lands

Data Name: **Virginia Conservation Lands Database**

Data Source: Virginia Department of Conservation and Recreation (VA DCR), Division of Natural Heritage

Data Type: GIS Data **Resolution:** NA

Geography Covered: Virginia

Date Range of Data 1998-Sept 2020. The database is constantly being edited and updated.

Overview:

Statewide GIS coverage of Conservation Lands in Virginia to serve as a land conservation planning tool. DCR began digitally mapping the boundaries for agency owned and managed State Parks and State Natural Area Preserves in 1998. In August of 1999, the Department of Technology Planning designated DCR as the lead agency in developing the Commonwealth's state-wide Conservation Lands Database. Since this mandate, the database has grown to include state, federal, private, and locally managed lands and conservation easements. DCR is also responsible for tracking Virginia's progress toward several important land conservation goals.

Methodology:

Compiled by VA-DCR Natural Heritage using tabular and spatial data submitted by many data providers in VA. GIS boundaries for conservation lands are acquired in digital form when available, from state and federal land management agencies and localities. DCR State Park and State Natural Area Preserve boundaries were created in-house from best available sources, including digital surveys. Boundaries for many locally owned and managed conservation lands were created by DCR staff using a variety of maps and other sources. The methods of digital boundary creation, and the resulting accuracy, are dependent on the mapping sources available at the time a boundary is created. Several attribute fields are included in the downloaded data that note the original format, accuracy, and origin of individual boundaries. This land conservation information is gathered from many sources on a monthly basis and managed within a geospatial and tabular Managed Areas Database. DCR includes these lands in the Conservation Lands Database as soon as an accurate boundary can be delineated. The Conservation Lands Database is constantly being edited and updated. Data is released to the public quarterly and posted to the download section of the DCR website.

Available online? Yes

Data Link: https://www.dcr.virginia.gov/natural-heritage/cldownload

Citation:

Conservation Lands Database (2020). Virginia Department of Conservation and Recreation, Division of Natural Heritage.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Forest Conservation Lands

Data Name: **Forest Conservation Value**

Data Source: Virginia Department of Conservation and Recreation (DCR) and Virginia Department of Forestry (VDOF)

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Virginia

Date Range of Data 2020

Overview:

The Forest Conservation Value (FCV) model is a tool designed by the Virginia Department of Forestry (VDOF) to strategically identify the highest priority forestland for conservation in Virginia. The intent is to maximize the efficiency of limited resources by focusing conservation efforts on the highest quality, most productive, and most vulnerable forestland statewide.

The FCV is further intended to contribute to the Virginia Conservation Vision, the suite of GIS models maintained by the Virginia Department of Conservation and Recreation (DCR) to inform a cohesive, statewide strategy for land conservation.

Methodology:

The original Forest Conservation Value (FCV) model was developed in 2013 by the VDOF. In 2017, VDOF's Forestland Conservation Program implemented a new conservation ranking and prioritization system designed to identify the highest priority projects on a quarterly basis; the FCV is a key component of this ranking system. The 2018 model applied a completely new approach, with different criteria, methodology, and datasets selected for the analysis than were used in 2013. In 2020 the model was updated again with more recent data for Conserved Lands and SSURGO soils, and with multi-year data from the National Land Cover Dataset (NLCD). The multi-year NLCD allowed development of a more accurate forest cover dataset based on a pattern of productive forest landuse over time rather than the landcover class from a single year. The 2020 model replaces the 2018 version and direct comparison among versions is not recommended. The 2020 FCV model evaluates criteria to prioritize the highest value forestlands for conservation. The model ranks all forestland in Virginia from 1 (lowest) to 5 (highest) FCV.

Available online? Yes

Data Link: https://www.dcr.virginia.gov/natural-heritage/vaconvisforest

Citation:

Biasiolli, K., J. Pugh, and M. Santucci. 2020. Forest Conservation Value Model, 2020 Edition. Virginia Department of Forestry, Charlottesville, VA, USA.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Natural Areas

Data Name: **Delaware Natural Areas**

Data Source: Delaware Department of Natural Resources and Environmental Control (DNREC)

Data Type: GIS Data **Resolution:** NA

Geography Covered: Delaware

Date Range of Data 1978-present; updated August 5, 2021

Overview:

A geospatial data set depicting the current Natural Areas as identified by the Delaware Department of Natural Resources and Environmental Control.

Methodology:

In 1978, the State of Delaware enacted the Natural Areas Preservation System (7 Del. Code, Chapter 73) for the purpose of establishing an inventory of natural areas statewide and a system of nature preserves. A "natural area" as defined by the law is an "area of land or water, or of both land and water, whether in public or private ownership, which either retains or has reestablished its natural character (although it need not be undisturbed), or has unusual flora or fauna, or has biotic, geological, scenic or archaeological features of scientific or educational value. This data set depicts the current Natural Areas as identified by the Delaware Department of Natural Resources and Environmental Control.

Available online? Yes (Requires Username and Password)

Data Link: https://data.delaware.gov/Energy-and-Environment/Delaware-Natural-Areas/9be9-z9z2

Citation:

Delaware Natural Areas (2021).Data. Delaware Dept of Natural Resources and Environmental Control (DNREC).https://data.delaware.gov/dataset/Natural-Areas/aryx-uafh

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Land and Water Conservation Fund Investments

Data Name: **Delaware Land and Water Conservation Fund**

Data Source: State of Delaware

Data Type: GIS Data **Resolution:** NA

Geography Covered: Delaware

Date Range of Data Updated to October 23, 2020

Overview:

The shapefile represents lands where LWCF investments have been made. These lands must remain protected in perpetuity.

Methodology:

Administered by the National Park Service, the Land and Water Conservation Fund (LWCF) State Assistance Program was established in 1965 to provide matching grants to States and through States to local units of government, for the acquisition and development of public outdoor recreation sites and facilities. Since the origin of the LWCF program in 1965, over $3.7 billion has been apportioned to the 50 states for planning, acquisition, and development of outdoor recreation resources in the United States. LWCF-assisted parks are located in over 98 percent of counties in the United States. The income for the LWCF is provided largely from Outer Continental Shelf mineral receipts.

Available online? Yes

Data Link: https://opendata.firstmap.delaware.gov/datasets/delaware-land-and-water-conservation-fund/explore?location=39.128170%2C-75.417300%2C9.00

Citation:

Delaware Land and Water Conservation Fund (2020). Data. State of Delaware. https://opendata.firstmap.delaware.gov/datasets/delaware-land-and-water-conservation-fund/explore?location=39.128170%2C-75.417300%2C9.00

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Nature Preserves

Data Name: **Delaware Nature Preserves**

Data Source: Delaware Department of Natural Resources and Environmental Control Division of Parks and Recreation

Data Type: GIS Data **Resolution:** NA

Geography Covered: Delaware

Date Range of Data Updated August 5, 2021

Overview:

Lands that are preserved under the designation of Nature Preserve.

Methodology:

This polygon coverage geographically indicates those lands that are preserved under the designation of Nature Preserve. These lands may be part of other protected lands under other designation. The key characteristic is that these lands are dedicated Nature Preserves. Data is used for general mapping purposes, land acquisition analyses, statistical calculations for reports, development of management and landuse plans, and environmental assessments.

Available online? Yes

Data Link: https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-nature-preserves/about

Citation:

Delaware Nature Preserves (2020). Data. Delaware Department of Natural Resources and Environmental Control Division of Parks and Recreation. https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-nature-preserves/about or https://data.delaware

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Public Protected Lands

Data Name: **Delaware Public Protected Lands**

Data Source: Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Parks and Recreation

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Delaware

Date Range of Data updated to June 27, 2019

Overview:

The dataset is a compilation of federal, state, county, municipal, and privately managed protected lands that are open to public access; Publicly accessible Protected Lands throughout Delaware

Methodology:

The Outdoor Recreation Inventory (ORI) was originally created to track publicly owned lands within Delaware that are open for public recreation. The database has since been expanded to include all publicly and privately owned protected lands (Federal, State, County, Municipal and private conservation) regardless of whether or not they are open to the public. A majority of the property boundaries are based on publicly accessible tax parcel data; however, boundaries for the Delaware State Parks are based on a combination of parcel data and land surveys.

Available online? Yes

Data Link: https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-public-protected-lands/about

Citation:

Delaware Public Protected Lands (2019). Data. Delaware Department of Natural Resources and Environmental Control, Division of Parks and Recreation. https://opendata.firstmap.delaware.gov/datasets/delaware::delaware-public-protected-lands/about

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Biodiversity Conservation Network

Data Name: **Biodiversity Conservation Network -Watershed Resources Registry -**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Unknown

Overview:

The Biodiversity Conservation Network (or BioNet) of Maryland layer systematically identifies and prioritizes ecologically important lands to conserve Maryland's biodiversity (i.e., plants, animals, habitats, and landscapes).

Methodology:

This dataset aggregates numerous separate data layers hierarchically according to the BioNet Criteria Matrix. These data were needed to maximize the influence and effectiveness of public and private conservation investments; promote shared responsibilities for land conservation between public and private sectors; and guide and encourage compatible land uses and land management practices.

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

Biodiversity Conservation Network (2021). Data. Watershed Resources Registry. Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category MD Critical Areas

Data Name: **MD Critical Areas - Watershed Resources Registry**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Unknown

Overview:

Maryland Critical Areas mapped

Methodology:

In 1984, the General Assembly enacted the Chesapeake Bay Critical Area Act to regulate development, manage land use and conserve natural resources on land in those areas designated as Critical Area. For this document, the Critical Area is all land and water areas within 1000 feet of the tidal waters' edge or from the landward edge of adjacent tidal wetlands and the lands under them. Georeferenced digital data files of the critical Area have been produced for Baltimore City and the 16 Maryland counties with land located within the Critical Area. The digital maps produced for each jurisdiction are polygons depicting the Critical Area and the land use classifications recognized by the Chesapeake Bay Critical Area Commission (CBCAC). Each jurisdiction is a separate file. The data were produced from hard copy parcel maps originally submitted by the counties as part of the requirements for developing their Critical Area Program. For the purpose of the MD iMAP web service the Critical Area Data is displayed by two data layers, one general layer and one layer showing the available critical area data for local towns.

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

Maryland Critical Areas (2021). Map viewer and Data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Protected Lands

Data Name: **Protected Lands - Watershed Resources Registry**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Varies

Overview:

Polygon boundaries of various protected lands throughout Maryland.

Methodology:

Polygon boundaries of various protected lands in Maryland including: DNR Owned Properties and Conservation Easements, Rural Legacy Properties, MD Environmental Trust Easements, Forest Conservation Act Easements, MD Agricultural Land Preservation Foundation Easements, Local Protected Lands, Coastal and Estuarine Land Conservation Program, Private Conservation Lands and Protected Federal Lands. Information on the number of acres protected in Maryland can be found on the Maryland Protected Lands Reporting site at http://dnrweb.dnr.state.md.us/gis/plreports/.

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

Protected Lands (2021). Map viewer and data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Conserved Lands

Category Conserved Lands

Data Name: **The GreenPrint Map**

Data Source: Maryland Department of Natural Resources (DNR)

Data Type: Online Map Viewer **Resolution:** NA

Geography Covered: Maryland

Date Range of Data updated to Dec 2018

Overview:

The GreenPrint map displays Targeted Ecological Areas (TEAs), lands and watersheds of high ecological value that have been identified as conservation priorities by the Maryland Department of Natural Resources (DNR).The GreenPrint map also displays information about four of Maryland's most active State operated land conservation programs: Program Open Space (POS) - Stateside, the Maryland Agricultural Land Preservation Foundation (MALPF), the Maryland Environmental Trust (MET), and the Rural Legacy Program.

Methodology:

The Green Infrastructure Assessment (GIA), based on principles of landscape ecology and conservation biology, identified an ecological network using satellite imagery to characterize land cover, Geographic Information System (GIS) data on road, stream, wetland and other resource features, and biological databases. The model and resulting maps were peer reviewed by scientists and local government staff. Non-natural gaps in the GI were identified as potential candidates for restoration activities. The Parcel Evaluation Tool provides a Conservation Benefits and Ecosystem Service Assessment Report Card for every land parcel in Maryland. Ecosystem service value does not equate to a Fair Market appraisal. The Report Card values reflect many of the ecological priorities established for Stateside Program Open Space (POS).

Available online? Yes

Data Link: https://geodata.md.gov/greenprint/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Salt Marsh

Data Name: **Maryland Salt Marsh - Salt Marsh**

Data Source: MD-DNR

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Maryland

Date Range of Data 1988-1995

Overview:

These digital data files are records of salt marsh location and extent as defined by the U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI) program.

Methodology:

In coastal Maryland these data were extracted from data mapped by Maryland Department of Natural Resources (MD DNR) using Maryland's Digital Orthophoto Quarter Quads. The wetlands were photo interpreted from the photography flown for the Digital Orthophoto Quarter Quads. These were flown over a period from 1988 to 1995. Outside of coastal Maryland these data were compiled by The Nature Conservancy from other National Wetlands Inventory data developed by USFWS.

Available online? Yes

Data Link: https://data.imap.maryland.gov/datasets/maryland::maryland-salt-marsh-salt-marsh/about

Citation:

MD iMAP Data Catalog (DOIT)

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Wetlands

Data Name: **National Wetlands Inventory (NWI)**

Data Source: U.S. Fish and Wildlife Service

Data Type: Online map viewer; GIS Data **Resolution:** Data intended for use with base maps or imagery at a scal

Geography Covered: National

Date Range of Data 1977- 2017, Continuously being improved and new data added on a biannual basis

Overview:

Information on the status, extent, characteristics and functions of wetlands, riparian, and deep water habitats. Wetland type and extent are shown using a biological definition of wetlands. There is no attempt to define the limits of proprietary jurisdiction of any Federal, State, or local government, or to establish the geographical scope of the regulatory programs of government agencies. The Wetlands Mapper integrates a robust geosearch engine which allows users to search by place names, addresses and geographic coordinates, and it can leverage the GPS functionality of your device to zoom to your location. Basemaps provide a platform for the wetlands data, making it easier to visualize, understand and analyze. The Service's wetland and riparian data are graphic representations of the type, size and location of the wetlands, deep water or riparian habitats in the United States. It has been developed in collaboration with the U.S. Geological Survey (USGS).

Methodology:

The coverages use a shoreline basemap generated in-house from digital ortho quarter quadrangles (DOQQs) using photo-interpretation techniques. The shoreline is re-coded to reflect features and attributes observed in the field. The metadata file accompanies the coverages and defines attribute accuracy, data development, and any use restrictions that pertain to data. These data have been prepared from the analysis of high-altitude imagery in conjunction with collateral data sources and field work. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any site, may result in revision of the wetland boundaries of classification established through image analysis. The Service uses the Cowardin et al. 2nd Edition (2013) definition of wetland which represents a biological definition of wetlands and deep-water habitats. This definition is the standard for the agency and is the National Standard for wetland mapping, monitoring, and data reporting as determined by the Federal Geographic Data Committee in 2013. For the purposes of adapting the wetland classification system to map form, a series of letter and number codes has been developed. These alpha-numeric codes are used in the Wetlands Mapper and correspond to the classification nomenclature that best describes the habitat. Some wetland habitats may be underrepresented or excluded in certain areas because of the limitations of aerial imagery as the primary data source used to detect wetlands.

Available online? Yes

Data Link: https://www.fws.gov/wetlands/data/data-download.html

Citation:

National Wetlands Inventory (NWI) (2021). Data. U.S. Fish and Wildlife Service, Washington, D.C.https://www.fws.gov/wetlands/data/data-download.html.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Beaches

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

The Virginia Shoreline Inventory is a series of reports that describe the condition of tidal shorelines for individual localities in VA. It also includes contemporary digital inventory information using a combination of Geographic Information Systems (GIS), Global Positioning System (GPS), and remote sensing technology.

