

GREENHOUSE GAS REDUCTION PROGRAMS

FY 2023

Environment Article, Section 2-1305(c)

DEPARTMENT OF NATURAL RESOURCES

March 2025

Maryland Department of Natural Resources
Climate Mitigation, Adaptation, Education and Outreach
2023 Report

Environmental Article § 2-1305(c), (SB 528, Chapter 38 and HB 570, Chapter 570 in 2022)

Introduction

Climate change is an important consideration under the mission and operations of the Maryland Department of Natural Resources (DNR). The department uses science, data, monitoring and modeling to inform investment decisions, determine impacts to habitat, and understand the potential effects climate change has on our waterways and our communities. The department also leads the Maryland Commission on Climate Change Adaptation and Resiliency Working Group (ARWG), which recommends actions on preparedness from sea level rise and more intense storms, among other anticipated impacts from climate change.

The Maryland Greenhouse Gas Reduction Act (GGRA), required a 25% reduction in greenhouse gas (GHG) emissions from 2006 levels by 2020. The law, reauthorized during the 2016 legislative session, further extended the goal to a 40% reduction by 2030 and again in the 2022 session through the Climate Solutions Now Act (CSNA) has been increased to 60% reduction of gross emissions by 2031 and net-zero emissions by 2045. The department contributes to mitigating greenhouse gasses through managing public and private forests, planting trees, and restoring streams and wetlands. This report reflects changes in how we are calculating the carbon benefits of the programs for the 2031/2045 plan. This document details what the department has done in the past year to contribute to greenhouse gas mitigation and our progress towards the goals laid out in Maryland's Climate Mitigation plan, to be released by the end of 2023. It also details our work providing guidance for climate adaptation and what we have done to provide education and resources on how climate change will impact Marylanders.

Highlight Facts/Figures

- Both Planting and Managing Forests Have Exceeded the 2020 goal and are progressing towards the 2031 goals
- 43,943 Forest Acres Managed in 2022 - 102% of 15 year average.
- 798 Forest Acres Planted in 2022 - 53% of 15 year average.
- The Chesapeake and Atlantic Coastal Bays Trust Fund restored 239.5 acres of wetlands and 20.5 acres of riparian buffers in FY22, and has funded the restoration of 3,527 acres of wetlands and 1,608 acres of riparian buffers since 2009.

Table of Contents

Greenhouse Gas Mitigation Programs	5
1. Managing More Forests to Capture Carbon	5
2. Planting Forests in Maryland	10
3. Maryland's Blue Carbon	14
Wetland Area and Carbon Change in 2030 and 2045	17
4. Biomass for Energy Production	21
5. Increasing Urban Trees to Capture Carbon	23
Overview	34
1. Maryland Coast Smart Council	34
2. Adaptation and Resiliency Working Group of the Maryland Commission on Climate Change	34
3. Chesapeake Bay Program, Management Board and Work Groups	34
2023 Project and Program Updates	35
1. Practice and Place	35
2. Community Engagement and Communication	40
3. Advancing the Science	43

Planning for 2031 and 2045

The department will continue to track all the programs included in GGRA tracking for meeting Maryland's Climate Solutions Now 2031 and 2045 GHG reduction goals. While the 2031 plan is based on a reduction to gross emissions, which does not factor in Maryland's natural carbon sinks from forests and wetlands, the 2045 plan is for the state to reach net-zero emissions, so removals from the atmosphere through natural sinks or carbon removal and storage will need to balance remaining emissions. Taking action now to preserve and enhance our natural carbon sinks is necessary to ensure Maryland is able to meet its ambitious 2045 goal.

There are changes in the 2031/2045 plan relative to what was included in the original 2020 plan to reflect new carbon accounting, scientific data, understanding, and tools. For example, emission of methane from wetlands makes the net GHG impact of restoring wetlands uncertain, so we now only include tidal wetland restoration where methane emissions are typically negligible. The 2031/2045 plan deemphasizes associating carbon outcomes with specific programs, with the exception of tree planting. The 2020 plan measured progress relative to a baseline of no action, whereas for the 2031/2045 plan progress is measured as absolute change in the natural lands carbon sink in Maryland, which is the determining factor for measuring the removal aspect of net GHG emissions (in addition to any future GHG removal technology to be utilized in the state). Taking an inventory approach for measuring progress means that the actions of the state cannot be easily disaggregated from other factors influencing the forest or wetland carbon sink, like sea level rise or increasing disturbance rates in forests due to climate change. We can have confidence that actions like climate smart forest management or wetland restoration will contribute towards increasing the resiliency of these systems, but the degree to which they will increase our natural carbon sink by 2031 or 2045 is difficult to quantify. Conversely, for tree planting we have partnered with Maryland Department of the Environment (MDE) and University of Maryland (UMD) to utilize an advanced model of tree growth and monitoring approach so we can have confidence about the carbon outcomes, and that the program will be additive to the existing forest carbon sink.

While DNR did not realize GHG benefits from 2006-2022 associated with Biomass for Energy Production, Geological Opportunities to Store Carbon, or Creating Ecosystems Markets, work is underway that may produce results during the 2023-2030 period. For example, Maryland is one of eight partner states in the Midwest Region Carbon Sequestration Partnership whose role is to identify, locate, and characterize potential geologic storage opportunities.

Maryland is actively working to promote biomass to energy and anticipates new installations prior to 2030 which will promote the development of markets that support stewardship of forests. Facilities utilizing wood for energy provide financially feasible outlets for otherwise nonmarketable wood, keeps energy dollars within local communities, and adds or preserves local jobs, often in our least prosperous areas. The Maryland Forest Service was awarded Wood Innovations Grant funding in 2021 that was renewed in 2023 from the U.S. Department of Agriculture (USDA) to develop priority projects with the assistance of the Maryland Wood Energy Team. This partnership with the Maryland Clean Energy Center (MCEC), Maryland Department of Commerce, University of Maryland Extension, the USDA Forest Service, and others aim to develop modern, low-emissions wood energy facilities creating new jobs and opening renewable energy markets for underutilized forest products, which will in turn benefit the health of Maryland's sustainable forests. The funding is supporting the staffing of the MCEC Wood

Energy Coordinator in collaboration with the Maryland Wood Energy Team to identify wood energy opportunities throughout the state. The Maryland Forest Service and experts at the USDA Forest Service provide supply mapping and system design assistance to five to ten facilities annually showing high probability for successful conversion to wood fuel.

Maryland is also actively working to advance markets for the forest industry, including advocating for policy changes related to Thermal Renewable Energy Credits (TRECs) that would provide greenhouse gas benefits. MDE commissioned a report released in October of 2023 studying a potential Clean Heat Standard for Maryland which would include qualifying biomass as a source of TRECs. Diverse markets that include outlets for low-value wood from urban tree management, thinning, timber stand improvement help land managers carry out sustainable forestry and generate a mix of forest products.

The US Climate Alliance (USCA) funded a project led by the University of Maryland which worked with partners including DNR, Delaware Department of Natural Resources and Environmental Control, and the World Resource Institute to combine high resolution LiDAR based estimates of forest carbon with annual estimates of forest cover change from satellite imagery. This has been applied to Maryland's greenhouse gas inventory allowing for a better understanding both of how much forest is being lost or gained and how that translates into our carbon budget. This allows the state to more frequently and accurately track progress towards our forestry goals. The estimates of forest change and trees outside of forests. The resulting inventory estimates have been integrated into Maryland's 2020 GHG inventory¹ and have been backcasted to 2006 in order to assess progress relative to Maryland's inventory baseline.

Environmental Justice

Environmental Justice (EJ) and Diversity, Equity, Inclusion and Justice (DEIJ) are very important to DNR and the department has made efforts to integrate these factors into departmental operations. Forests and forest management have important connections with environmental justice. For instance, tree canopy has been shown to remove air pollutants and reduce risk of respiratory and cardiac health problems². DNR works to address these issues in Maryland through various programs including tree planting in urban areas. For example, DNR has funded organizations that have planted over 12,000 trees in Baltimore City over the past 10 years.

Environmental justice is also a concern when considering how climate change is impacting our coastal wetlands and communities. Saltwater intrusion is causing some farm acreage to become non-arable and forests to die off every year, particularly on Maryland's lower Eastern Shore. The Maryland Department of Planning has created a saltwater intrusion plan to identify problem areas and suggest viable paths forward, and DNR is examining ways their land conservation and easement programs might allow landowners to receive compensation for lands they are losing by converting them to wetlands.

Additionally, the department uses tools such as the EJ Screening Tool and the Maryland Park Equity Tool with the Chesapeake and Atlantic Coastal Bays Trust Fund and in public lands planning to help identify appropriate areas for green infrastructure investment.

¹ Maryland Department of the Environment. Maryland's Greenhouse Gas Inventory Methodology. <https://mde.maryland.gov/programs/air/climatechange/pages/greenhousegasinventory.aspx>

² U.S. EPA. Environmental Benefits Mapping and Analysis Program: Community Edition (BenMAP-CE) User Manual and Appendices. Research Triangle Park, NC, USA. April, 2017. www.epa.gov/benmap

Greenhouse Gas Mitigation Programs

1. Managing More Forests to Capture Carbon

Program Description

Managing more forests to capture carbon promotes sustainable forestry management practices in existing Maryland forests on both public and private lands. Enrolling unmanaged forests into forest management plans and implementing sustainable forest best management practices can enhance forest productivity, which increases rates of carbon sequestration in forest biomass and the amount of carbon stored in harvested durable wood products, and decreases the risk of forest pest or disease outbreaks. This can translate to economic benefits for the landowner and the forest products industry in Maryland, which had an annual economic impact of over \$3.3 billion in 2019. Over 90% of State Forests are dual certified for sustainable forest management and sustainable practices are regularly implemented on other state owned lands like Wildlife Management Areas and State Parks. Only ~40% of privately owned forests in Maryland are enrolled in forest management plans, with the remaining lands representing opportunities to engage these landowners in sustainable forest management.

The 2020 GGRA goals of this program were to improve sustainable forest management on 30,000 acres of private land annually, and ensure 50% of state-owned forest lands will be third-party certified as sustainably managed. These goals have been achieved; the 2020 15 year target goal for cumulative acres managed was exceeded in 2018. The CSNA 2031 goals of this program are to improve sustainable forest management on 38,000 acres of private land annually, and ensure greater than 50% of state-owned forest lands will continue to be third-party certified as sustainably managed. This annual acreage target was exceeded in 2020, 2021 and 2022.

Carbon Accounting

Sustainable forest management (sometimes referred to as “climate smart forest management”) refers to a broad suite of practices that are meant to increase the health of the forest and meet the management objectives of the landowner. In some cases these practices have clear and measurable benefits in terms of increasing carbon sequestration in the forest (e.g. extended rotations, plantings to increase density), some practices are likely to increase carbon capture but are difficult to quantify (e.g. invasive species removal, deer browse control) and some do not increase carbon sequestration, but are likely to increase the resilience of the forest to climate impacts, increase the economic return of the forest, or improve the quality of wildlife habitat (e.g. timber stand improvement, thinnings).