Methodology:

Beaches are coded as linear features to portray their spatial location only. The land water interface for beach environments is delineated between the dry beach and wet beach (if present) or the dry beach and the shallow water (if wet beach is not present). These parameters are delineated based on color signature; color explicit in the infra-red imagery where: dry beach is represented by “stark white,” and wet beach by “gray white.”

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Dunes

Data Name: **Lidar-derived beach morphology (dune crest, dune toe, and shoreline) for U.S sandy coastlines**

Data Source: USGS

Data Type: Tabular Data **Resolution:** Varies

Geography Covered: Virginia, Maryland, Delaware

Date Range of Data 1998-2020

Overview:

The USGS National Assessment of Coastal Change Hazards project aims to identify areas of the nation's coastline that are most vulnerable to extreme storms and long-term shoreline change. These assessments require coastal elevation data across diverse geographic regions and covering a time span of many years. The datasets published here, organized by individual field activity numbers (FANs), define the dune crest (denoted by DC in the feature type attribute), dune toe (denoted by DT in the feature type attribute), and shoreline (denoted by SL in the feature type attribute) at 10m intervals alongshore for each processed lidar elevation survey. Beach width and beach slope as calculated from dune toe to shoreline are also included at each shoreline location.

Methodology:

The Storm-Induced Coastal Change Hazards component of the National Assessment of Coastal Change Hazards project focuses on understanding the magnitude and variability of extreme storm impacts on sandy beaches. Lidar-derived beach morphologic features such as dune crest, toe and shoreline help define the vulnerability of the beach to storm impacts. This dataset defines the elevation and position of the seaward-most dune crest and toe and the mean high water shoreline derived from lidar survey. Beach width is included and is defined as the distance between the dune toe and shoreline along a cross-shore profile. The beach slope is calculated using this beach width and the elevation of the shoreline and dune toe.

Available online? Yes

Data Link: https://coastal.er.usgs.gov/data-release/doi-F7GF0S0Z/

Citation:

Doran, K.S., Long, J.W., Birchler, J.J., Brenner, O.T., Hardy, M.W., Morgan, K.L.M, Stockdon, H.F., and Torres, M.L., 2017, Lidar-derived beach morphology (dune crest, dune toe, and shoreline) for U.S. sandy coastlines (ver. 4.0, October 2020): U.S. Geology

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Natural and Nature-Based Features (NNBFs)

Data Name: **Coastal Natural and Nature-Based Features (NNBFs) Ranked: Co-Benefits for Coastal Buildings and Target Areas for the Creation of New or Restoration of NNBFs in Coastal Virginia**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** Varies

Geography Covered: Coastal Virginia - Lands at less than 10-feet

Date Range of Data 2021

Overview:

"Community resilience to storm-driven coastal flooding is improved with the presence of natural and nature-based features (NNBFs) such as wetlands, wooded areas, living shorelines, and beaches. These natural and created features can provide multiple benefits for a local community, including mitigating the impacts of storm surge and sea-level rise and allowing communities to take advantage of programmatic incentive programs like FEMA's Community Rating System and nutrient reduction crediting.As part of a NOAA-funded project NA17NOS4730142, an exportable geospatial protocol and NNBF ranking methodology was developed with the goal of incentivizing the protection and creation of NNBFs across Chesapeake Bay localities by highlighting the multiple benefits these features can provide, identifying target areas where new or restored NNBFs would benefit buildings that lack in benefits from existing NNBFs, and incorporating this information within existing online tools for local and state managers and regulators."

Methodology:

It is based on the Inundation Pathway (IP) Model. The IP Model utilizes the least cost path geoprocessing algorithms in ESRI's ArcGIS Pro. The IP Model approach identifies those NNBFs that provide flooding mitigation benefits to infrastructure-at-risk. IPs delineate the lowest elevation pathways that connect each building to nearby shorelines, and are based on detailed digital elevation models (DEMs). These IPs do not depict flooding inundation extents across the landscape, but identify the lowest-lying areas that flooding waters rising from the shoreline will likely flow through on approach to buildings and allow for the identification of those NNBFs that will intercept flooding waters.

Available online? Yes

Data Link: https://doi.org/10.25773/d9pv-gb12

Citation:

Mason, Pamela; Hendricks, Jessica; and Herman, Julie, "Coastal Natural and Nature-Based Features (NNBFs) Ranked: Co-Benefits for Coastal Buildings and Target Areas for the Creation of New or Restoration of NNBFs in Coastal Virginia" (2021). Data. William

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Maritime Forest

Data Name: **Coastal Maritime Forests in Virginia – Delineation and Distribution**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: Report with map

Resolution: 2 Feet

Geography Covered: Virginia

Date Range of Data 2007

Overview:

The project had two major goals. The first builds on an earlier effort by the Virginia Department of Forestry, who delineated maritime forests using remote sensing techniques. Their project integrated land use and soils data to generate a map that defines potential boundaries of maritime forest. This study follows an identical approach with two major exceptions. The first is the soils data used in this study is mapped at a much finer scale. The second is this study has a field validation component that reviewed random sites around selected locations to ground-truth the remote sensing output. The Virginia Department of Forestry provided staff support from various regional offices to perform all field work. Ancillary data such as soils and aerial imagery were also used where wetland and dune habitat could be distinguished. The second major goal of this project was to compute, on a county-by-county basis, the amount of maritime forest cover present in each coastal locality, and the extent of maritime forests located within conservation lands. Boundaries for conserved lands data from VA DCR were used.

Methodology:

Delineation was generated for each county or city evaluated by digitizing and editing boundaries according to field recommendations while using maritime forest soils and 2002 VBMP high resolution imagery (2 ft resolution) for guidance. ArcMap® was used and shape files were generated. A separate review by the VADCR Division of Natural Heritage indicated an absence of coverage on the eastern shore barrier islands. These were added to the final map compositions using comparable image processing techniques, but no field validation. Referenced survey data provided by Natural Heritage Program provided a comfortable level of ground-truthing

Available online? Yes

Data Link: https://scholarworks.wm.edu/cgi/viewcontent.cgi?article=1508&context=reports

Citation:

Berman, M., & Berquist, H. (2007) Coastal Maritime Forests in Virginia – Delineation and Distribution. Virginia Institute of Marine Science, William & Mary. https://doi.org/10.21220/V5Q71P

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Wetlands

Data Name: **Delaware Wetlands**

Data Source: Delaware Department of Natural Resources and Environmental Control (DNREC)

Data Type: GIS Data **Resolution:** NA

Geography Covered: Coastal Delaware

Date Range of Data Updated to June 21, 2021

Overview:

Data show the approximate boundaries and classifications of Delaware wetlands as interpreted from leaf-off color infrared aerial photography (1992, 2007, 2017). Statewide wetland maps are used for local and regional site-specific planning and management purposes and allow for status and trends assessments providing information on the type, amount, location and causes of wetland changes. The purpose of the data is to identify and map areas likely to be wetland on the landscape. Statewide wetland mapping is conducted to assess the aerial extent and functional benefits over time when new aerial imagery is available. Methods use the most current wetland mapping techniques while recognizing that land use, degree of wetness at the time, and availability of decision-supporting secondary spatial data can create variability in the data. This data should be used for guidance purposes only and is not considered regulatory.

Methodology:

Wetlands mapping utilizes a standardized wetlands classification scheme which was adapted from the U.S. Fish and Wildlife Service's National Wetlands Inventory (Cowardin, et al. 1979, and 2016 revision for 2017 data). The 1992 data was created by DNREC under contract with Photoscience, Inc. and Environmental Resource, Inc., and in partnership with the National Wetlands Inventory (NWI). The 2007 and 2017 map data were created by DNREC and completed under contract with Virginia Polytechnic Institute and University, Conservation Management Institute, and in coordination with NWI. Methods used meet or exceed NWI procedures and the guidelines of the Federal Geographic Data Committee's Wetland Mapping Standard (document FGDC-STD-015-2009). The 2017 wetlands are identified at a minimum mapping unit of .25 acres with smaller, highly recognizable polygons (e.g., ponds) mapped down to approximately 0.10 acres. Photo interpreters identified the wetland targets at a scale of approximately to 1:10,000 with delineations completed at 1:5,000 and, occasionally, larger as necessary. The 2017 mapping used the NWI 2.0 guidelines which incorporate hydrography spatial data (National Hydrography Dataset – NHD) along with wetlands data.

Available online? Yes

Data Link: https://enterprise.firstmap.delaware.gov/arcgis/rest/services/Hydrology/DE_Wetlands/FeatureServer/6

Citation:

Delaware Wetlands (2021). Vector Polygon Data. Delaware Department of Natural Resources and Environmental Control. https://enterprise.firstmap.delaware.gov/arcgis/rest/services/Hydrology/DE_Wetlands/FeatureServer/6

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Tidal Wetlands

Data Name: **Delaware Regulated Tidal Wetlands Index**

Data Source: Delaware Dept of Natural Resources and Environmental Control (DNREC)

Data Type: Online Map viewer; downloada **Resolution:** NA

Geography Covered: Coastal Delaware

Date Range of Data Varies

Overview:

Aerial map with index boxes to select older aerial photos with Tidal Wetland Delineation information

Methodology:

Aerial photos with Tidal Wetland Delineation Information in a map view.

Available online? Yes

Data Link: https://dnrec.alpha.delaware.gov/water/wetlands-subaqueous/state-regulated-wetlands/

Citation:

State Regulated Wetlands Map Index (2021). Web map. Delaware.gov. https://dnrec.alpha.delaware.gov/water/wetlands-subaqueous/state-regulated-wetlands/

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Wetlands

Data Name: **Virginia Wetlands Catalog**

Data Source: Virginia Department of Conservation and Recreation, Division of Natural Heritage

Data Type: GIS Data

Resolution: Varies

Geography Covered: Virginia

Date Range of Data 2014

Overview:

The Virginia Wetlands Catalog (VWC) is an inventory of wetlands and potential wetlands with prioritization summaries for conservation and restoration purposes by parcel, subwatershed, and wetland boundaries. The VWC can be used to prioritize wetlands, parcels, and subwatersheds for conservation or restoration purposes, to inform project-design processes to make them more efficient, to assess impacts of proposed projects, and to identify possible mitigation sites. The primary funder of the VWC, the U.S. Department of Agriculture--Natural Resources Conservation Service (NRCS), Virginia State Office, uses the catalog for ranking wetlands for values related to wildlife habitat and water quality and for conserving wetlands under the Wetland Reserve Easement (WRE) program.

Methodology:

The first step was to develop a wetlands and associated features layer by combining wetlands, potential wetlands, floodplains, and streams from the National Wetlands Inventory, the National Hydrography Dataset, the Digital Flood Insurance Rate Map Database, and the Soil Survey Geographic Database. The next step was to attribute this layer with information for ranking wetlands for either conservation or restoration purposes. The conservation attributes included weighted information pertaining to plant and animal biodiversity, significant natural communities, natural lands that provide ecosystem services, natural corridors and stream buffers, proximity to conserved lands, relatively clean watersheds, and drinking water sources. Several of these attributes were reused as restoration attributes, albeit with some weight modifications, with the addition of information related to degraded watersheds, impaired waters, prior converted and agricultural wetlands, and stream reaches with relatively low aquatic biodiversity that potentially could be restored. Information pertaining to parcels, subwatersheds, existing mitigation banks, and development was added for reference and summary uses.

Available online? Yes

Data Link: https://www.dcr.virginia.gov/download-files-registration?2015-04-21-20-46-35-315247-ey8

Citation:

Weber, J. T. and J. F. Bulluck 2014. Virginia Wetlands Catalog: An Inventory of Wetlands and Potential Wetlands with Prioritization Summaries for Conservation and Restoration Purposes by Parcel, Subwatershed, and Wetland Boundaries. Natural Heritage Techn

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Beaches

Data Name: **No Build Line - Bay**

Data Source: Delaware Department of Natural Resources and Environmental Control (DNREC)

Data Type: GIS Data **Resolution:** NA

Geography Covered: Coastal Delaware

Date Range of Data Updated to May 1, 2020

Overview:

Line designated by DNREC for restricting construction along the coast.

Methodology:

To ensure that beaches and dunes are able to perform their protective and recreational functions, construction must be kept off them. A Building Line has been established along the coast as part of the Regulations Governing Beach Protection and the Use of Beaches. The Building Line, which parallels the coastline, is designated on DNREC maps. No construction may take place seaward of the Line without a Coastal Construction Permit or Coastal Construction Letter of Approval from the Department of Natural Resources and Environmental Control(DNREC).

Available online? Yes

Data Link: https://firstmap-delaware.opendata.arcgis.com/datasets/delaware::no-build-points-bay/about

Citation:

No Build Line - Bay (2020). Data. Delaware Department of Natural Resources and Environmental Control (DNREC).https://firstmap-delaware.opendata.arcgis.com/datasets/Delaware::no-build-points-bay/about

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Barrier Islands

Data Name: **Virginia Eastern Shore Coastal Resilience Tool - Historic Shoreline Change Database**

Data Source: Data developed ‘‘in-house’’ or from well-known repositories, including University of Virginia, United States Geological Survey, and National Park Service.

Data Type: Online map viewer; GIS Data **Resolution:** Multiple spatial and temporal scales

Geography Covered: Virginia Barrier Islands

Date Range of Data 1849-2014

Overview:

Beaches and barrier islands are dynamic systems that move constantly in response to processes that erode,transport, and deposit sand. The Historical Data module of the Coastline Change app in the Coastal Resiliencetool uses a robust dataset that covers 165 years of observed shoreline changes along the Virginia barrierislands (including Assateague Island), allowing users to explore how much and in which direction these shorelines have changed over this time period. The Historical Data module in the Coastline Change app allows users to view two kinds of data: (1) the geographic location of past shorelines, and (2) the calculated change rates (in meters per year) for shorelines over short- and longer-term time ranges. Users can explore the historical shorelines by playing an animation that illustrates sequential shoreline locations over the years for which data exist or by manually selecting multiple shorelines to display side by side.

Methodology:

The data used to calculate the rate and direction of shoreline movement over a particular time period comefrom a variety of sources. These sources include aerial photographs taken perpendicular to the land surface(orthophotographs), beach surveys on the ground using Global Positioning System (GPS) technology or othersurvey technology (e.g., beach profiles), historical maps and T-sheets (nautical charts), and, more recently, airborneLight Detection and Ranging (LiDAR) technology. Most scientists agree that the high water line (HWL), i.e., the boundary between the wet and dry parts of a beach, is the best representation of a shoreline. However, maps, T-sheets, and LiDAR can use other reference lines as the shoreline (e.g., mean high water [MHW]; mean low low water [MLLW], etc.).

Available online? Yes

Data Link: maps.coastalresilience.org/virginia

Citation:

Virginia Eastern Shore Coastal Resilience Tool, Historic Shoreline Change Database (2014). University of Virginia, et al. https://maps.coastalresilience.org/virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Beaches

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** Scale 1:1,000

Geography Covered: Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

The Maryland Shoreline Inventory is a series of reports that describe the condition of tidal shorelines for individual localities in MD. It also includes contemporary digital inventory information using a combination of Geographic Information Systems (GIS), Global Positioning System (GPS), and remote sensing technology.