The department partnered with American Forests, US Forest Service, Northern Institute of Applied Climate Science, Canadian Forest Service, and Michigan State University to identify a broad suite of forest management scenarios for Maryland and simulated forest growth and removals over 150 years. The modeling showed that increasing sustainable forest management practices like extended rotations, deer browse control, restocking, reducing high grading, silvopasture, and afforestation would significantly increase the carbon sink in the state by approximately 47% (0.37 million metric tons carbon dioxide equivalent, MMTCO₂e, per year) by 2050 relative to a business as usual scenario. A no-harvest scenario was simulated as well,

and while this scenario does result in the greatest carbon accumulation within forests over time, it was shown to create conditions where the forest sector became a net emitter of GHGs by 2060. This is due to the leakage of some forest harvest to areas outside of Maryland in response to decreased in-state harvests, forgone carbon storage in long lasting wood products that will no longer be produced, and the likely use of more emission intensive building materials if locally sourced wood was not available.

While this study was useful in identifying relative benefits of different forest management practices, it was not meant to be predictive of the Maryland Greenhouse Gas Reduction Plan. As such, there is not a specific carbon outcome associated with this pathway, but forest management is clearly essential in maintaining and increasing our forest carbon sink. Progress will continue to be tracked and ultimately be reflected in the forest and harvested wood product sinks in Maryland's GHG Inventory.

Implementation Milestones

Public Lands:

- Since 2006, 211,000 acres of State Forests have been certified with dual third party certification for Forest Sustainability to the Sustainable Forestry Initiative and Forest Sustainability Certification standards.
- DNR is developing similar sustainable forest management practices on wildlife land. Forest Stewardship Plans are being developed for State Park lands to control invasive species and improve the health of the forest.
- DNR's Wildlife and Heritage Service is developing Forest Stewardship Plans on several Wildlife Management Areas.
- The DNR has accelerated pace of silvicultural activity:
 - Savage River State Forest will increase the number of timber sales from 14 to 20.
 - State Forest Annual Work Plans included State Forest Annual Work Plans include 3,296 acres of timber harvests planned for FY24 that will be naturally regenerated.

Private Lands:

- Since 2006 we have implemented-
 - 379,561 acres of stewardship plans
 - 225,561 acres of sediment control
 - 124,864 acres of forest stand improvements (e.g., State Forest regeneration, timber stand improvements, wildlife habitat)
 - Total of 729,986 acres of forest management planning activities on private lands
- DNR has met the 2020 goal.

Technical Assistance Provided:

- Forest Stewardship Plan preparation
- Forest Stewardship Plan implementation – expanded Special Rivers project
- Financial assistance – state and federal cost sharing
 - Woodland Incentive Program
 - Healthy Forests/Healthy Waters

- Working on the next round of projects
 - Backyard Buffer Program
 - Environmental Quality Incentive Program (EQIP)
 - Conservation Reserve Enhancement Program (CREP)
 - Income Tax Modification (TAXMOD)
 - Expanded eligibility of forestry practices in 2014
 - Forest Conservation and Management Program
 - Woodland Assessment Program
- Completed the development and application of the University of Maryland remote sensing capability for forest carbon assessment. This work is the basis for the forest carbon sink that has been included in the 2020 GHG Inventory, released by MDE in October 2022.
- Launch of National Aeronautics and Space Administration, U.S. Department of Agriculture and U.S. Department of Energy climate science project for remote sensing, modeling and field-based measurements to quantify the carbon consequences of alternate development and management plans across rapidly changing forests in Maryland.
- Forest Management Study
 - DNR identified a forest management site that utilizes three forest management plans: Low Management (100% hardwoods), Moderate Management (50-70% pines: 30-50% oaks) and High Management (100% pine). DNR's Resource Assessment Service continues to evaluate the below ground carbon sequestration on these management plots to complement the determination of carbon sequestration in the above-ground forest. Baseline data was collected annually from 2011 to 2014. After analysis of the 2014 data, this project was changed to a 5-year sampling interval. Expected project completion is 2030.
- DNR worked with federal partners at the US Department of Commerce and an array of Maryland conservation and economic development agencies to conduct an Economic Adjustment Strategy for the forestry industry in Maryland.

Table 1 Acres of Forest Management

Calendar Year	Stewardship Plan(1)	Sediment Control(1)	State Forest Regeneration(2)	Timber Stand Improvement(1)	Wildlife Habitat(1)	Total Acres
2006	13,834.10	9,113.10	2,417.00	3,092.90	2,172.60	30,629.70
2007	14,135.00	11,204.80	1,731.00	5,925.60	3,331.40	36,327.80
2008	26,787.30	11,692.20	1,823.50	5,611.20	4,146.40	50,060.70
2009	17,936.90	11,044.40	2,234.10	3,789.20	3,212.80	38,217.40
2010	14,921.20	9,539.80	2,158.20	3,178.00	2,070.60	31,867.80
2011	22,012.10	11,585.80	1,891.80	4,496.00	3,302.10	43,287.80
2012	19,486.40	12,177.60	1,723.60	3,910.00	2,705.80	40,003.40
2013	18,945.00	12,235.90	1,524.90	5,054.90	1,062.50	38,823.10
2014	16,580.00	13,100.60	1,249.20	3,072.90	434	34,436.60
2015	23,111.60	13,973.80	1,803.70	5,373.80	279	44,541.90
2016	35,224.30	18,022.10	1,866.60	3,802.10	696.2	59,611.30
2017	24,795.10	18,048.60	2,504.70	3,506.30	1,223.40	50,078.00
2018	26,369.10	16,571.80	2,469.60	3,233.80	525.6	49,170.00
2019	25,145.40	11,547.70	2,324	3,940.40	608.4	43,566.00
2020	26,128	11,466	1,500.00	3,486	716	43,296
2021	31,100.5	16,516.8	1,374.0	1,007.7	328.5	50,327.4
2022	23,048.7	17,720.1	2,026.5	881.8	265.7	43,942.8
Total	379,560.7	225,561.1	34,421.4	63,362.4	27,081.0	729,986.6
Average Annual	22,327.1	13,268.3	2,024.8	3,727.2	1,593.0	42,940.4

From the Maryland Forest Service PMAS report where a calendar year is defined as Quarters 3 & 4 of the preceding year, and Quarters 1 & 2 of the current Fiscal Year. For example, the number for 2006 represents the reported values from PMAS for Q3 & Q4 of 2006 and Q1 & Q2 of 2007.

State Forest harvest acres are only tracked by FY. Number reported from the annual State Forest Harvest Report and harvest data from WMAs and demonstration forests for the same fiscal year.

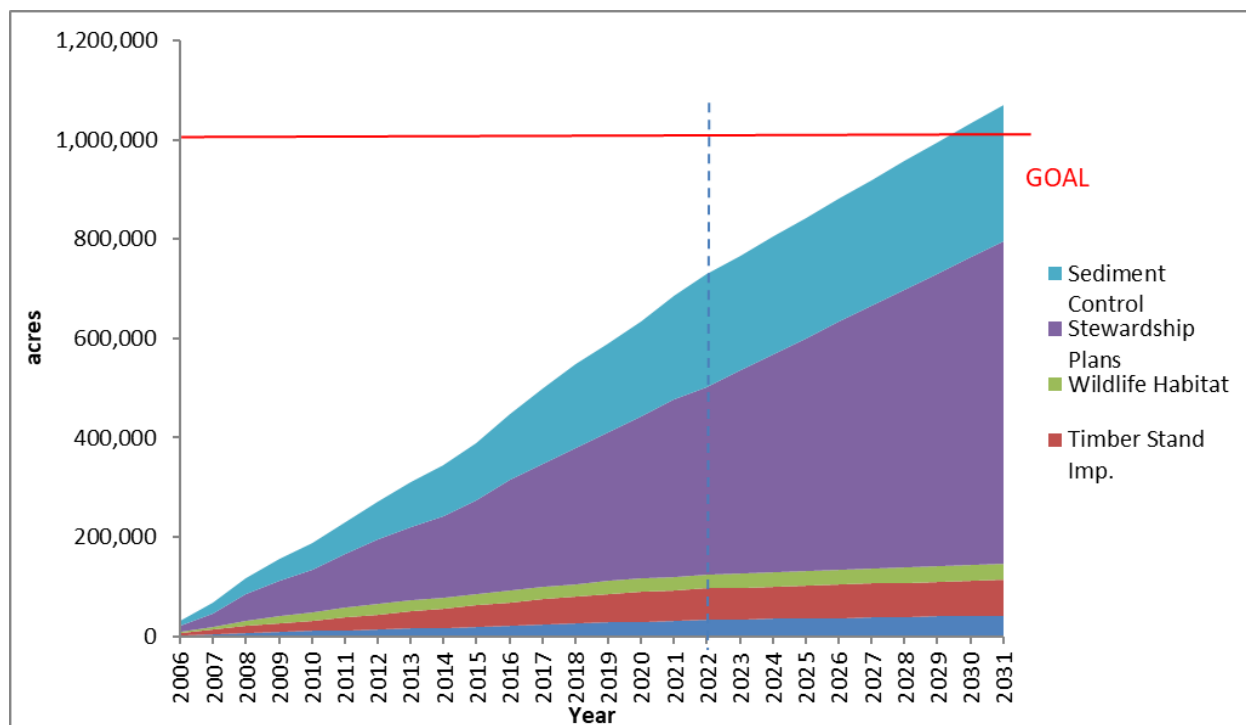


Figure 1: Managing Forests to Capture Carbon. The Maryland Department of Natural Resources is promoting sustainable forestry management practices in existing forests on public and private land through a suite of efforts, policies and programs. The dotted line indicates current progress through 2022.

Enhancement Opportunities

There are many potential actions by federal and non-profit partners other than Maryland state government that could result in increasing natural and working lands' carbon sinks in the state, contributing toward our 60 by 30 goal and the 2045 net-zero goal. Market-based solutions that incentivize public-private partnerships, enhanced outreach to landowners, and additional incentives are examples.

The Nature Conservancy and the American Forest Foundation have partnered to create the Family Forest Carbon Program targeted towards smaller forest landowners. They are working with the carbon verifier Verra to conduct carbon friendly forest management practices on smaller forest parcels and create a practice-based protocol with a much lower cost (~75% less) for verification than traditional approaches. This program has recently expanded to Maryland, and landowners in Garrett, Allegany, Washington, Frederick, and Carroll counties with between 30 and 2,400 acres of forest are eligible to enroll. Landowners sign a contract and agree to conduct specific forest management practices shown to reduce carbon in exchange for regular annual payments over the contract period. Maryland Forest Service foresters began assisting forest landowners with enrollment in November, 2021 and as of October 2023, 31 landowners have enrolled a total of 3,164 acres in the program.

Funding

The Woodland Incentive Fund is the progenitor of much of the activity on private lands. This fund receives revenues from a number of sources including fees for service and assistance in implementation of an approved practice, funding from the Chesapeake and Atlantic Coastal Bays Trust Fund (under § 8-2A-04 of § 5-307), and subject to approval by the secretary and the Board of Public Works, a portion of the revenues derived from the forestry practices on designated lands owned and managed by DNR. Another important revenue source is property tax from the transfer of forest lands (up to \$200,000 per year).

Maryland was recently selected for a \$10 million over four years NRCS Regional Conservation Partnership Program project to conduct tree plantings and climate smart forest management. These additional funds will support technical assistance to landowners and the implementation of projects on agricultural land in Maryland.

Challenges

The lack of a reliable market for low quality wood is a challenge because without the ability to sell wood after thinning, the landowner will bear a cost, even with cost share from the state and often chooses to forgo forest management without the ability for it to pay for itself. Educating the public on the benefits of climate-smart and forest health driven forest management will likely increase the willingness of landowners to implement management actions.