Methodology:

Beaches are coded as linear features to portray their spatial location only. The land water interface for beach environments is delineated between the dry beach and wet beach (if present) or the dry beach and the shallow water (if wet beach is not present). These parameters are delineated based on color signature; color explicit in the infra-red imagery where: dry beach is represented by “stark white,” and wet beach by “gray white.”

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Rivers and Streams

Data Name: **National Hydrography Dataset (NHD)**

Data Source: USGS

Data Type: GIS Data

Resolution: 1:24,000 (some states 1:36,360)

Geography Covered: National

Date Range of Data Varies

Overview:

The National Hydrography Dataset represents the water drainage network of the United States with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and stream gauges. The NHD is the most up-to-date and comprehensive hydrography dataset for the Nation.

Methodology:

NHD is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system.

Available online? Yes

Data Link: https://www.usgs.gov/core-science-systems/ngp/national-hydrography/national-hydrography-dataset?qt-science_support_page_related_con=0

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Wetlands

Data Name: **MD DNR Wetlands - Watershed Resources Registry**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Updated to 4/5/1995

Overview:

Polygon layer of National Wetland Inventory (NWI) wetlands in Maryland.

Methodology:

The Maryland Department of Natural resources began updating the National Wetlands Inventory (NWI) mapping of wetlands in Maryland in the early 1990s. This database lists the 3.75' x 3.75' USGS quadrangles for which 'DNR Wetlands' have been mapped. It identifies the date of source photography used to map wetlands, and the status of mapping effort. This database also gives the five-letter abbreviation used for naming 'DNR_Wetlands' files. In most cases, the first five characters are the first 'five characters' of the 'USGS 7.5' Quad Name.' When completed, the series will provide coverage for the entire State of Maryland. Last Updated: 04/05/1995

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

MD DNR Wetlands (1995). Map viewer and Data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

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Current as of: September 2022

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Wetlands

Data Name: **Wetlands Special State Concern - Watershed Resources Registry**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Updated to August 2017

Overview:

Polygons of wetlands with rare, threatened, endangered species or unique habitat receive special attention that required a 100 foot buffer from development

Methodology:

In Maryland certain wetlands with rare, threatened, endangered species or unique habitat receive special attention. The Code of Maryland Regulations (COMAR) Title 26, Subtitle 23, Chapter 06, Sections 01 & 02 identifies these Wetlands of Special State Concern (WSSC) and affords them certain protections including a 100 foot buffer from development. The Maryland Department of the Environment is responsible for identifying and regulating these wetlands. In general, the US Fish and Wildlife Service's National Wetlands Inventory wetlands provide the basis for identifying these special wetlands. Additional information, determined from field inspections, is used to identify and classify these areas. Last Updated: 08/2017

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

Wetlands Special State Concern (2017). Map viewer and data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Dunes

Data Name: **Chesapeake Bay Dune Systems: Monitoring**

Data Source: Shoreline Studies Program (SSP), Virginia Institute of Marine Science (VIMS)

Data Type: Report

Resolution: Not Applicable

Geography Covered: Chesapeake Bay

Date Range of Data 2005

Overview:

This study addresses the variable nature of dune systems around Chesapeake Bay in terms of shoreline change and developmental pressures. In order to better understand these issues, this study developed a Bay-wide monitoring program of selected dune sites. This program characterizes the seasonality of dune resources, performs biological assessments, and analyzes historical shoreline change for selected dune fields (with emphasis on secondary dunes). In addition, this study defines adjacent dune ecosystems that complement functions of coastal primary dunes (secondary dunes and dune fields).

Methodology:

The dune classification system is three tiered. The primary tier characterizes the level or type of human involvement in the dune system. These three categories (Natural, Man Influenced, or Man-Made) reflect how the state of the dune is most impacted. In addition the classification includes the parameters most influential in defining the status of a given dune system.

Available online? Yes

Data Link: https://www.vims.edu/GreyLit/VIMS/Shoreline%20Evol%20Reports/CBDuneSystems2005.pdf

Citation:

Milligan, D.A., Hardaway, Jr., C.S., Thomas, G. R., Varnell, L.M., Barnard, T. Reay, W., Comer, T. R., Wilcox, C.A., 2005. Chesapeake Bay Dune Systems: Monitoring Final Report. Virginia Institute of Marine Science, College of William & Mary, Gloucester

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Tree Fringe

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

Linear Tree Fringe features. The Virginia Shoreline Inventory is a series of reports that describe the condition of tidal shorelines for individual localities in the Commonwealth of Virginia. This inventory series started with historic reports produced in the 1970's. It also includes contemporary digital inventory updates generated from 1998 to the present using a combination of Geographic Information Systems (GIS), Global Positioning System (GPS), and remote sensing technology.

Methodology:

Tree fringe is coded as linear features to portray their spatial location only. The delineation of the tree fringe was conducted by using onscreen digitizing techniques at a scale of 1:1,000. Bing and Google Earth online imagery were used to provide additional interpretive information to improve the accuracy of marsh boundaries.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/virginia/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/virginia/index.php

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Virginia Institute of Marine Science
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Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Beaches Above High Water

Data Name: **Beaches Above High Water**

Data Source: Shoreline Studies Program (SSP), Virginia Institute of Marine Science (VIMS)

Data Type: Map viewer; Tabular Data **Resolution:** NA

Geography Covered: Coastal Virginia

Date Range of Data 2005-2006

Overview:

This data set was developed in order to determine the extent of supratidal beaches (beaches above mean high water) that are currently unregulated. Virginia's coastal localities that are outside the purview of the Dunes and Beaches Act (non-jurisdictional localities) were analyzed to determine the extent of their beaches. Under Virginia's current regulatory scheme, beaches above mean high water are regulated in only nine localities. Although it was known that a number of other coastal localities had beaches, there had never been an assessment of the extent or location of these beaches. In these localities development and the reduction in width of beaches threaten the erosion control and habitat values of beaches above mean high water. Several options for assuring better management of supratidal beaches outside of the nine Dune and Beach Act localities are currently under consideration. In order to adequately evaluate these options, it was determined that an assessment of non-jurisdictional supratidal beaches was needed.

Methodology:

Aerial video of the James River (Isle of Wight, Surry, and Prince George, Charles City, James City, and Newport News), the York River (York, New Kent, King William, King and Queen, and Gloucester), the Rappahannock River (Middlesex, Essex, and Richmond), and the Potomac River (Westmoreland, King George, and Stafford) was reviewed to determine the extent of beaches in each locale. Beaches were defined as sand above last high tide and contiguous to mean low water. Virginia's beaches in the non-jurisdictional localities were identified from the aerial video, and their locations input to a GIS database. Several attributes were collected from the video as well. These attributes include: whether the beach appears to natural, man-influenced, or man-made; its length; average width; time and stage of previous tide at the site; landward boundary condition; geomorphic setting; beach stability; underlying substrate; and a list of structures influencing the beach. About 550 miles of aerial video has been obtained for all of Virginia's non-jurisdictional localities except Portsmouth, Suffolk, and Poquoson.

Available online? Yes

Data Link: https://gaia.vcu.edu/GemsMap/?extent=-8622879.4296%2C4433048.7104%2C-8405492.5212%2C4530582.3585%2C102100&showLayers=CoastalWildlife_MIL1_1625_0%3BCoastalWildlif

Citation:

Virginia's Non-jurisdictional Beach Assessment (2006). Virginia Institute of Marine Science Shoreline Studies Program.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Wetlands

Data Name: **Maryland Wetlands (National Wetlands Inventory)**

Data Source: Maryland Department of Natural Resources (MD DNR - Maryland.gov)

Data Type: GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data September 27, 2017

Overview:

The Maryland Department of Natural resources began updating the National Wetlands Inventory (NWI) mapping of wetlands in Maryland in the early 1990s. This database lists the 3.75' x 3.75' USGS quadrangles for which 'DNR Wetlands' have been mapped. It identifies the date of source photography used to map wetlands, and the status of mapping effort. This database also gives the five-letter abbreviation used for naming 'DNR_Wetlands' files. In most cases, the first five characters are the first 'five characters' of the 'USGS 7.5' Quad Name.' When completed, the series will provide coverage for the entire State of Maryland.

Methodology:

This data set represents the extent, approximate location and type of wetlands and deep water habitats in the conterminous United States. These data delineate the areal extent of wetlands and surface waters as defined by Cowardin et al. (1979). Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and near shore coastal waters. Some deep water reef communities (coral or tubificid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery. By policy, the Service also excludes certain types of farmed wetlands as may be defined by the Food Security Act or that do not coincide with the Cowardin et al. definition. Contact the Service's Regional Wetland Coordinator for additional information on what types of farmed wetlands are included on wetland maps. This is a MD iMAP hosted service layer. Find more information at https://imap.maryland.gov.Feature Service Layer Link: https://geodata.md.gov/imap/rest/services/Hydrology/MD_Wetlands/MapServer/2Purpose: Maryland Wetlands - Wetlands (National Wetlands Inventory)

Available online? Yes

Data Link: https://data.imap.maryland.gov/datasets/maryland::maryland-wetlands-wetlands-national-wetlands-inventory/about

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Submerged Aquatic Vegetation

Data Name: **Submerged Aquatic Vegetation 2019**

Data Source: Maryland Department of Natural Resources (MD DNR), Maryland Coastal Atlas

Data Type: Online map viewer; GIS Data **Resolution:** NA

Geography Covered: Chesapeake Bay and Chincoteague

Date Range of Data 2019

Overview:

Chesapeake Bay Submerged Aquatic Vegetation Coverage 2019

Methodology:

The 2019 Chesapeake Bay SAV Coverage was mapped from digital multispectral imagery with a 25cm GSD to assess water quality in the Bay. WorldView 2 satellite imagery acquired from Digital Globe through the NGA NextView program was used to augment the aerial imagery for the Belmont Bay portion of the Potomac River. Each area of SAV was interpreted from the rectified imagery and classified into one of four density classes by the percentage of cover. The SAV beds were entered into an SDE GIS feature class using the quality control procedures documented below. The dataset contains all SAV areas that were identified from the areas flown. Some areas that are presumed to contain no SAV were not flown. Some small beds, particularly along narrow tributaries may not have been distinguishable on the aerial photography. This map service provides data on vegetative surface cover and submerged aquatic vegetation (SAV) for the Chesapeake Bay and Chincoteague Bay areas (2019). Historic SAV can be found on the archive server at https://archive.geodata.md.gov/imap/rest/services/Biota/MD_ArchivedSubmergedAquaticVegetation/MapServer

Available online? Yes

Data Link: https://geodata.md.gov/imap/rest/services/Biota/MD_SubmergedAquaticVegetation/MapServer

Citation:

Submerged Aquatic Vegetation (2019). Data. Maryland Department of Natural Resources. https://geodata.md.gov/imap/rest/services/Biota/MD_SubmergedAquaticVegetation/MapServer

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Economic and Social Community Characteristics

Category Environmental Justice

Data Name: **EJSCREEN: Environmental Justice Screening and Mapping Tool**

Data Source: EPA

Data Type: Online map viewer; GIS Data; T **Resolution:** Not Applicable

Geography Covered: National

Date Range of Data 2015

Overview:

EJSCREEN is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators. EJSCREEN users choose a geographic area; the tool then provides demographic and environmental information for that area. All of the EJSCREEN indicators are publicly-available data. EJSCREEN simply provides a way to display this information and includes a method for combining environmental and demographic indicators into EJ indexes. EJSCREEN includes:11 environmental indicators6 demographic indicators11 EJ indexes

Methodology:

EJSCREEN is based on nationally consistent data and an approach that combines environmental and demographic indicators in maps and reports.

Available online? Yes

Data Link: https://ejscreen.epa.gov/mapper/ - https://www.epa.gov/ejscreen/download-ejscreen-data

Citation:

EPA Environmental Justice Screening and Mapping Tool (EJSCREEN). https://www.epa.gov/ejscreen/what-ejscreen

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Economic and Social Community Characteristics

Category Environmental Justice

Data Name: **CB EJ SCREEN**

Data Source: Chesapeake Bay Program Chesapeake Research Consortium

Data Type: Map Viewer **Resolution:** NA

Geography Covered: Chesapeake Bay

Date Range of Data 2016

Overview:

EJ Screen Chesapeake is a modified version of the national EJ Screen tool that integrates Chesapeake Bay Program Partnership data resources. It was originally developed as a pilot effort to demonstrate how data important to multiple Outcomes of the Chesapeake Bay Watershed Agreement could be used alongside national environmental justice information to inform decisions throughout the Chesapeake Bay Watershed.

Methodology:

EJSCREEN is based on nationally consistent data and an approach that combines environmental and demographic indicators in maps and reports. One of the main features of EJ Screen Chesapeake that distinguishes it from the national tool is the ability to investigate Diversity layers in conjunction with data connected with other Outcomes of the Chesapeake Bay Watershed Agreement.

Available online? Yes

Data Link: https://gis.chesapeakebay.net/cbpejscreen/

Citation:

EJ Screen Chesapeake is a collaborative project of the CBP Diversity Workgroup and other Workgroups and staff of the Chesapeake Bay Program Office.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Economic and Social Community Characteristics

Category Physical Vulnerability

Data Name: **Physical Vulnerability Index (PVI)**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Census tract

Geography Covered: Coastal Virginia

Date Range of Data 2015

Overview:

Physical Vulnerability Index (PVI) for the Chesapeake Bay region provides a broad perspective on the vulnerability of the Tidewater region, creating a composite measure of general flood impact rather than the threat of any one particular storm track. While there have been a number of efforts to categorize physical risk, the analysis behind this physical vulnerability index allows for application at a variety of scales, such as the county or US Census tract level.

Methodology:

The physical vulnerability index focuses on elevation as the percent of area under 10 ft mean sea level, and volume/area of area under 10 ft (inverse), land use (developed lands), relative wave exposure, and tide range (inverse). While the other factors are common in the literature, incorporating the “developed land” further focuses the study on the application at human community scales. The PVI is a robust platform for examining the broad relationships between the impacts of coastal flooding and physical characteristics.

Available online? Yes

Data Link: https://scholarworks.wm.edu/data/441/

Citation:

Nunez, Karinna; Mitchell, Molly; and Renaud, Alexander, "Physical Vulnerability Index" (2021). Data. William & Mary. https://doi.org/10.25773/hz0r-jx50

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Fetch

Data Name: **CCRM Exposure Model**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: 25 meters

Geography Covered: Coastal Virginia

Date Range of Data 2018

Overview:

This data was created using the Fetch Model developed at CCRM/VIMS to calculate the average maximum fetch based on the values within four quadrants (NE, SE, SW, and NW). The final fetch input layer had information about the maximum single line fetch, and the maximum average quadrant fetch classification adapted from Hardaway and Byrne (1999), is based on a mean derived from all compass points within a 90-degree angle, with values of “Low”, “Moderate”, or “High”, where: Low = 0 - 0.8 Km, Moderate = 0.8 – 3.2 Km, High = >3.2 Km The longest fetch vector and the average of the fetch vectors by quadrant computed at a given point determine the fetch class for that point.

Methodology:

Fetch is determined as the longest distance over water to the nearest shoreline based on 16 directions radiating from a point on the shoreline. This data was created using the Fetch Model developed at CCRM/VIMS to calculate the average maximum fetch based on the values within four quadrants (NE, SE, SW, and NW). The final fetch input layer had information about the maximum single line fetch, and the maximum average quadrant fetch classification adapted from Hardaway and Byrne (1999), is based on a mean derived from all compass points within a 90-degree angle, with values of “Low”, “Moderate”, or “High”, where: Low = 0 - 0.8 Km, Moderate = 0.8 – 3.2 Km, High = >3.2 Km. The longest fetch vector and the average of the fetch vectors by quadrant computed at a given point determine the fetch class for that point.