2. Planting Forests in Maryland

Program Description

Planting trees expands forest cover and associated carbon stocks by regenerating or establishing healthy, functional forests through practices such as soil preparation, erosion control, supplemental planting and full site planting. These actions help to ensure optimum conditions to support forest growth and expand forest area. By 2020, the implementation goal of this program was to achieve the afforestation and reforestation of 43,030 acres in Maryland. This goal was exceeded in 2019 with 44,931 cumulative acres planted through 2020. In 2021 the Tree Solutions Now Act was passed, establishing the goal of planting 5 million trees by 2031, in addition to the tree planting goals established in Maryland's 2019 GHG reduction plan.

While Maryland has successfully implemented an aggressive tree planting program over time, the overall trend of tree canopy cover in the state has been essentially stable since 1999, according to the 2022 Maryland Forest Technical Study.³ This was despite the population in the state increasing by 17% over that period, a credit to tree planting initiatives as well as the Forest Conservation Act forest loss mitigation requirements and local tree conservation ordinances. The study did find a loss in forest cover compared to overall tree canopy, a decrease of 0.7% between 2013 and 2018, indicating an increase in forest fragmentation over that period.

Program Objectives and Carbon Accounting

³ Chesapeake Conservancy, 2022. Maryland Forest Technical Study.
<https://www.chesapeakeconservancy.org/projects/maryland-forest-technical-study>

By 2031, the implementation goal of this program is to achieve the afforestation (planting trees in areas that are not currently forested) of 21,812 acres in Maryland cumulatively since 2006. This goal includes the acres tracked under the riparian buffer category. To meet this goal, as well as the five million tree goal, ~11,800 acres will need to be planted over the next nine years (2023-2031). Achieving the target should increase the state's forest carbon sink by approximately 87,000 metric tons of CO₂ equivalent (0.087 MMTCO₂e) annually, on average over the first 30 years of growth.

Reforestation, i.e. planting trees in areas that are or were recently forest, such as after a harvest, is also an important function of the state to maintain forest land as forest. Reforestation does not increase the forest carbon sink relative to current conditions, but it is essential in maintaining the sink into the future. Maryland DNR has reforested nearly 14,000 acres since 2006 and plans to reforest an additional 5000 acres by 2031. These plantings increase the forest carbon sink by 0.075 MMTCO₂e, relative to a scenario of forest loss on those acres.

Implementation Milestones

The department is implementing this program through a suite of efforts, policies and programs, including:

Public Lands:

- State Forest annual work plan implementation
- The Maryland Park Service, in partnership with the Maryland Forest Service, Chesapeake and Coastal Service, and various non-profit environmental stewardship groups reforested approximately 284 acres of parkland in 2023. An additional 92 acres were put into early successional meadow habitat as well. The majority of these reforestation and meadow creation projects occurred on land that was previously part of conventional, row-crop agriculture, further contributing to the carbon reduction of the restoration projects.

Private Lands:

- Technical Assistance
 - Forest Stewardship Plan implementation
 - Forest Conservation Act (FCA) implementation

Financial Assistance – Rural Lands: State and Federal Cost Sharing:

- Woodland Incentive Program (WIP –MD Forest Service)
- Income Tax Modification (TAXMOD)- expanded eligibility of forestry practices in 2014
- Environmental Quality Incentive Program (EQIP – federal/NRCS)
- Conservation Reserve Enhancement Program (CREP – federal/NRCS)

Estimated Emission Reductions for CY 2022

Cumulative plantings since 2006 increase Maryland's forest carbon sink by approximately 0.10 MMTCO₂e in 2022.

Table 2 Forest Planted in Maryland

	Year	Afforestation(1)(2)	Reforestation(1)(3)	Riparian Buffers(4)	Total Acres
	2006	845.7	3,318.00	388.2	4,551.9
	2007	343.4	1,990.20	242.8	2,576.4
	2008	404.9	1,598.20	191.2	2,194.3
	2009	531.1	1,497.40	162.6	2,191.1
	2010	596	417.4	545.6	1,559.0
	2011	1,223.60	633.9	503.1	2,360.6
	2012	433.7	615.3	320.1	1,369.1
	2013	198.1	593.6	237	1,028.6
	2014	409.8	559.2	287.3	1,256.2
	2015	294.1	633.1	213.7	1,140.9
	2016	180	638.9	263	1,081.9
	2017	97.6	434	127.4	659.0
	2018	134.2	423.4	212.9	724.6
	2019	107.3	254.2	115.6	526.5
	2020	239	312	163.6	714.6
	2021	168.8	234.6	169.0	572.4
	2022	393.8	189.0	215.2	798.0
	Total	6,600.8	14,342.2	4,361.8	25,304.8
	Average Annual	388.3	843.7	256.6	1,488.5
(1).	From the Maryland Forest Service PMAS report where a calendar year is defined as Quarters 3 & 4 of the preceding year, and Quarters 1 & 2 of the current Fiscal Year. For example, the number for 2006 represents the reported values from PMAS for Q3 & Q4 o				

(2)	PMAS field CREP/HEL Afforestation plus the Other Afforestation Acres.
(3)	PMAS field Reforestation Acres.
(4)	Acres reported by the Maryland Forest Service Riparian Forest Buffer Restoration Program. http://dnr.maryland.gov/forests/Pages/programapps/rfbrestoration.aspx
(5)	Estimated area of privately owned forest regenerated annually following timber harvest. Assumes 20% of Sediment and Erosion Control permitted acres reported by counties are actually harvested and regenerated. Historically, the average is 1,400 acre/year.