Available online? No

Data Link: NA

Citation:

Center for Coastal Resources Management. 2018. Shoreline Management Model, version 5. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Groundwater Information

Category Groundwater Flow

Data Name: **USGS Groundwater Data for the United States**

Data Source: USGS National Water Information System: Web Interface

Data Type: Tabular Data **Resolution:** Unknown

Geography Covered: National (and by state and territory)

Date Range of Data 2007-present (for historic observation datasets)

Overview:

The USGS National Water Information System (NWIS) contains extensive water data for the nation. Public access to many of these data is provided via the USGS Water Data for the Nation site. The Groundwater database consists of more than 850,000 records of wells, springs, test holes, tunnels, drains, and excavations in the United States. Available site descriptive information includes well location information such as latitude and longitude, well depth, and aquifer. There is also a National Water Dashboard (custom maps) with real-time data for a variety of water-related parameters. https://dashboard.waterdata.usgs.gov/app/nwd/?region=lower48&aoi=default

Methodology:

Five types of data: (1) Current conditions at selected sites based on the most recent data from on-site automated recording equipment. (2) Historic observations include both active and discontinued sites with data for any part of the period October 1, 2007, through the present. (3) Summary of all data for each day for the period of record and may represent the daily mean, median, maximum, minimum, and/or other derived value. (4) Statistics are computed from approved daily mean data at each site. (5) Field measurements are manual measurements of depth to water in wells.

Available online? Yes

Data Link: https://waterdata.usgs.gov/va/nwis/gw

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Land Cover Projections

Data Name: **ICLUS (Integrated Climate and Land-Use Scenarios) Land Cover data for SSP2 and SSP5 socioeconomic scenarios. SSP2 (Shared Socioeconomic Pathway) is considered middle of the road and SSP5 is fossil**

Data Source: EPA

Data Type: GIS Data

Resolution: Unknown

Geography Covered: National

Date Range of Data 2018

Overview:

The projections are based on the 2010 U.S. Census and use fertility, mortality and immigration rates from the Wittgenstein Centre to project decadal population to 2100. These projections are therefore consistent with the demographic assumptions of the SSP2 and SSP5 socioeconomic scenarios. ICLUS population projections are used as inputs to a land use model.

Methodology:

ICLUS population projections are used as inputs to a land use model, which spatially allocates five residential land uses (exurban-low, exurban-high, suburban, urban-low, urban-high) as well as commercial and industrial.

Available online? Yes

Data Link: https://www.epa.gov/gcx/iclus-fourth-national-climate-assessment

Citation:

U.S. EPA. Updates to the Demographic and Spatial Allocation Models to Produce Integrated Climate and Land Use Scenarios (ICLUS) (Version 2) (External Review Draft). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-14/324, 2016.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Land Cover Projections

Data Name: **Conterminous United States Landscape Projections from 1992 to 2100**

Data Source: USGS

Data Type: GIS Data **Resolution:** 250 meter pixel

Geography Covered: National

Date Range of Data 4 IPCC SRES scenarios from 1992 to 2100

Overview:

U.S. Geological Survey (USGS) scientists have produced a unique set of land cover projections for the conterminous United States based on Intergovernmental Panel on Climate Change (IPCC) scenarios (http://www.esajournals.org/doi/full/10.1890/13-1245.1). Scenario-based projections of land use and land cover (LULC) change are needed to quantify the potential for biological carbon sequestration and to analyze strategies to mitigate impacts of greenhouse gas emissions. For more info see: https://eros.usgs.gov/doi-remote-sensing-activities/2013/usgs/1992-2100-land-cover-projections-conterminous-united-states

Methodology:

The FORE-SCE (FOREcasting SCEnarios of land use change) model was used to produce the LULC projections (http://www.tandfonline.com/doi/abs/10.1080/17474230701218202#.U8AdzPldWgY). Four scenarios were generated, each consistent with storylines from the IPCC Special Report on Emissions Scenarios (SRES) (scenarios A1B, A2, B1, and B2).

Available online? Yes

Data Link: https://www.sciencebase.gov/catalog/item/5b96c2f9e4b0702d0e826f6d

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Land Cover Hindcast

Data Name: **Landuse and Landcover Backcasting from 1938 to 1992**

Data Source: USGS

Data Type: GIS Data

Resolution: 250 meter pixel

Geography Covered: National

Date Range of Data 1938-1992

Overview:

USGS Earth Resources Observation and Science (EROS) Center used a modeling approach to produce historical LULC maps back to 1938 for the conterminous United States. The resulting product is an annual, spatially explicit LULC database for the conterminous United States from 1938–1992, with 15 distinct LULC classes mapped at 250-m resolution. The data are designed to be consistent with existing modeled land cover data from 1992–2100, produced as part of the USGS Land Carbon project.

Methodology:

Historical remote sensing databases were combined with Agricultural Census data, demographic histories, a database of reservoir construction dates, county-level wetland drainage histories, and other historical data to construct historical "demand" back to 1938.

Available online? Yes

Data Link: https://www.sciencebase.gov/catalog/item/59d3c73de4b05fe04cc3d1d1

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Roads

Data Name: **Tiger/Line Data**

Data Source: US Census Bureau

Data Type: GIS Data

Resolution: Unknown

Geography Covered: National

Date Range of Data 1992, 2000, 2006 to 2020

Overview:

The TIGER/Line Shapefiles are extracts of selected geographic and cartographic information from the Census Bureau's Master Address File (MAF)/Topologically Integrated Geographic Encoding and Referencing (TIGER) Database (MTDB). The shapefiles include information for the fifty states, the District of Columbia, Puerto Rico, and the Island areas (American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and the United States Virgin Islands). The shapefiles include polygon boundaries of geographic areas and features, linear features including roads and hydrography, and point features.

Methodology:

For technical documentation see: https://www.census.gov/programs-surveys/geography/technical-documentation/complete-technical-documentation/tiger-geo-line.html

Available online? Yes

Data Link: https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Roads

Data Name: **Virginia Road Centerlines**

Data Source: Virginia Geographic Information Network (VGIN)

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Virginia

Date Range of Data Updated Quarterly

Overview:

The Virginia Geographic Information Network (VGIN) has coordinated and manages the development of a consistent, seamless, statewide digital Road Centerline (RCL) geospatial database as part of the Virginia Base Mapping Program (VBMP) which includes address ranges, road names, network routing elements, and specific VDOT business elements.

Methodology:

The Road Centerline Program (RCL) leverages the Commonwealth's investment in VBMP digital orthophotography and is focused on creating a single statewide, consistent digital road file. The RCL data layer is a dynamic dataset supported and maintained by Virginia's Local Governments, VDOT, and VGIN through VGIN efforts. VBMP RCL is extracted and provided back to local governments and state agencies in many geographic data sets every quarter.

Available online? Yes

Data Link: https://vgin.maps.arcgis.com/home/item.html?id=cd9bed71346d4476a0a08d3685cb36ae

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Roads

Data Name: **Open Street Map**

Data Source: Open Street Map (OSM)

Data Type: Map Viewer; GIS Data

Resolution: 1:5000 or smaller

Geography Covered: World

Date Range of Data Varies

Overview:

OpenStreetMap (OSM) is a collaborative map of the world where users can edit and update maps of their communities in real time.

Methodology:

OpenStreetMap emphasizes local knowledge. Contributors use aerial imagery, GPS devices, and low-tech field maps to verify that OSM is accurate and up to date.

Available online? Yes

Data Link: https://www.openstreetmap.org/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Buildings

Data Name: **Building Footprint**

Data Source: Virginia Geographic Information Network (VGIN)

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Virginia

Date Range of Data Updated Quarterly

Overview:

Virginia Base Mapping Program's (VBMPs) building footprints are a collection of locally submitted data. They do not contain addresses, ownership, resident information, or construction specifications. To date the majority of building footprints for Virginia's localities have been captured, but not all.

Methodology:

Building footprints are polygon outlines of structures remotely rendered through digitizing of Virginia Base Mapping Program's digital ortho-photogrammetry imagery, or digitizing of local government subdivision plats.

Available online? Yes

Data Link: https://vgin.maps.arcgis.com/home/item.html?id=994d0afa44c046498f9774613671ce9a

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Roads

Data Name: **Maryland Roads Centerlines - Comprehensive**

Data Source: Maryland Department of Transportation (MDOT)

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Maryland

Date Range of Data 2019; updated annually

Overview:

Maryland Roadway Centerline data consists of linear geometric features which represent the street centerline for all public roadways in the State of Maryland. The centerline represents the geographic location on the roadway between both shoulders (physical center), which often but not always coincides with the center painted line dividing bi-directional travel lanes. Roadway Centerlines data plays an important role in transportation management and planning, while also being the basis for all other roadway related data products. Maryland Roadway Centerline data is the end product of a statewide data sharing process between the Federal Highway Administration (FHWA), Maryland Department of Transportation (MDOT), Maryland Department of Transportation State Highway Administration (MDOT SHA), county governments and local municipal governments.

Methodology:

Some centerlines were created in-house using imagery, GPS data, and MDOT SHA's Highway Performance Monitoring System (HPMS) database and others were received from county governments and updated in house using imagery, GPS data and MDOT SHA's HPMS database.

Available online? Yes

Data Link: https://data-maryland.opendata.arcgis.com/pages/mdot-data

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Ditches Crossing Wetlands

Category Tax ditches

Data Name: **Eastern Shore Regional GIS Cooperative (ESRGC) Tax Ditches and PDAs (public drainage associations)**

Data Source: Eastern Shore Regional GIS Cooperative (ESRGC)

Data Type: GIS Data **Resolution:** Unknown

Geography Covered: Maryland - Lower Eastern Shore

Date Range of Data 2004

Overview:

In the Summer and Fall of 2004 the ESRGC assisted the Maryland Department of Agriculture in digitizing and annotating tax ditches and public drainage associations in selected areas on the Lower Eastern Shore. Tax ditches from the Pocomoke, Nanticoke and Coastal Bays watersheds are available for free download as are PDAs from the Pocomoke and Coastal Bays watersheds.

Methodology:

Tax ditch lines were digitized from paper maps provided by the Department of Agriculture.

Available online? Yes

Data Link: https://www.esrgc.org/data/taxditch

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Ditches Crossing Wetlands

Category Ditches in Salt Marshes

Data Name: **Salt Marsh Ditches, Version 3.0, North Atlantic U.S. Coast**

Data Source: Designing Sustainable Landscapes Project

Data Type: Map Viewer; GIS Data **Resolution:** 1 meter

Geography Covered: North Atlantic US Coast

Date Range of Data 2019

Overview:

The data provide information about the potential magnitude of ditching, and impacts of ditching, in salt marshes. The data included are salt marsh ditches, a salt marsh ditch metric, and the data sources for the metric. In addition to web page(s) to download GIS data (dataset link) there is a map viewer to create and save maps at https://databasin.org/maps/new/#datasets=8b04346487a8457d98feea228d9b0275

Methodology:

Digital Elevation Models (DEMs) at 1 m resolution derived from LiDAR were compiled from a number of state and federal sources described in the Salt Marsh Ditch Sources and Status dataset. A custom image analysis process was then used to identify local depressions in salt marshes that could be ditches. The results were next analyzed to tag long (>75 m), fairly straight depressions as ditches using “morphological skeletonizing” and “clockfacing” algorithms. These mapped ditches constitute the “Salt Marsh Ditches” dataset. Finally, the Salt Marsh Ditch Metric measured the intensity of ditches in the neighborhood of each salt marsh cell using a kernel estimator.

Available online? Yes

Data Link: https://databasin.org/datasets/8b04346487a8457d98feea228d9b0275/

Citation:

McGarigal K, Compton BW, Plunkett EB, DeLuca WV, and Grand J. 2017. Designing sustainable landscapes: salt marsh ditching metric. Report to the North Atlantic Conservation Cooperative, US Fish and Wildlife Service, Northeast Region.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **VMRC Habitat Management Permits and Applications**

Data Source: Virginia Marine Resources Commission (VMRC)

Data Type: Online web viewer

Resolution: Not Applicable

Geography Covered: Virginia

Date Range of Data 1970 to present

Overview:

Database of environmental permits issued by the Habitat Management Division including three types; subaqueous or bottomlands, tidal wetlands, and coastal primary sand dunes. These permits include living shoreline projects. The division's authority and responsibilities emanate from Subtitle III of Title 28.2 of the Code of Virginia and specifically regulates physical encroachment into these valuable resource areas.

Methodology:

Data from Joint Permit Applications submitted to the Virginia Marine Resources Commission are provided in online viewer and search results available for download in Excel and PDF.

Available online? Yes

Data Link: https://webapps.mrc.virginia.gov/public/habitat/

Citation:

Virginia Marine Resources Commission (VMRC). 2021. Habitat Management Permits and Applications. Virginia Marine Resources Commission, Newport News, Virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **CCRM Shoreline Permit Database**

Data Source: Center for Coastal Resources Management (CCRM) at the Virginia Institute of Marine Science (VIMS)

Data Type: Tabular Data

Resolution: Not Applicable

Geography Covered: Coastal Virginia

Date Range of Data 1970-present

Overview:

Database of Joint Permit Applications submitted to the Virginia Marine Resources Commission (VMRC) involving shoreline erosion activities; includes information on shoreline project type as defined by CCRM, geo-location in latitude and longitude, consistency with Virginia shoreline management guidance, approval, status, contractor, agent, property owner, fetch, etc.

Methodology:

Information obtained from review of Joint Permit Applications (JPAs) involving shoreline erosion activity submitted to the Virginia Marine Resources Commission (VMRC) and categorized and defined by CCRM are inputted into a Microsoft Access database.

Available online? No

Data Link: NA

Citation:

Center for Coastal Resources Management (CCRM). 2020. Shoreline Permit Database. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **MDE Wetland and Waterways Permits - Watershed Resources Registry**

Data Source: Maryland Department of the Environment

Data Type: Online map viewer; GIS Data **Resolution:** Not Applicable

Geography Covered: Maryland

Date Range of Data Varies

Overview:

Permit Sites including Living Shoreline Projects

Methodology:

eCollaboration Screening Points from Plan Review

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **A Tour of Living Shorelines in Delaware**

Data Source: Delaware Living Shorelines Committee

Data Type: Story Map **Resolution:** Not Applicable

Geography Covered: Coastal Delaware

Date Range of Data Projects constructed around 2014-2016

Overview:

A story map of public living shorelines constructed in Delaware with information on construction, location, and living shoreline resources.

Methodology:

Collection of living shoreline project locations and information installed in Delaware and presented in a Story Map.

Available online? Yes

Data Link: https://dnrec.maps.arcgis.com/apps/MapJournal/index.html?appid=371a244682084370a78d0a54c5edb27a

Citation:

A Tour of Living Shorelines in Delaware (2016). Story Map. Delaware Living Shorelines Committee. https://dnrec.maps.arcgis.com/apps/MapJournal/index.html?appid=371a244682084370a78d0a54c5edb27a.

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William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **Watershed Resources Registry - MDE Wetland and Waterways Permits**

Data Source: Maryland Department of the Environment

Data Type: Map viewer; export Tabular Da **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Unknown

Overview:

Points of wetland and waterway permits that include living shorelines and other shoreline structures

Methodology:

eCollaboration Screening Points from Plan Review

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

MDE Wetland and Waterways Permits (2021). Watershed Resources Registry Map Viewer. Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **Living Shorelines - Beaches & Dunes**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: Story Map

Resolution: Not Applicable

Geography Covered: Coastal Virginia

Date Range of Data 2018; updated 2020

Overview:

Story Map providing location and project information (goals, techniques used, size, cost, partners, funding, and address) for living shorelines in coastal Virginia comprising beaches and dunes.

Methodology:

Information on living shoreline projects was compiled and displayed using ESRI Story Maps.

Available online? Yes

Data Link: https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=92e2148aa11e4216a21012ae1b2413e3%20

Citation:

Center for Coastal Resources Management (2020). Story Map. Living Shorelines: Beaches and Dunes. Virginia Institute of Marine Science. https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=92e2148aa11e4216a21012ae1b2413e3%20

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **Living Shorelines: Marshes and Oysters**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: Story Map

Resolution: Not Applicable

Geography Covered: Coastal Virginia

Date Range of Data 2018; updated 2020

Overview:

Story Map providing location and project information (Goals, techniques used, size, cost, partners, funding, and address) for living shorelines in Virginia comprising marshes and/or oysters.

Methodology:

Information on living shoreline projects in coastal Virginia using marshes and/or oysters was compiled and displayed using ESRI Story Maps.

Available online? Yes

Data Link: https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=0132309272c44ffeb61cac08ae07798f

Citation:

Center for Coastal Resources Management (2020). Story Map. Living Shorelines: Beaches and Dunes. Virginia Institute of Marine Science. https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=0132309272c44ffeb61cac08ae07798f

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **SAGE Searchable Project Database**

Data Source: SAGE (Systems Approach to Geomorphic Engineering)

Data Type: Searchable Online Database **Resolution:** NA

Geography Covered: Atlantic Coast

Date Range of Data Updated to 2016

Overview:

This database contains multiple coastal resilience projects around the nation, including Living Shorelines for shoreline stabilization, habitat restoration, and floodplain management. Each project includes a variety of site, design, and partner information. Use the pull-down lists or a Key Word search to find certain project names, partners, and other unique information.

Methodology:

SAGE partners at the US Army Corps of Engineers Institute for Water Resources and the Virginia Institute of Marine Science, College of William & Mary collected project records from a variety of sources like the NOAA Restoration Atlas, the COPRI Living Shorelines Database, state and local agencies, watershed organizations, private foundations, and others.

Available online? Yes

Data Link: http://sagecoast.org/info/sagesearch.html

Citation:

Not Provided

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Tidal Marsh/Phragmites Australis Inventory

Data Name: **Virginia Shoreline & Tidal Marsh Inventory (2010-2016)**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marinca Science (VIMS)

Data Type: GIS Data

Resolution: Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data 2010-2019

Overview:

The Virginia Tidal Marsh Inventory is a series of reports that describe the condition of tidal shorelines for individual localities in VA. It also includes contemporary digital inventory information using a combination of Geographic Information Systems (GIS), Global Positioning System (GPS), and remote sensing technology. The Tidal Marsh Inventory is an extensive survey of marsh extent and plant community composition covering every tidal marsh in Virginia.

Methodology:

Tidal marshes were field surveyed and delineated using the latest VBMP imagery at the time of the survey. The delineation of the marsh polygons was conducted by using onscreen digitizing techniques at a scale of 1:1,000. Bing and Google Earth online imagery were used to provide additional interpretive information to improve the accuracy of marsh boundaries. Polygons representing the different marsh community type were

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/virginia/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/virginia/index.php

Prepared by: The Center for Coastal Resources Management
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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Projected Marsh Migration Patterns

Category Marsh migration Data

Data Name: **Migration of the Tidal Marsh Range Under Sea Level Rise for Coastal Virginia, with Land Cover Data**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Unknown

Geography Covered: Coastal Virginia

Date Range of Data 2021

Overview:

The layers in this geodatabase were intended to represent the land that is encompassed by the average tidal range as sea level rises in the Virginia coastal region, including Chesapeake Bay and tributaries, the Atlantic Ocean side of the Eastern Shore, and Virginia Beach.

Methodology:

The data layers in this geodatabase represent each two foot range of elevation incremented by 0.5 ft (e.g. 0-2 ft, 0.5-2.5 ft, 1-3 ft, etc.) with the current land cover that exists in that range.

Available online? Yes

Data Link: https://doi.org/10.25773/sz4n-k694

Citation:

Herman, Julie and Mitchell, Molly, "Migration of the Tidal Marsh Range Under Sea Level Rise for Coastal Virginia, with Land Cover Data" (2021). Data. William & Mary. https://doi.org/10.25773/sz4n-k694

Prepared by: The Center for Coastal Resources Management
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William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Projected Marsh Migration Patterns

Category Marsh Migration Zones

Data Name: **Marsh Migration Zones, Northeast U.S**

Data Source: Northeast Conservation Planning Atlas

Data Type: GIS Data **Resolution:** NA

Geography Covered: Northeast U.S.

Date Range of Data 2017

Overview:

Northeast Region Marsh Migration is one of a suite of products from the Nature's Network (naturesnetwork.org) project. Marsh Migration addresses the unique problem of connectivity of tidal marsh habitat to adjacent uplands and the need for marshes to move in response to sea level rise. The Marsh Migration data identify which of the best opportunities for tidal marsh habitat have the greatest potential for upland migration with advancing sea -levels. Tidal marshes are among the most productive habitats on earth. The identification of tidal marsh in proximity to upland zones of migration, given projected sea- level rise, may be applied to help prioritize conservation and management actions aimed at encouraging a healthy extent of tidal marsh habitat into the future. The purpose of the data is to assess the undeveloped land available for marsh migration in response to sea level rise and to identify marshes in highest quality ecological condition that may be targets for conservation.

Methodology:

Detailed Methodology: https://coast.noaa.gov/data/digitalcoast/pdf/slr-marsh-migration-methods.pdf

Available online? Yes

Data Link: https://nalcc.databasin.org/datasets/14de01cdcd0b4243b04fce3165cf873c/

Citation:

Kevin Ruddock(Principal Investigator), North Atlantic Landscape Conservation Cooperative(administrator), 2017-05-16(creation), 2018-02-09(last update), 2017-03-22(Publication), Marsh Migration Zones, Northeast U.S.

Prepared by: The Center for Coastal Resources Management
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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Sea Level RiseB64:L109

Category Empirical Projections

Data Name: **Sea level report cards - Chesapeake Bay**

Data Source: Virginia Institute of Marine Science (VIMS)

Data Type: Graphs and charts

Resolution: 5 stations in the Bay

Geography Covered: Chesapeake Bay

Date Range of Data 2019

Overview:

Updated by the Virginia Institute of Marine Science each year as annual tide-gauge data become available, they display recent sea-level trends and project sea-level height to the year 2050

Methodology:

Use empirical tide gauge data from 1969-present

Available online? Yes

Data Link: https://www.vims.edu/bayinfo/bay_slrc/index.php

Citation:

Boon, J., Mitchell, M., Malmquist, M. Sea-Level Report CardsChesapeake Bay. Website. https://www.vims.edu/bayinfo/bay_slrc/index.php

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Sea Level Rise

Category GCM Projections

Data Name: **Sea Level Rise Viewer**

Data Source: NOAA

Data Type: GIS Data

Resolution: NOAA gauges

Geography Covered: National

Date Range of Data 2007-2009

Overview:

A web mapping tool to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). Photo simulations of how future flooding might impact local landmarks are also provided, as well as data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, and mapping confidence.

Methodology:

The coastal flood event frequencies and durations for tide gauges were calculated using observed tidal data over a three-year period (2007-2009). The future frequency and duration predictions are based on the addition of half-meter and one-meter sea level rise scenarios to the observed water levels over the three-year period. More details on the methods used to determine the flood frequency can be found here: coast.noaa.gov/slr/assets/pdfs/CO-OPS_Flood_Frequency_Methods.pdf

Available online? Yes

Data Link: https://coast.noaa.gov/htdata/Inundation/SLR/SLRdata/VA/VA_EasternShore_slr_data_dist.zip; https://coast.noaa.gov/htdata/Inundation/SLR/SLRdata/VA/VA_Northern_slr_data_dist.zip;

Citation:

NOAA Office for Coastal Management. Digital Coast. Sea Level Rise Viewer. Website. https://coast.noaa.gov/digitalcoast/tools/slr.html

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Sea Level Rise

Category GCM Projections

Data Name: **Sea-Level Change Curve Calculator**

Data Source: US Army Corps of Engineers and NOAA

Data Type: Webtool with graphs and chart **Resolution:** NOAA gauges

Geography Covered: National

Date Range of Data 2013-2017

Overview:

This is a calculator for sea level rise scenarios based on GCM and user defined inputs

Methodology:

Each scenario source has slightly different methods but all of them are based on regionalized global climate models

Available online? Yes

Data Link: https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html

Citation:

USACE. Sea-Level Change Curve Calculator (Version 2021.12). Website. https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Sea Level Rise

Category GCM projections

Data Name: **Sea-level Rise: Projections for Maryland 2018**

Data Source: MD Sea Level Rise Working Group and NOAA

Data Type: Webtool with graphs and chart **Resolution:** NOAA gauges

Geography Covered: Maryland

Date Range of Data 2018

Overview:

In fulfillment of requirements of the Maryland Commission on Climate Change Act of 2015, this report provides updated projections of the amount of sea-level rise relative to Maryland coastal lands that is expected into the next century. These projections represent the consensus of an Expert Group drawn from the Mid-Atlantic region.

Methodology:

The framework for these projections is explicitly tied to the projections of global sea-level rise included in the Intergovernmental Panel on Climate Change Fifth Assessment (2014) and incorporates regional factors such as subsidence, distance from melting glaciers and polar ice sheets, and ocean currents. The probability distribution of estimates of relative sea-level rise from the baseline year of 2000 are provided over time and, after 2050, for three different greenhouse gas emissions pathways: Growing Emissions (RCP8.5), Stabilized Emissions (RCP4.5), and meeting the Paris Agreement (RCP2.6).

Available online? Yes

Data Link: https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html

Citation:

Boesch, D.F., W.C. Boicourt, R.I. Cullather, T. Ezer, G.E. Galloway, Jr., Z.P. Johnson, K.H. Kilbourne, M.L. Kirwan, R.E. Kopp, S. Land, M. Li, W. Nardin, C.K. Sommerfield, W.V. Sweet. 2018. Sea-level Rise: Projections for Maryland 2018, 27 pp. University

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
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Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Bank Height

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

Contains information about upland riparian zone, bank, and shoreline for tidal waters by locality (county or city)

Methodology:

Depending upon age of inventory, bank heights were visually determined using shorelines and elevation data. Some bank heights were determined by extracting heights from lidar DEMs using a geoprocessing model protocol.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/virginia/index.php

Citation:

Center for Coastal Resources Management. 2019. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from https://www.vims.e

Prepared by: The Center for Coastal Resources Management
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William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Erosion Rates

Data Name: **Shoreline Evolution Database**

Data Source: Shoreline Studies Program (SSP), Virginia Institute of Marine Science (VIMS)

Data Type: Map Viewer

Resolution: Unknown

Geography Covered: Coastal Virginia

Date Range of Data 2009

Overview:

Shoreline erosion rates were determined from aerial photographs for coastal Virginia.

Methodology:

Shorelines were digitized using aerial photographs from 1937 and 2009. The Digital Shoreline Analysis System (DSAS) was used to determine the rate of change between the two shorelines and results are reported as end point shoreline change rates (EPRs).

Available online? Yes

Data Link: https://www.vims.edu/research/departments/physical/programs/ssp/shoreline_evolution/index.php

Citation:

Hardaway, Jr., C.S., Milligan, D.A., & Wilcox, C.A. (2020). Shoreline Evolution GIS Database 1937-2017. Retrieved from VIMS, Shoreline Studies Program website www.vims.edu

Prepared by: The Center for Coastal Resources Management
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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Erosion Rates

Data Name: **Maryland Shoreline Changes - Baseline Changes**

Data Source: Maryland Geological Survey

Data Type: Map Viewer; GIS Data; Tabular **Resolution:** Unknown

Geography Covered: Coastal Maryland

Date Range of Data Varies

Overview:

Baseline shoreline change

Methodology:

Shoreline was derived from aerial photographs and DSAS was used to determine rate of change.

Available online? Yes

Data Link: https://data.imap.maryland.gov/datasets/maryland::maryland-shoreline-changes-baseline/about

Citation:

Not Provided

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Virginia Institute of Marine Science
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Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Groundwater Information

Category Groundwater Tables

Data Name: **Depth to Water Table**

Data Source: USGS

Data Type: Tabular Data

Resolution: Unknown

Geography Covered: National

Date Range of Data Varies

Overview:

"How can I find the depth to the water table in a specific location?" These are databases of individual samples.

Methodology:

Databases containing depth-to water measurements can also be helpful, though they don't always have current data: 1) The USGS National Water Information System (NWIS) has depth-to-water measurements made in the present and the past. A convenient way to find data for your area is by using the NWIS Mapper and selecting "Groundwater Sites" in the menu on the left. Click on any red groundwater pin to access the data. 2) The National Groundwater Mentoring Network is a compilation of groundwater monitoring wells from federal, state, and local groundwater networks across the nation. Use their Data Portal to zoom in to your area of interest and click on any site. 3) Your state government probably maintains a database of drillers' logs that have water-levels recorded when a well was drilled, and hydrologic consultants often have reports that contain water-level data from shallow boreholes.

Available online? Yes

Data Link: https://www.usgs.gov/faqs/how-can-i-find-depth-water-table-a-specific-location?qt-news_science_products=0

Citation:

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Current Land Cover

Data Name: **Virginia Land Cover Dataset**

Data Source: VGIN (Virginia Geographic Information Network)

Data Type: GIS Data

Resolution: 1 meter pixel

Geography Covered: Virginia

Date Range of Data 2016

Overview:

The Virginia Geographic Information Network (VGIN) and its partners have coordinated the development of a statewide Land Cover Dataset, improving land coverage data to assist localities in planning and implementing stormwater management programs. The Land Cover product leverages the Commonwealth's investment in the VBMP digital orthophotography and is focused on creating a consistent, statewide 1 meter digital land classification. Land Cover data extraction is being publicly provided back to local governments and state agencies in both raster and vector data formats.

Methodology:

Aerial imagery were used to determine land cover using machine learning techniques. Additional datasets from external sources (e.g. detailed marsh data) were incorporated into the final product.

Available online? Yes

Data Link: https://vgin.maps.arcgis.com/home/item.html?id=d3d51bb5431a4d26a313f586c7c2c848

Citation:

Virginia Geographic Information Network (VGIN), Department of Conservation & Recreation (DCR), Department of Environmental Quality (DEQ), Virginia Department of Forestry (VDOF), Tidal Marsh Inventory (TMI), National Hydrography Dataset (NHD), National Wet

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Current Land Cover

Data Name: **National Land Cover Database (NLCD)**

Data Source: Multi-Resolution Land Characteristics (MRLC) Consortium

Data Type: GIS Data

Resolution: 30 meter pixel

Geography Covered: National

Date Range of Data Varies

Overview:

NLCD is generated in cooperation with the Multi-Resolution Land Characteristics Consortium (MRLC) a partnership of Federal agencies working together to produce current, nationally consistent, land cover products for all 50 states and Puerto Rico.

Methodology:

Satellite imagery is classified into land cover and land use categories. Datasets are available from 2001, 2004, 2006, 2008, 2011, 2013, 2016, and 2019 as well as a land cover change index layer that allows visualization of change between the 8 dates.