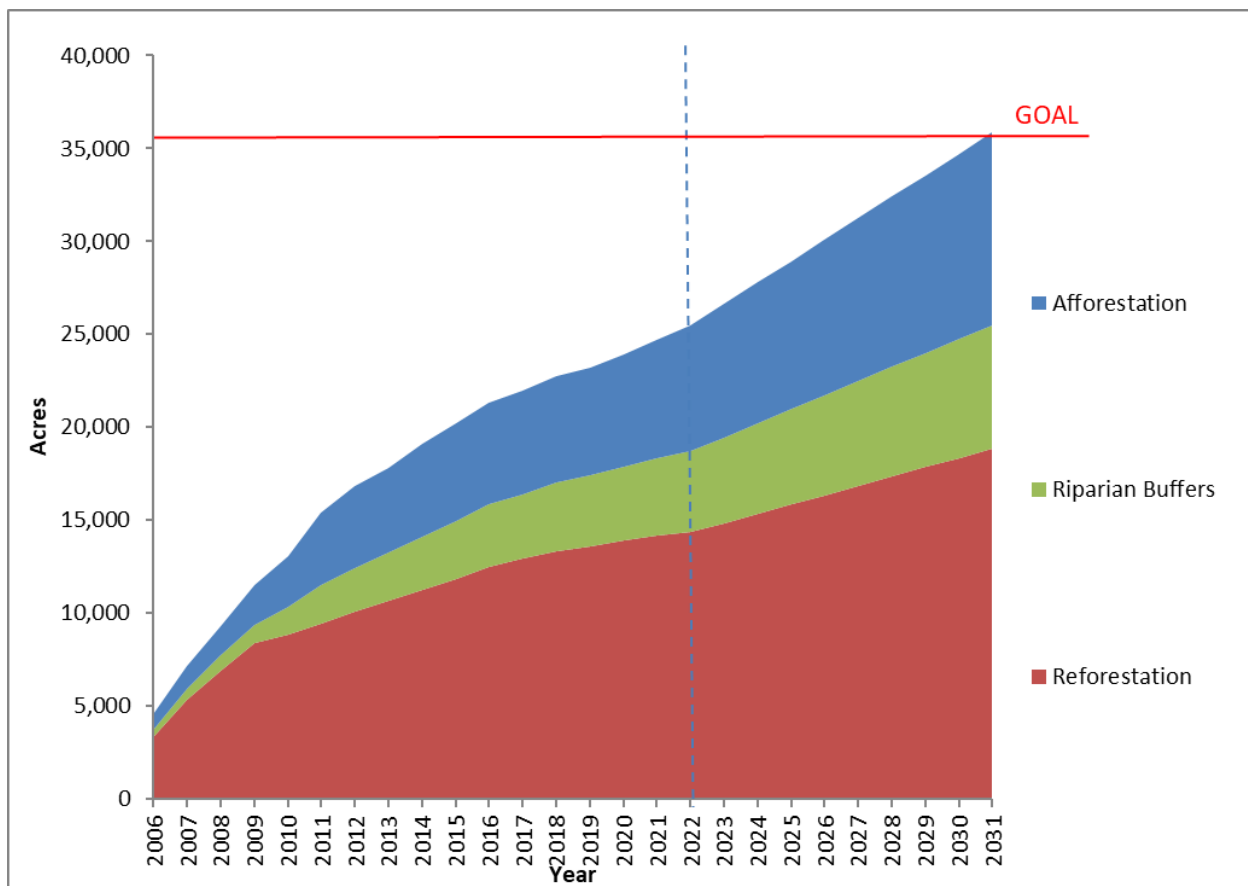


Figure 2 Planting Forests in Maryland. Riparian buffers are tracked separately from afforestation, but together they represent progress towards the 5 Million Tree goal, whereas reforestation acres are not. The dotted line represents progress through 2022.

Enhancement Opportunities

The Tree Solutions Now Act, House Bill 991, was passed by the Maryland legislature in 2021 and requires that five million trees be planted in the state by 2031. These trees must be in addition to trees already projected to be planted in Maryland's 2030 Greenhouse Gas Reduction Plan and 10% must be

planted in urban underserved areas, as defined in the bill. The bill dedicates \$10 million per year for urban tree plantings to be administered by the Chesapeake Bay Trust and that \$2.5 million of the Chesapeake and Atlantic Coastal Bays Trust Fund will go towards tree planting per year, and to support 13 additional staff. The bill also stipulates that the Maryland Department of Agriculture can pay an additional \$1000 per acre for tree plantings through MDA and the Conservation Reserve Enhancement Program (CREP). The recently selected NRCS RCPP project will provide funding for tree planting as well.

The additional 13 positions to DNR from HB991 will provide technical assistance, planning, and coordination related to tree plantings, tree buffer management, and forest management, including invasive vine removal, on public, private, and agricultural lands and in “underserved areas”. These positions can expand awareness of existing and new planting programs to accelerate progress towards climate mitigation goals.

In 2023 the Maryland Legislature passed an update of the Forest Conservation Act that increases replanting requirements when forest is lost due to development and allows for forest conservation to be credited towards mitigation. The goal of the act is to increase the area of forest in Maryland, which will help the state grow the forest carbon sink.

Funding

Important challenges faced by this program include engaging landowners willing to plant more trees, funding site preparation for successful tree planting in challenging urban locations, and maintenance needs after grants for establishment have ended.

Challenges

The Maryland Department of Planning projects the state’s population to grow by 800 thousand people by 2045. Population growth and associated demand for land will need to continue to be balanced with land conservation and forest cover. Tools to facilitate that balance include priority funding areas, transfer of development rights, land conservation programs, and the Forest Conservation Act.

3. Maryland’s Blue Carbon

Program Description

In addition to forests, wetlands are known to be efficient at sequestering carbon. DNR is planting forested stream buffers (captured under Planting Forests) and pursuing the creation, protection and restoration of wetlands to promote carbon sequestration through several means including the Natural Filters Program provided through the Chesapeake and Atlantic Coastal Bays Trust Fund, which restores wetlands and buffers on state and public lands to meet water quality goals. The objectives of the Coastal Wetlands Initiative include restoring natural tidal marsh hydrology to coastal wetlands through ditch plugging practices and the development of a terrestrial carbon sequestration protocol and DNR’s Shoreline Conservation Service funds or finances living shoreline projects that can function to protect and enhance carbon stocks.