Available online? Yes

Data Link: https://www.mrlc.gov/data?f%5B0%5D=category%3Aland%20cover&f%5B1%5D=region%3Aconus

Citation:

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Current Land Cover

Data Name: **C-CAP (Coastal Change and Analysis Program) Regional Land Cover and Change**

Data Source: NOAA

Data Type: GIS Data **Resolution:** 30 meter pixel

Geography Covered: Coastal Areas of the United States

Date Range of Data Varies

Overview:

Nationally standardized, raster-based inventories of land cover for the coastal areas of the U.S. C-CAP data form the coastal expression of the National Land Cover Database (NLCD).

Methodology:

Data are derived, through the Coastal Change Analysis Program, from the analysis of multiple dates of remotely sensed imagery. Two file types are available: individual dates that supply a wall-to-wall map, and change files that compare one date to another.

Available online? Yes

Data Link: https://coast.noaa.gov/digitalcoast/data/ccapregional.html

Citation:

Not Provided

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Current Land Cover

Data Name: **Chesapeake Bay High-Resolution Land Cover Project**

Data Source: Chesapeake Conservancy Conservation Innovation Center

Data Type: GIS Data **Resolution:** 1 meter pixel

Geography Covered: Chesapeake Bay watershed including New York, Pennsylvania, West Virginia, Maryland, Delawar

Date Range of Data 2016

Overview:

High resolution land cover dataset for the Chesapeake Bay watershed. The land cover data represent land cover conditions as evident in NAIP (National Agriculture Imagery Program) imagery for the years 2013/2014. Updates for the years 2017/2018 and 2021/2022 are currently planned, assuming NAIP continues as anticipated. Both statewide and Chesapeake Bay watershed layers are available for download. VA created a separate statewide high-resolution land cover dataset, which has unique class names and descriptions. For the purposes of a matching bay-wide dataset, this VA dataset was reclassified and some classes were edited to better match the Chesapeake Bay Dataset class definitions use for the other states.

Methodology:

Data layers used to create the raster layers include LiDAR, NAIP imagery, and orthoimagery when available were used, as well as county planimetrics, statewide and federal road datasets, and National Wetlands Inventory polygons.

Available online? Yes

Data Link: https://www.chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/

Citation:

Not Provided

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Erosion Rates

Data Name: **Maryland Shoreline Changes - Legacy Shoreline**

Data Source: Maryland Geological Survey

Data Type: Map Viewer; GIS Data; Tabular **Resolution:** Unknown

Geography Covered: Coastal Maryland

Date Range of Data Varies

Overview:

Legacy (historic) shoreline change

Methodology:

Shorelines were digitized from mylar T-sheets and hydrographic surveys.

Available online? Yes

Data Link: https://data.imap.maryland.gov/datasets/b7dec3418668473c82002ee28e280eae_3/about

Citation:

Not Provided

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Soil Data

Data Name: **Web Soil Survey**

Data Source: NRCS (USDA)

Data Type: Map Viewer; GIS Data; Tabular **Resolution:** Varies

Geography Covered: National

Date Range of Data Varies

Overview:

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey.

Methodology:

Digital versions of NRCS Soil Surveys

Available online? Yes

Data Link: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Citation:

Not Provided

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Sediment Loading

Data Name: **Recommendations of the Expert Panel to Define Removal Rates for Shoreline Management Projects**

Data Source: Urban Stormwater Work Group, Chesapeake Bay Partnership

Data Type: Report

Resolution: Not Applicable

Geography Covered: Maryland and Virginia

Date Range of Data 2010

Overview:

The tidal shoreline erosion contributes sediment and nutrients to the Chesapeake Bay. Limitedstudies quantify the tidal shoreline erosion rate and the associated TSS, TN, and TP pollutantload to the waters. Cerco et al. (2010) provided average annual shoreline erosionmass loadings for Maryland and Virginia. Chesapeake Bay shoreline characteristics and shoreline erosion mass loading (averaged) Page 13 of report.

Methodology:

Data sources to estimate tidal shore erosion loading rates and their application in the model werereviewed by the Panel. Shoreline erosion information in MD was compiled by the MarylandGeologic Survey (MGS) and in VA by the Virginia Institute of Marine Science (VIMS).

Available online? Yes

Data Link: https://www.chesapeakebay.net/channel_files/21151/attachment_c--uswg_shoreline_management_041414.pdf

Citation:

Cerco, Carl F., Sung-Chan Kim, and Mark R. Noel. 2010. The 2010 Chesapeake BayEutrophication Model: A report to the US EPA CBPO and to the USACE Baltimore District. USACE and Development Center. Vicksburg, MS.

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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Subsidence Rates

Category Subsidence-Bay wide

Data Name: **Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region**

Data Source: USGS

Data Type: Report with Map

Resolution: Coarse but varies by data source

Geography Covered: Chesapeake Bay

Date Range of Data 2013

Overview:

The report includes information about the causes of subsidence and a map of the rates on a coarse scale. The southern Chesapeake Bay region is experiencing land subsidence and rising water levels due to global sea-level rise; land subsidence and rising water levels combine to cause relative sea-level rise. Land subsidence has been observed since the 1940s in the southern Chesapeake Bay region at rates of 1.1 to 4.8 millimeters per year (mm/yr), and subsidence continues today.

Methodology:

There are several reliable and accurate techniques for measuring land subsidence. Multiple monitoring techniques are often used together to understand different aspects of land subsidence, such as borehole extensometers, geodetic surveying, and NOAA CORS data (Continuously Operating Reference Stations).

Available online? Yes

Data Link: http://dx.doi.org/10.3133/cir1392

Citation:

Eggleston, Jack, and Pope, Jason, 2013, Land subsidence and relative sea-level rise in the southern Chesapeake Bay region: U.S. Geological Survey Circular 1392, 30 p., http://dx.doi.org/10.3133/cir1392

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William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Subsidence Rates

Category Subsidence

Data Name: **Toward Sustained Monitoring of Subsidence at the Coast Using InSAR and GPS: An Application in Hampton Roads, Virginia**

Data Source: Geophysical Research Letters

Data Type: Open access publication **Resolution:** 30 meter

Geography Covered: Hampton Roads, VA

Date Range of Data 2020

Overview:

This paper develops a cost-effective approach for ongoing monitoring that leverages publicly available data products derived from the Sentinel-1 satellite. Maps can be downloaded.

Methodology:

A cost-effective workflow for generating a product using InSAR (interferometric synthetic aperture radar), which is data from the Sentinel-1 satellite, and GPS to measure surface displacements.

Available online? Yes

Data Link: https://digitalcommons.odu.edu/ccpo_data/1/

Citation:

Buzzanga, B., Bekaert, D. P. S.,Hamlington, B. D., & Sangha, S. S.(2020). Toward sustained monitoring of subsidence at the coast using Insured GPS: An application in Hampton Roads, Virginia. Geophysical Research Letters, 47, e2020GL090013. https://doi.org

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Suspended Sediments

Category Sediment

Data Name: **Input and Predictions from a suspended-sediment SPARROW model CBSS V2 in the Chesapeake Bay watershed**

Data Source: USGS

Data Type: GIS Data **Resolution:** NA

Geography Covered: Chesapeake Bay

Date Range of Data 2002

Overview:

These data represent both inputs for and estimates from a medium-resolution (1:100,000 scale) NHDPlus Spatially Referenced Regression on Watershed attributes (SPARROW) model for the Chesapeake Bay watershed (CBSS_v2). The model spatially correlates long-term mean annual suspended-sediment flux in 113 non-tidal streams to likely upland and stream-corridor sources, landscape factors affecting upland sediment transport and delivery to stream corridors, and fluvial and reservoir retention representing the early 2000 time period.

Methodology:

Sparrow model

Available online? Yes

Data Link: https://data-chesbay.opendata.arcgis.com/datasets/input-and-predictions-from-a-suspended-sediment-sparrow-model-cbss-v2-in-the-chesapeake-bay-watershed-1?geometry=-94.963%2C36.887%2C-

Citation:

Brakebill, J.W., Ator, S.W., and Sekellick, A. J., 2019. Input and predictions from a suspended-sediment SPARROW model CBSS_V2 in the Chesapeake Bay watershed: U.S. Geological Survey data release https://doi.org/10.5066/P9Q2YQY6.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Suspended Sediments

Category Turbidity

Data Name: **Virginia Estuarine and Coastal Observing System (VECOS)**

Data Source: Chesapeake Bay National Estuarine Research Reserve (CBNERR)

Data Type: Tabular Data **Resolution:** Unknown

Geography Covered: Virginia Chesapeake Bay and Tributaries

Date Range of Data Varies

Overview:

Five types of water quality data: DATAFLOW data, fixed continuous station data, real-time continuous station data, long-term data, and profiler data. Data include parameters such as turbidity, salinity, and dissolved oxygen.

Methodology:

The Virginia Estuarine and Coastal Observing System (VECOS) is a website designed to distribute the results of water quality and meteorological data monitoring efforts from the Chesapeake Bay and associated tributaries within Virginia. These data are provided from a variety of monitoring programs conducted by the Chesapeake Bay National Estuarine Research Reserve - Virginia, including high resolution mapping of surface water quality (DATAFLOW), high-frequency measurements of water quality taken every 15 minutes from fixed, shallow water monitoring stations (CONMON), continuous measurements taken from deeper waters along multiple depths (Profiler). VECOS also provides links to external monitoring programs, including high-frequency water quality and meteorological monitoring at deep water locations in the Chesapeake Bay as part of the Chesapeake Bay Interpretive Buoy System (CBIBS), meteorological monitoring locations specific to the York River watershed, and long-term routine water quality sampling, typically taken 12-20 times per year since 1985 through the Chesapeake Bay Program (Long-term).

Available online? Yes

Data Link: http://vecos.vims.edu/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Suspended Sediments

Category TSS (Total Suspended Solids)

Data Name: **Chesapeake Bay Program Monitoring Data includes Chesapeake Bay Program Water Quality Database (1984-present)**

Data Source: Chesapeake Bay Program

Data Type: Tabular Data

Resolution: Unknown

Geography Covered: Chesapeake Bay

Date Range of Data Varies

Overview:

The Chesapeake Bay Monitoring Program, which began in 1984, is a Bay-wide cooperative effort involving Maryland, Pennsylvania, Virginia, the District of Columbia, several federal agencies, 10 institutions and over 30 scientists. Monitoring the Chesapeake Bay and its tributaries allows Bay Program partners to detect changes that take place; improves our understanding of the natural environment; and reveals trends over time that can provide valuable information to policy makers.

Methodology:

Nineteen physical, chemical and biological characteristics are monitored 20 times a year in the Bay's mainstem and many tributaries. Includes parameters such as total suspended solids (TSS), salinity, dissolved oxygen (DO), among many others. Data available at https://www.chesapeakebay.net/what/downloads/cbp_water_quality_database_1984_present

Available online? Yes

Data Link: https://www.chesapeakebay.net/what/data

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Topographic and Topobathy Data

Category Bathymetric Data

Data Name: **Topobathymetric Lidar**

Data Source: NOAA

Data Type: GIS Data

Resolution: Varies

Geography Covered: National

Date Range of Data Varies

Overview:

Lidar data for bathymetric surfaces.

Methodology:

These data are collected using lidar collectors on an aerial platform (as opposed to satellite).

Available online? Yes

Data Link: https://data.noaa.gov/onestop/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Topographic and Topobathy Data

Category Elevation Data

Data Name: **Topographic Lidar**

Data Source: USGS

Data Type: GIS Data

Resolution: Varies

Geography Covered: National

Date Range of Data Varies

Overview:

Lidar data for terrestrial surfaces. Point cloud data and DEMS available.

Methodology:

These data are collected using lidar collectors on an aerial platform (as opposed to satellite)

Available online? Yes

Data Link: https://prd-tnm.s3.amazonaws.com/LidarExplorer/index.html

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

CCRM Comprehensive inventory of shoreline structures (armoring, docks, piers, etc.)

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/virginia/index.php

Citation:

Center for Coastal Resources Management. 2021. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from https://www.vims.e

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Scale 1:12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series 2002-2006

Overview:

Comprehensive inventory of shoreline structures (armoring, docks, piers, etc.) in Coastal Maryland

Methodology:

The data inventory developed for the Shoreline Situation Report is based on a three-tiered shoreline assessment approach. In most cases this assessment characterizes conditions that can be observed from a small boat navigating along the shoreline. Hand-held GPS units are used to log features observed. The three tiered shoreline assessment approach divides the shore zone into three regions: 1) the immediate riparian zone, evaluated for land use; 2) the bank, evaluated for height, stability, cover and natural protection; and 3) the shoreline, describing the presence of shoreline structures for shore protection and recreational access.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management. 2021. Maryland Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from http://https://www

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Delaware Shoreline Inventory - Indian River Watershed**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: Online Viewer; GIS Data; Summ **Resolution:** 1:12,000

Geography Covered: Delaware - Indian River Watershed

Date Range of Data Series of phases beginning in 2005

Overview:

Comprehensive inventory of shoreline structures (armoring, docks, piers, etc.)

Methodology:

Each inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes.

One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

O'Brien, D.L., Jacobs, A., Berman, M.R., Rudnicky, T., McLaughlin, E., Howard, A., 2007. Refinement and validation of a multi-level assessment method for Mid-Atlantic tidal wetlands. Center for Coastal Resources Management, Virginia Institute of Marine Sc

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **CCRM Shoreline Permit Database**

Data Source: Center for Coastal Resources (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: Tabular Data **Resolution:** NA

Geography Covered: Coastal Virginia

Date Range of Data 1970-present

Overview:

Database of Joint Permit Applications submitted to the Virginia Marine Resources Commission (VMRC) involving shoreline erosion activities; includes information on shoreline project type as defined by CCRM, geo-location in latitude and longitude, consistency with Virginia shoreline management guidance, approval, status, contractor, agent, property owner, fetch, etc.

Methodology:

Information obtained Joint Permit Applications (JPAs) involving shoreline erosion activity submitted to the Virginia Marine Resources Commission (VMRC) is categorized and defined by CCRM and entered into a Microsoft Access database.

Available online? No

Data Link: NA

Citation:

Center for Coastal Resources Management (CCRM). 2017. Shoreline Permit Database. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **VMRC Habitat Management Permits and Applications**

Data Source: Virginia Marine Resource Commission (VMRC)

Data Type: Online viewer with tabular data **Resolution:** Not Applicable

Geography Covered: Virginia

Date Range of Data Approximately 1970 to present

Overview:

Database of environmental permits issued by the Habitat Management Division including three types; subaqueous or bottomlands, tidal wetlands, and coastal primary sand dunes. These permits include shoreline erosion control structures. The division's authority and responsibilities emanate from Subtitle III of Title 28.2 of the Code of Virginia and specifically regulates physical encroachment into these valuable resource areas.

Methodology:

Data from Joint Permit Applications submitted to the Virginia Marine Resources Commission are provided in online viewer and search results available for download in Excel and PDF.

Available online? Yes

Data Link: https://webapps.mrc.virginia.gov/public/habitat/

Citation:

Virginia Marine Resources Commission (VMRC). 2021. Habitat Management Permits and Applications. Virginia Marine Resources Commission, Newport News, Virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Shoreline Defense Structure Permits

Data Name: **VIMS Shoreline Permit Records Website Database**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS); Virginia Marine Resources Commission (VMRC)

Data Type: Searchable online database **Resolution:** Not Applicable

Geography Covered: Coastal Virginia

Date Range of Data 1971-2015

Overview:

Searchable website to access scanned Joint Permit Applications (and other permit supporting documents) submitted to Virginia Marine Resources Commission (VMRC) for tidal wetland, beach and dune, and subaqueous impacts from 1970 to approximately 2015.

Methodology:

Joint Permit Applications submitted to Virginia Marine Resources Commission (VMRC) and associated permit support documents scanned into searchable online -folders

Available online? Yes

Data Link: http://ccrm.vims.edu/perms/newpermits.html

Citation:

VIMS Shoreline Permit Records Website Database (2015). Website database. Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science. William & Mary, Gloucester Point, VA.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Delaware Permit Search**

Data Source: Delaware Dept of Natural Resources and Environmental Control

Data Type: Searchable Records **Resolution:** NA

Geography Covered: Delaware

Date Range of Data Varies

Overview:

Website with field attributes used to search for specific permit types

Methodology:

Website with fields to search for permit types in Delaware

Available online? Yes

Data Link: http://www.nav.dnrec.delaware.gov/den3/Search/PermitSearch.aspx

Citation:

Permit Search (2021). Permit Search Website. Delaware.gov. http://www.nav.dnrec.delaware.gov/den3/Search/PermitSearch.aspx?issueStartDate=&issueEndDate=&expirationStartDate=&expirationEndDate=&type=30&status=F&pitypeid=89

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Delaware Shoreline Inventory - National Estuarine Research Reserve Sites**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data, online viewer, summa **Resolution:** 1:12,000

Geography Covered: Delaware (Appoquinimink River, Blackbird Creek, St Jones River)

Date Range of Data 2007

Overview:

Comprehensive inventory of shoreline structures (armoring, docks, piers, etc.) along a portion of Delaware shoreline

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory: Rehoboth Bay, SRAMSOE #435, Comprehensive Coastal Inventory Program, Center for Coastal Resources Ma

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Delaware Shoreline Inventory - Rehoboth Bay**

Data Source: Center for Coastal Zone Management (CCRM), Virginia Institute of Marine Science (VIMS), William & Mary

Data Type: GIS Data, online viewer, summa **Resolution:** 1:12,000

Geography Covered: Delaware - Rehoboth Bay

Date Range of Data 2012

Overview:

Comprehensive inventory of shoreline structures (armoring, docks, piers, etc.) in Rehoboth Bay

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory: Rehoboth Bay, SRAMSOE #435, Comprehensive Coastal Inventory Program, Center for Coastal Resources Ma

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **MDE Wetland Waterways Permits - Watershed Resources Registry**

Data Source: Maryland Department of the Environment

Data Type: Map Viewer and GIS Data **Resolution:** NA

Geography Covered: Maryland

Date Range of Data Varies

Overview:

Points of permitted activities including shoreline structures such as bulkhead, revetments, etc. along Maryland shoreline

Methodology:

Maryland Wetlands and Waterway Permit Sites

Available online? Yes

Data Link: https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Citation:

MDE Wetland Waterway Permits (2021). Map viewer and GIS data. Watershed Resources Registry, Maryland Department of the Environment. https://watershedresourcesregistry.org/map/?config=stateConfigs/maryland.json&screening=on

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Beach Nourishment

Data Name: **National Beach Nourishment Viewer**

Data Source: NOAA Office for Coastal Management, Program for the Study of Developed Shoreline

Data Type: Online viewer (table, chart and **Resolution:** Unknown

Geography Covered: National

Date Range of Data 1923-2019

Overview:

This viewer provides access to a database containing general location of sand placement, primary funding source and funding type, volume of placed sediment, length of nourished beach, and cost and inflated cost for over 2,000 beach nourishment projects dating back to 1923.

Methodology:

This site provides a portal to PSDS' beach nourishment database: a 25-year research and data collection effort that, to the best of our knowledge, represents the most comprehensive compilation of beach nourishment history in the United States.

Available online? Yes

Data Link: https://beachnourishment.wcu.edu/oneState?state=VA

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Beach Nourishment

Data Name: **National Beach Nourishment Database**

Data Source: NOAA, American Shore and Beach Preservation Association, Army Corps of Engineers Regional Sediment Management Program

Data Type: Map Viewer; GIS Data **Resolution:** Unknown

Geography Covered: National

Date Range of Data 1951-2020

Overview:

This database features information on nearly 400 projects that have placed nearly 1.5 billion cubic yards of sand along the continental U.S. coastline. The database includes the number of nourishment events, oldest project, newest project, known total cost, total volume, and known length. Pie charts for each project also indicate whether the project was a federal beach nourishment, a regional sediment management placement of dredged navigation sand on the beach, or other type of project such as state, local, or privately sponsored.

Methodology:

The database was updated internally in 2012 using over 65 individual data sources including the Program for the Study of Developed Shorelines at Western Carolina University, SANDAG, Florida Department of Environmental Protection, as well as personal communication with many of the 1,000 ASBPA members nationwide. Also now visible is a separate online geodatabase called the Navigation Sediment Database which classifies sediment placement types for USACE dredging projects. This online geodatabase, developed in a collaboration with the U.S. Army Corps of Engineers (USACE) Regional Sediment Management Program, contains data from the 2012 version, described above, updated with information from new state publications, such as the N.C. Beach and Inlet Management Plan, the USACE Dredging Information System, and personal communication with our members, particularly the ASBPA Science and Technology Committee. Members include state beach managers, industry professionals, universities, communities, the USACE, and other agencies. The research objective of the database is to understand the anthropogenic influence on long-term coastal change. The applied objective is to provide our members and the public with detailed information on U.S. nourishment projects at the National, State, and Project level.

Available online? Yes

Data Link: https://gim2.aptim.com/ASBPANationwideRenourishment

Citation:

Elko, N., Briggs, T.R., Benedet, L., Robertson, W., Thomson, G., Webb, B.M., Garvey, K., 2021. A Century of U.S. Beach Nourishment. Ocean & Coastal Management, 199(2021) 105406, ISSN 0964-5691, https://doi.org/10.1016/j.ocecoaman.2020.105406

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Current as of: September 2022

Chesapeake Bay Program
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Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Hardened Shoreline

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Scale 1:12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002 - 2006

Overview:

The data inventory developed for the Shoreline Situation Report is based on a three-tiered shoreline assessment approach. In most cases this assessment characterizes conditions that can be observed from a small boat navigating along the shoreline. Hand-held GPS units are used to log features observed. The three tiered shoreline assessment approach divides the shore zone into three regions: 1) the immediate riparian zone, evaluated for land use; 2) the bank, evaluated for height, stability, cover and natural protection; and 3) the shoreline, describing the presence of shoreline structures for shore protection and recreational access.

Methodology:

Three GIS coverages are developed from GPS datasets collected in the field. The lubc coverage are features related to land use in the riparian zone, and conditions at the bank. This is an arc coverage. The sstruc coverage includes information pertaining to structures for shoreline defense. This is an arc coverage. Finally, astruc identifies structures that are typically built for access and recreational activities at the shore. This is a point coverage.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Riparian Land Use

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970's to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. This Shoreline Inventory report continues a process which updates and expands the earlier reports.

Methodology:

Shoreline attributes recorded by boat with a GPS unit with a horizontal accuracy of +/- 5 meters. Data transferred from GPS boat track to existing digital shoreline coverage by projecting data to the shoreline at a 90-degree angle from the boat track. Positional accuracy for data that has been corrected with imagery which has a resolution of 2 meters or better. Time period: 1998-2013. Using the latest VBMP (2009, 2011, 2013, 2015, or 2017 depending on locality) imagery as a background, conditions visible on shore were used to code a digital shoreline created using VBMP imagery at a scale of 1:1000. Conditions were also verified using Google Earth, Bing Birds Eye, VBMP 2011, and VBMP 2009 imagery. Time period: 2013 to 2019. Data reports conditions surveyed in the immediate riparian zone, bank, and along shoreline. Dataset is the result of combining the most recent digital shoreline inventories for Virginia. Three shapefiles are part of the Shoreline Inventory database: *lubc (land use and bank cover), *astru (access structures), and *sstru (shoreline structures). For more information, visit http://www.vims.edu/ccrm/research/inventory/virginia/index.php.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/index.php

Citation:

Center for Coastal Resources Management. 2019. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Riparian Land Use

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1: 12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970s to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each of the Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. The techniques developed for Virginia's shoreline are used to create similar reports for the Maryland shoreline. Data collected describes conditions in the immediate riparian zone, the bank, and along the shore. These data should not be used for jurisdictional permit determinations beyond providing general shoreline condition or status information. These data have not been surveyed to property boundaries. This is a MD iMAP hosted service. Find more information on https://imap.maryland.gov.

Methodology:

The statewide shoreline inventory was accomplished in a series of phases over four years beginning in 2002. Tidal shoreline was digitally generated from digital ortho-imagery (DOQQs) for all tidal localities in Maryland. Shorelines have been surveyed using Global Positioning Systems (GPS) following protocols developed by VIMS Comprehensive Coastal Inventory. Handheld GPS units log conditions observed from a shoal draft boat moving along the shoreline. Riparian land use, bank characteristics, shoreline modifications, shoreline habitat, and bank and shoreline stability are classified. All shoreline data collected in the field are processed using GIS techniques and corrected to the shoreline basemap developed from DOQQs. Frequency analyses are run to compute distribution of features and conditions surveyed. Following a rigorous series of quality control measures, final maps are developed to
illustrate shoreline conditions for the locality. A three-part plate series uses a combination of colors and symbols to depict riparian land use, bank condition, and shoreline features. Tables report cumulative conditions for each plate or each major tributary. Final report, maps, and processed GIS data are available at
http://ccrm.vims.edu/disclaimer_shoreline_situation.html.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Bank Height

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1:12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

Data collected describes conditions in the immediate riparian zone, the bank, and along the shore. These data should not be used for jurisdictional permit determinations beyond providing general shoreline condition or status information. These data have not been surveyed to property boundaries. This is a MD iMAP hosted service.

Methodology:

Depending upon age of inventory, bank heights were visually determined using shorelines and elevation data. Some bank heights were determined by extracting heights from lidar DEMs using a geoprocessing model protocol. The statewide shoreline inventory was accomplished in a series of phases over four yearsbeginning in 2002. Tidal shoreline was digitally generated from digital ortho-imagery(DOQQs) for all tidal localities in Maryland. Shorelines have been surveyed usingGlobal Positioning Systems (GPS) following protocols developed by VIMS Comprehensive Coastal Inventory. Handheld GPS units log conditions observed from a shoal draft boat moving along the shoreline.Riparian land use, bank characteristics, shoreline modifications, shoreline habitat, and bank and shoreline stability are classified.All shoreline data collected in the field are processed using GIS techniques and correctedto the shoreline basemap developed from DOQQs. Frequency analyses are run tocompute distribution of features and conditions surveyed.Following a rigorous series of quality control measures, final maps are developed toillustrate shoreline conditions for the locality. A three part plate series uses acombination of colors and symbols to depict riparian land use, bank condition, andshoreline features. Tables report cumulative conditions for each plate or each majortributary. Final report, maps, and processed GIS data are available on a websitehttp://ccrm.vims.edu/disclaimer_shoreline_situation.html.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Phragmites

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1: 12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970s to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each of the Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. The techniques developed for Virginia's shoreline are used to create similar reports for the Maryland shoreline. Data collected describes conditions in the immediate riparian zone, the bank, and along the shore. These data should not be used for jurisdictional permit determinations beyond providing general shoreline condition or status information. These data have not been surveyed to property boundaries. This is a MD iMAP hosted service. Find more information on https://imap.maryland.gov.

Methodology:

The statewide shoreline inventory was accomplished in a series of phases over four yearsbeginning in 2002. Tidal shoreline was digitally generated from digital ortho-imagery(DOQQs) for all tidal localities in Maryland. Shorelines have been surveyed usingGlobal Positioning Systems (GPS) following protocols developed by VIMS Comprehensive Coastal Inventory. Handheld GPS units log conditions observed from a shoal draft boat moving along the shoreline.Riparian land use, bank characteristics, shoreline modifications, shoreline habitat, and bank and shoreline stability are classified.All shoreline data collected in the field are processed using GIS techniques and correctedto the shoreline basemap developed from DOQQs. Frequency analyses are run tocompute distribution of features and conditions surveyed.Following a rigorous series of quality control measures, final maps are developed toillustrate shoreline conditions for the locality. A three part plate series uses acombination of colors and symbols to depict riparian land use, bank condition, andshoreline features. Tables report cumulative conditions for each plate or each majortributary. Final report, maps, and processed GIS data are available on a websitehttp://ccrm.vims.edu/disclaimer_shoreline_situation.html.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Access Structures

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1:12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

Dataset contains information about the shoreline access structures along the shoreline (e.g. docks, boathouse, boat ramps, etc.) Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970s to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each of the Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. The techniques developed for Virginia's shoreline are used to create similar reports for the Maryland shoreline. Data collected describes conditions in the immediate riparian zone, the bank, and along the shore. These data should not be used for jurisdictional permit determinations beyond providing general shoreline condition or status information. These data have not been surveyed to property boundaries. This is a MD iMAP hosted service. Find more information on https://imap.maryland.gov.

Methodology:

The statewide shoreline inventory was accomplished in a series of phases over four yearsbeginning in 2002. Tidal shoreline was digitally generated from digital ortho-imagery(DOQQs) for all tidal localities in Maryland. Shorelines have been surveyed usingGlobal Positioning Systems (GPS) following protocols developed by VIMS Comprehensive Coastal Inventory. Handheld GPS units log conditions observed from a shoal draft boat moving along the shoreline.Riparian land use, bank characteristics, shoreline modifications, shoreline habitat, and bank and shoreline stability are classified.All shoreline data collected in the field are processed using GIS techniques and correctedto the shoreline basemap developed from DOQQs. Frequency analyses are run tocompute distribution of features and conditions surveyed.Following a rigorous series of quality control measures, final maps are developed toillustrate shoreline conditions for the locality. A three part plate series uses acombination of colors and symbols to depict riparian land use, bank condition, andshoreline features. Tables report cumulative conditions for each plate or each majortributary. Final report, maps, and processed GIS data are available on a websitehttp://ccrm.vims.edu/disclaimer_shoreline_situation.html.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Marsh Buffer

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1:12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

Dataset contains information marsh presence along the shoreline. Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970s to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each of the Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. The techniques developed for Virginia's shoreline are used to create similar reports for the Maryland shoreline. Data collected describes conditions in the immediate riparian zone, the bank, and along the shore. These data should not be used for jurisdictional permit determinations beyond providing general shoreline condition or status information. These data have not been surveyed to property boundaries. This is a MD iMAP hosted service. Find more information on https://imap.maryland.gov.

Methodology:

The statewide shoreline inventory was accomplished in a series of phases over four yearsbeginning in 2002. Tidal shoreline was digitally generated from digital ortho-imagery(DOQQs) for all tidal localities in Maryland. Shorelines have been surveyed usingGlobal Positioning Systems (GPS) following protocols developed by VIMS Comprehensive Coastal Inventory. Handheld GPS units log conditions observed from a shoal draft boat moving along the shoreline.Riparian land use, bank characteristics, shoreline modifications, shoreline habitat, and bank and shoreline stability are classified.All shoreline data collected in the field are processed using GIS techniques and correctedto the shoreline basemap developed from DOQQs. Frequency analyses are run tocompute distribution of features and conditions surveyed.Following a rigorous series of quality control measures, final maps are developed toillustrate shoreline conditions for the locality. A three part plate series uses acombination of colors and symbols to depict riparian land use, bank condition, andshoreline features. Tables report cumulative conditions for each plate or each majortributary. Final report, maps, and processed GIS data are available on a websitehttp://ccrm.vims.edu/disclaimer_shoreline_situation.html.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Bank Cover

Data Name: **Maryland Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1:12,000

Geography Covered: Coastal Maryland

Date Range of Data Locality based series from 2002-2021

Overview:

Data collected describes bank cover conditions (total, partial, bare) in the immediate riparian zone, the bank, and along the shore. Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970s to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each of the Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. The techniques developed for Virginia's shoreline are used to create similar reports for the Maryland shoreline. Data collected describes conditions in the immediate riparian zone, the bank, and along the shore. These data should not be used for jurisdictional permit determinations beyond providing general shoreline condition or status information. These data have not been surveyed to property boundaries. This is a MD iMAP hosted service. Find more information on https://imap.maryland.gov.