In 2022 Maryland became one of the first states to integrate blue carbon into its GHG inventory. Blue carbon in Maryland refers to the carbon captured by the ocean and coastal ecosystems,

including coastal salt marshes and seagrasses. For the Maryland GHG inventory, blue carbon stocks and fluxes comprise the state's estuarine wetlands and seagrasses, otherwise referred to as submerged aquatic vegetation (SAV). Many of the wetland projects tracked here do not have benefits to Maryland's carbon sink for reasons explained below, but all are important in providing climate resilience benefits, wildlife habitat, and improving water quality.

The department is including another best practice for carbon sequestration through its Shoreline Conservation Service projects to install Living Shorelines. These are additional coastal wetland restoration practices that may function to sequester carbon, or protect existing wetland carbon stocks.

Carbon Accounting

Methane emissions are an important consideration when assessing the climate impact of wetlands. Freshwater and brackish wetlands tend to support a bacterial community within their soils that produces methane, with higher salinity (18+ ppt, parts salt per thousand parts water) wetland soils typically not being sources of methane. For that reason, we only considered wetlands in the southern, saltier region of the Chesapeake Bay and the Coastal Bays for the MD GHG Inventory and for the projections here. This includes the mesohaline region, where salinities range between 5 and 18 ppt and significant methane emissions do exist, but carbon sequestration in soils has a larger climate benefit, on average. It should also be noted that the choice of global warming potential (GWP) for methane greatly impacts the net GHG impact of wetlands. Under a 20 year GWP where methane warming is 86 times that of carbon dioxide Maryland coastal wetlands are a net source of GHGs. Results here are presented using the 100 year GWP of methane; 28 times that of CO₂. Under that assumption tidal wetlands and SAV in the Chesapeake Bay and Atlantic Coastal Bays removed 0.3349 MMTCO₂e in 2020. It is estimated that wetlands in the mesohaline portion of the Chesapeake Bay removed 1.57 MTCO₂e per acre per year and wetlands in the polyhaline region (essentially just the Atlantic Coastal Bays) remove 2.99 MTCO₂e per acre per year. SAV removes a smaller amount of carbon per acre, varying between 0.15 and 0.45 MTCO₂e per acre per year.

Tidal Wetlands Restored from 2006-2022 and Estimated Carbon Benefit

For this initial estimate we only consider tidal wetlands restored from 2006 to 2022 and use the rate of 1.57 MT of CO₂e per acre per year for restored wetlands for mesohaline wetlands in the Maryland Blue Carbon Inventory methodology.⁴ The coastal wetland initiative predominantly restored tidal fresh wetlands. These wetlands typically emit levels of methane that exceed the rates of carbon sequestration in soils, so no GHG benefit was estimated for these acres. Existing US Army Corps of Engineers (USACE) documents show over 2,000 acres of tidal wetland creation and restoration have occurred at Poplar Island, Barren Island, and James Island, see Table 3. Some tidal wetland projects, like thin layer placement, do not create new wetland habitat, and while they will likely extend the lifespan of the marsh they do not change the near term carbon removal of the wetland.

⁴Maryland Department of Natural Resources and Department of the Environment. Blue Carbon Inventory Methodology.2023.
https://mde.maryland.gov/programs/air/ClimateChange/Documents/VIMAL/MD_BlueCarbon_Flux_Methodology_01.06.23.pdf

Table 3 Carbon Sequestration Estimate from Coastal Wetlands

Funding Source	Acres Restored	Carbon Sequestration MT CO ₂ e per year
Coastal Wetland Initiative	505.6	0
DNR Trust Fund	3.8	6.0
DNR Resiliency through Restoration	2.36	3.7
Federal Partners	2096.9	3292.1
Total	2608.66	3301.8

Implementation Milestones

On the ground wetland and waterway restoration projects:

The Natural Filters Program restored 0 acres of wetlands on state and public land and planted 6.5 acres of streamside forest buffers on state and public lands in state fiscal year 2023. Typically these acres contribute towards the state's Watershed Implementation Plan (WIP) goals for state and public lands. Funded through The Chesapeake and Atlantic Coastal Bays Trust Fund, these projects are designed to accelerate bay restoration by focusing limited financial resources on the most efficient, cost-effective non-point source pollution control projects, which include wetland and buffer restoration projects. Additional wetland restoration projects are anticipated in SFY24.

The Chesapeake and Atlantic Coastal Bays Trust Fund has, as of the end of state fiscal year 2023, funded the restoration of 300 acres of wetlands and 116 acres of riparian buffers, totalling 3,827 acres of wetlands and 1,724 acres of riparian buffers funded since 2009. These totals include restoration gains from the Natural Filters Program, as documented above, and projects that have occurred on private lands. From this point onward, implementation tracking will be expanded to include both public and private land restoration projects that are funded through the Trust Fund, to more accurately reflect potential carbon sequestration gains.

Through a partnership between DNR, The Nature Conservancy (TNC), U.S. Fish and Wildlife Service, Natural Resources Conservation Service and National Oceanic and Atmospheric Administration, we were able to restore 2,174 acres via a five-year grant agreement between TNC and DNR (Chesapeake and Coastal Bays Trust Fund). The Pocomoke project's primary focus was to reconnect the mainstem, and to channelize the Pocomoke River with its historic

floodplain. The wetlands restored were mostly forested riparian wetlands, with some emergent wetlands restored in agricultural fields in the watershed.