Methodology:

The statewide shoreline inventory was accomplished in a series of phases over four yearsbeginning in 2002. Tidal shoreline was digitally generated from digital ortho-imagery(DOQQs) for all tidal localities in Maryland. Shorelines have been surveyed usingGlobal Positioning Systems (GPS) following protocols developed by VIMS Comprehensive Coastal Inventory. Handheld GPS units log conditions observed from a shoal draft boat moving along the shoreline.Riparian land use, bank characteristics, shoreline modifications, shoreline habitat, and bank and shoreline stability are classified.All shoreline data collected in the field are processed using GIS techniques and correctedto the shoreline basemap developed from DOQQs. Frequency analyses are run tocompute distribution of features and conditions surveyed.Following a rigorous series of quality control measures, final maps are developed toillustrate shoreline conditions for the locality. A three part plate series uses acombination of colors and symbols to depict riparian land use, bank condition, andshoreline features. Tables report cumulative conditions for each plate or each majortributary. Final report, maps, and processed GIS data are available on a websitehttp://ccrm.vims.edu/disclaimer_shoreline_situation.html.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Citation:

Center for Coastal Resources Management (CCRM), 2021. Maryland Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/maryland/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Bank Cover

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data

Resolution: Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970's to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. This Shoreline Inventory report continues a process which updates and expands the earlier reports. Data collected reports conditions surveyed in the immediate riparian zone, the bank, and along the shoreline. This dataset is the result of combining the most recent digital shoreline inventories for Virginia.

Methodology:

Shoreline attributes recorded by boat with a GPS unit with a horizontal accuracy of +/- 5 meters. Data transferred from GPS boat track to existing digital shoreline coverage by projecting data to the shoreline at a 90-degree angle from the boat track. Positional accuracy for data that has been corrected with imagery which has a resolution of 2 meters or better. Time period: 1998-2013. Using the latest VBMP (2009, 2011, 2013, 2015, or 2017 depending on locality) imagery as a background, conditions visible on shore were used to code a digital shoreline created using VBMP imagery at a scale of 1:1000. Conditions were also verified using Google Earth, Bing Birds Eye, VBMP 2011, and VBMP 2009 imagery. Time period: 2013 to 2019. Data reports conditions surveyed in the immediate riparian zone, bank, and along shoreline. Dataset is the result of combining the most recent digital shoreline inventories for Virginia. Three shapefiles are part of the Shoreline Inventory database: *lubc (land use and bank cover), *astru (access structures), and *sstru (shoreline structures). For more information, visit http://www.vims.edu/ccrm/research/inventory/virginia/index.php.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/index.php

Citation:

Center for Coastal Resources Management. 2019. Virginia Shoreline Inventory Database. Center for Coastal Resources Management, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia. Retrieved from https://www.vims.e

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **Virginia Shoreline Inventory**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** Scale 1:1,000

Geography Covered: Coastal Virginia

Date Range of Data Locality based series from 2002 - 2021

Overview:

Shoreline stabilization structures that include marsh toe revetments and breakwaters are included in this dataset. Shoreline Situation Reports (SSR) were first generated by VIMS in the 1970's to report the condition and status of the shore lands. The SSR series were published in hardcopy on a county by county basis for each Tidewater Virginia localities. The reports were intended to assist planners, managers, and regulators in decisions pertaining to management of coastal areas and natural resources therein. This Shoreline Inventory report continues a process which updates and expands the earlier reports. Data collected reports conditions surveyed in the immediate riparian zone, the bank, and along the shoreline. This dataset is the result of combining the most recent digital shoreline inventories for Virginia.

Methodology:

Shoreline attributes recorded by boat with a GPS unit with a horizontal accuracy of +/- 5 meters. Data transferred from GPS boat track to existing digital shoreline coverage by projecting data to the shoreline at a 90-degree angle from the boat track. Positional accuracy for data that has been corrected with imagery which has a resolution of 2 meters or better. Time period: 1998-2013. Using the latest VBMP (2009, 2011, 2013, 2015, or 2017 depending on locality) imagery as a background, conditions visible on shore were used to code a digital shoreline created using VBMP imagery at a scale of 1:1000. Conditions were also verified using Google Earth, Bing Birds Eye, VBMP 2011, and VBMP 2009 imagery. Time period: 2013 to 2019. Data reports conditions surveyed in the immediate riparian zone, bank, and along shoreline. Dataset is the result of combining the most recent digital shoreline inventories for Virginia. Three shapefiles are part of the Shoreline Inventory database: *lubc (land use and bank cover), *astru (access structures), and *sstru (shoreline structures). For more information, visit http://www.vims.edu/ccrm/research/inventory/virginia/index.php.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/index.php

Citation:

enter for Coastal Resources Management (CCRM), 2021. Virginia Shoreline Inventory. Virginia Institute of Marine Science, William & Mary. https://www.vims.edu/ccrm/research/inventory/index.php

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Bank Height

Data Name: **Delaware Shoreline Inventory - Rehoboth Bay**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1:12,000

Geography Covered: Delaware - Rehoboth Bay

Date Range of Data 2012

Overview:

Comprehensive inventory of Bank Height shoreline conditions along Rehoboth Bay shoreline

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

Berman, M., Killeen, S., Hershner, C., Nunez, K., Reay, K., Angstadt, K., Rudnicky, T., Schatt, D., & Stanhope,D. (2013) Rehoboth Bay, Delaware Shoreline Inventory Report Methods and Guidelines. Special Report inApplied Marine Science and Ocean Engine

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/LandCover (Current and Projected)

Category Riparian Land Use

Data Name: **Delaware Shoreline Inventory - Rehoboth Bay**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data **Resolution:** 1:12,000

Geography Covered: Delaware - Rehoboth Bay

Date Range of Data 2012

Overview:

Comprehensive inventory of Riparian Land Use shoreline conditions along Rehoboth Bay shoreline

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

Berman, M., Killeen, S., Hershner, C., Nunez, K., Reay, K., Angstadt, K., Rudnicky, T., Schatt, D., & Stanhope,D. (2013) Rehoboth Bay, Delaware Shoreline Inventory Report Methods and Guidelines. Special Report inApplied Marine Science and Ocean Engine

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Shoreline Erosion

Category Bank Height

Data Name: **Delaware Shoreline Inventory - National Estuarine Research Reserve Sites**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data, online viewer, summa **Resolution:** 1:12,000

Geography Covered: Delaware (Appoquinimink River, Blackbird Creek, St Jones River)

Date Range of Data 2007

Overview:

Comprehensive inventory of bank height shoreline conditions along portions of Delaware shoreline

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory: Rehoboth Bay, SRAMSOE #435, Comprehensive Coastal Inventory Program, Center for Coastal Resources Ma

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Marsh, Beach, Phragmites

Data Name: **Delaware Shoreline Inventory - National Estuarine Research Reserve Sites**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data, online viewer, summa **Resolution:** 1:12,000

Geography Covered: Delaware (Appoquinimink River, Blackbird Creek, St Jones River)

Date Range of Data 2007

Overview:

Comprehensive inventory of shoreline conditions including Marsh, Beach, & Phragmites along portions of Delaware shoreline

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

Berman, M.R., Hershner, C.H., Angst, K., Killeen, S., Nunez, K., Rudnicky, T., Schatt, D., Stanhope, D., and D. Weiss, 2013. Delaware Shoreline Inventory: Rehoboth Bay, SRAMSOE #435, Comprehensive Coastal Inventory Program, Center for Coastal Resources Ma

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Landuse/Landcover (Current and Projected)

Category Riparian Land Use

Data Name: **Delaware Shoreline Inventory - Indian River Watershed**

Data Source: Center for Coastal Resources Management (CCRM), Virginia Institute of Marine Science (VIMS)

Data Type: GIS Data, online viewer, summa **Resolution:** 1:12,000

Geography Covered: Delaware - Indian River Watershed

Date Range of Data 2005

Overview:

Comprehensive inventory of shoreline conditions including Riparian Land Use in Indian River Watershed, Delaware

Methodology:

Inventory was generated using on-screen, digitizing techniques in ArcGIS while viewing conditions observed in the most recent imagery available. The geographic extent of each inventory is first defined with a shoreline shapefile. Three GIS shapefiles are then generated from the digitized shoreline to classify various shoreline conditions, also called attributes. One shapefile describes land use and bank conditions, the second reports shoreline structures that are described as arcs or lines, and the third shapefile includes all structures that are represented as points. A metadata file is provided with the shapefiles to define attribute accuracy, data development, and any use restrictions that pertain to the inventory data.

Available online? Yes

Data Link: https://www.vims.edu/ccrm/research/inventory/delaware/index.php

Citation:

O'Brien, D.L., Jacobs, A., Berman, M.R., Rudnicky, T., McLaughlin, E., Howard, A., 2007. Refinement and validation of a multi-level assessment method for Mid-Atlantic tidal wetlands. Center for Coastal Resources Management, Virginia Institute of Marine Sc

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Phragmites

Data Name: **Invasive Phragmites Experiment**

Data Source: SERC Global Change Research Wetland

Data Type: Tabular Data

Resolution: Unknown

Geography Covered: Edgewater, MD

Date Range of Data 2011-2019

Overview:

This is data from a chamber experiment conducted at SERC to understand the response of invasive Phragmites australis to climate change. Specifically, the experiment was designed to test how invasion rates of introduced Phragmites australis will respond to elevated carbon dioxide and nitrogen pollution with consideration for the importance of genetic diversity.

Methodology:

In 2011, the scientists in SERC's Global Change Research Wetland (GCREW) set up 12 open-top chambers on the border of a Phragmites invasion front. They built the chambers so that one-third of each chamber enclosed the encroaching Phragmites stand into the native marsh. This set up allowed them to track not only Phragmites' response to global change, but the rate of its invasion across the marsh. Inside half of the chambers, they raised the carbon dioxide concentration from 340 to 700 parts per million. Half of the plots also received 25g of nitrogen per year, simulating a more polluted marsh.

Available online? Yes

Data Link: https://serc.si.edu/gcrew/phragmitesdata

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Type and Extent of Shoreline Alterations

Category Living Shorelines

Data Name: **TNC Coastal Resilience Map portal**

Data Source: The Nature Conservancy

Data Type: Map Viewer

Resolution: Unknown

Geography Covered: Virginia's Eastern Shore

Date Range of Data Varies

Overview:

These maps allow a user to identify areas suitable for nature-based shoreline enhancement techniques. Suitability is determined using living shoreline engineering guidelines.

Methodology:

This model combines information from 2 sub-models: The Living Shoreline Explorer Model and the Marsh Vulnerability Index. The Living Shoreline Explorer Model considers five variables: wind wave and boat wake exposure, the elevation and shape of the marsh edge, and marsh vegetation characteristics. The Marsh Vulnerability Index leverages high resolution spatial data on eight tidal salt marsh erosion variables: wind wave and boat wake exposure, the elevation and shape of the marsh edge, marsh vegetation characteristics, current rate of sea level rise, and moderate intensity storm surge. Variables are assigned a risk value in the range of 1 to 5 in order of increasing vulnerability and combined via a simple spatial computation to reveal erosion and inundation vulnerability.

Available online? Yes

Data Link: https://maps.coastalresilience.org/virginia/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Assessments of Marsh Resilience

Category Coastal Wetlands

Data Name: **TNC Coastal Resilience Map portal**

Data Source: The Nature Conservancy

Data Type: Map Viewer

Resolution: Unknown

Geography Covered: Virginia's Eastern Shore

Date Range of Data Varies

Overview:

These maps show the vulnerability of marshes to a variety of stressors, including: wind wave and boat wake energy, current rate of sea level rise, and moderate intensity storm surge.

Methodology:

The Marsh Vulnerability Index is a spatial modeling tool which determines the vulnerability of tidal salt marshes to erosion and inundation on the Virginia Eastern Shore. The Marsh Vulnerability Index leverages high resolution spatial data on eight tidal salt marsh erosion variables: wind wave and boat wake exposure, the elevation and shape of the marsh edge, marsh vegetation characteristics, current rate of sea level rise, and moderate intensity storm surge. Variables are assigned a risk value in the range of 1 to 5 in order of increasing vulnerability and combined via a simple spatial computation to reveal erosion and inundation vulnerability.

Available online? Yes

Data Link: https://maps.coastalresilience.org/virginia/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Distribution of Natural Resources

Category Tidal Wetlands

Data Name: **TNC Coastal Resilience Map portal**

Data Source: The Nature Conservancy

Data Type: Map Viewer

Resolution: Unknown

Geography Covered: Virginia's Eastern Shore

Date Range of Data Future

Overview:

This map shows how the size and distribution of tidal marshes and other coastal habitats may change in response to future projected sea-level rise scenarios. The tool allows the user to select different scenarios and years and filter by particular habitats and/or area. Data can be easily downloaded from the site.

Methodology:

The maps were generated from the Sea Level Affecting Marshes Model (SLAMM) that incorporates elevation, land cover and wetland extent with locally derived empirical data on tides, accretion and erosion rates to predict where tidal marshes may migrate upland in response to changes in sea level over time. Relative sea-level rise scenarios are based on the intermediate-low, intermediate, high and extreme projections from the 2017 National Climate Assessment that have been adjusted for local land subsidence rates by the Virginia Institute of Marine Science. For each of the four sea-level rise curves, the model was run for the following years: 2030, 2050, 2075, and 2100.

Available online? Yes

Data Link: https://maps.coastalresilience.org/virginia/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022

Shoreline, Sea Level Rise, and Marsh Migration Data for Wetland Restoration Targeting Metadata Fact Sheet

Topic: Surface Elevation Table Distribution

Category Coastal Wetlands

Data Name: **Chesapeake Bay Sentinel Site Cooperative SET Inventory**

Data Source: Maryland Sea Grant/NOAA

Data Type: Map Viewer and GIS Data **Resolution:** NA

Geography Covered: Chesapeake Bay and coastal bays

Date Range of Data Varies

Overview:

This site provides data from a collection of Surface Elevation Table (SET) sampling stations throughout the tidal marshes in the Chesapeake Bay. Sentinel sites are discrete locations across the Bay region where researchers conduct intensive studies and sustained observations to detect and understand changes in coastal ecosystems. They include: Assateague National Seashore, Blackwater National Wildlife Refuge, Chesapeake Bay National Estuarine Research Reserve –Maryland, Chesapeake Bay National Estuarine Research Reserve –Virginia, Paul S Sarbanes Ecosystem Restoration Project at Poplar Island, Smithsonian Environmental Research Center, Virginia Coast Reserve Long Term Ecological Research, and Virginia Commonwealth University Rice Rivers Center.

Methodology:

A SET is a portable, mechanical leveling device that, when attached to an in situ reference mark, enables the measurement of surface elevation change over time allowing insight into how well the marsh can withstand local sea level rise. The ecosystem within which the SET station is located affects the potential for sediments to accumulate on wetland surfaces, so several ecological parameters are included in the metadata. How each organization operates and measures the SETs determines the availability of data. Methods vary slightly by the originator of the data, users should examine the associated metadata to determine specific methods.

Available online? Yes

Data Link: http://chesapeakebayssc.org/maps/

Citation:

Not Provided

Prepared by: The Center for Coastal Resources Management
Virginia Institute of Marine Science
William & Mary
Current as of: September 2022