Coastal Wetlands Initiative Program: As of 2023, 505.6 acres of coastal wetlands have been restored by plugging existing drainage ditches to restore these drained wetlands.

Living Shorelines through the Shoreline Conservation Service: Between 2006 and 2020 13.24 acres of Living Shoreline have been created or restored.

The Resiliency through Restoration program has constructed 2.36 acres of wetlands to date.

Wetland restoration and enhancement by federal agencies: The US Fish and Wildlife Service has restored or enhanced 211 acres of tidal wetlands in the Blackwater National Wildlife Refuge over the past 10 years. The US Army Corps of Engineers has created, restored, or enhanced 1875 acres of tidal wetlands in the Maryland portion of the Chesapeake Bay since 2006, with the most significant projects being a wetland enhancement project on Deal Island and wetland creation on Poplar Island. Recent research has shown that the Poplar Island created wetlands are sequestering carbon at similar rates to natural wetlands.

Wetland Area and Carbon Change in 2030 and 2045

In 2021 Maryland DNR partnered with The Nature Conservancy, George Mason University and Warren Pinnacle, Inc. to simulate change in coastal wetlands and other lands over a 100 year period in 10 year increments under six different sea level rise (SLR) scenarios. The scenarios ranged from 1.2 to 1.5 feet of SLR by 2050, with results for the scenario simulating 1.4 feet by 2050 used here. Results for 2045 were obtained by averaging the 2040 and 2050 model results. In all of the scenarios wetland area increased over time, due to migration into areas that are now upland forests, agriculture, or open areas and existing marshes largely being able to keep up with SLR through building of new soils. Low elevation counties on the southern Eastern Shore in particular are expected to experience extensive wetland migration into uplands. This region is already experiencing the impacts of saltwater intrusion as sea level rises, with ghost forests and less productive or barren agricultural fields becoming more common. Carbon loss due to land-use conversion driven by SLR is likely to be significant, but is not quantified here. The changes projected are just due to expected SLR and do not account for any ecological restoration efforts the state may engage in, such as thin layer placement or tidal wetland creation. Rates of coastal wetland restoration implementation have been low; only 510 acres have been restored by the state and 2,096 acres restored by federal agencies since 2006.

Wetlands Over Time

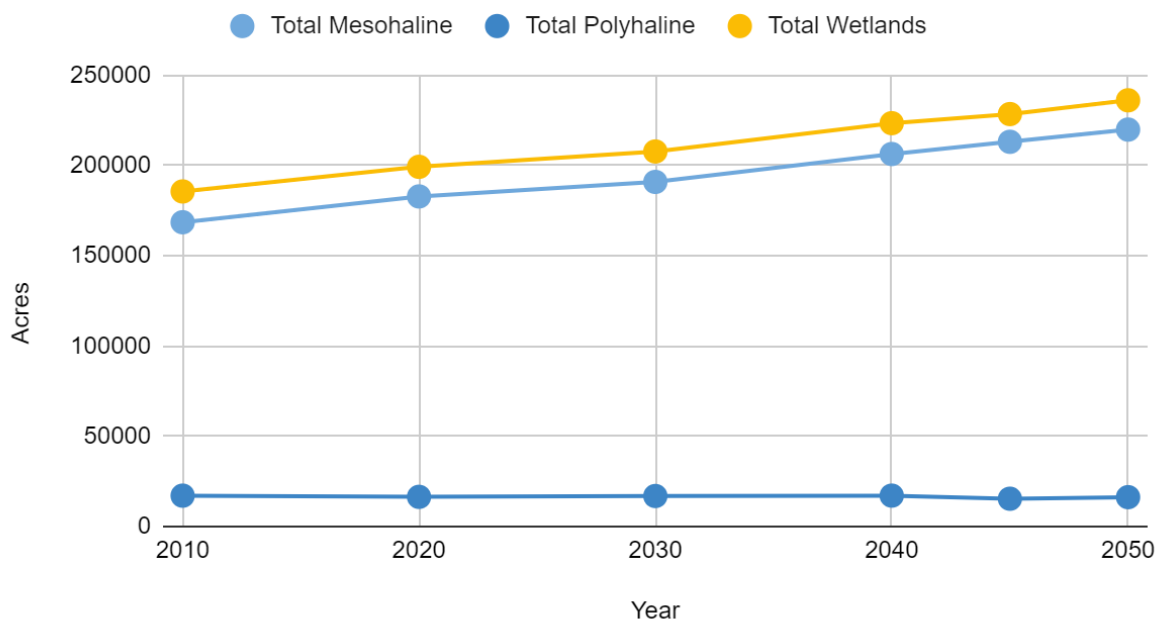


Fig 3. Change in Maryland's mesohaline and polyhaline wetlands over time under a 1.4 feet of SLR by 2050 scenario

According to the SLAMM results for wetland area change under the chosen SLR scenario and our current best understanding of wetland carbon accumulation and methane emission rates Maryland's blue carbon sink is projected to increase by 14%, from -336,000 metric tons of CO₂e per year in 2020 to -383,000 metric tons of CO₂e per year in 2045. While this is one plausible scenario, different models of SLR and wetland change may result in different results, although the differences between models and scenarios becomes greater as they extend into the future. In the scenarios modeled under this SLAMM run 2070-2080 is an important inflection point, with higher rates of SLR outpacing many wetlands' ability to keep up through soil building and rapid, extensive wetland loss projected to occur. However, under lower SLR projections, such as those expected to be experienced under a stable emissions scenario, many wetlands are able to keep up with those lower rates and wetland area is projected to be relatively stable.⁵

⁵ Warren Pinnacle. 2021. Application of the Sea-Level Affecting Marshes Model to Coastal Maryland https://warrenpinnacle.com/prof/SLAMM/EESLR_MD/EESLR_MD_SLAMM_Report_12-28-2021.pdf

Maryland Blue Carbon Sink

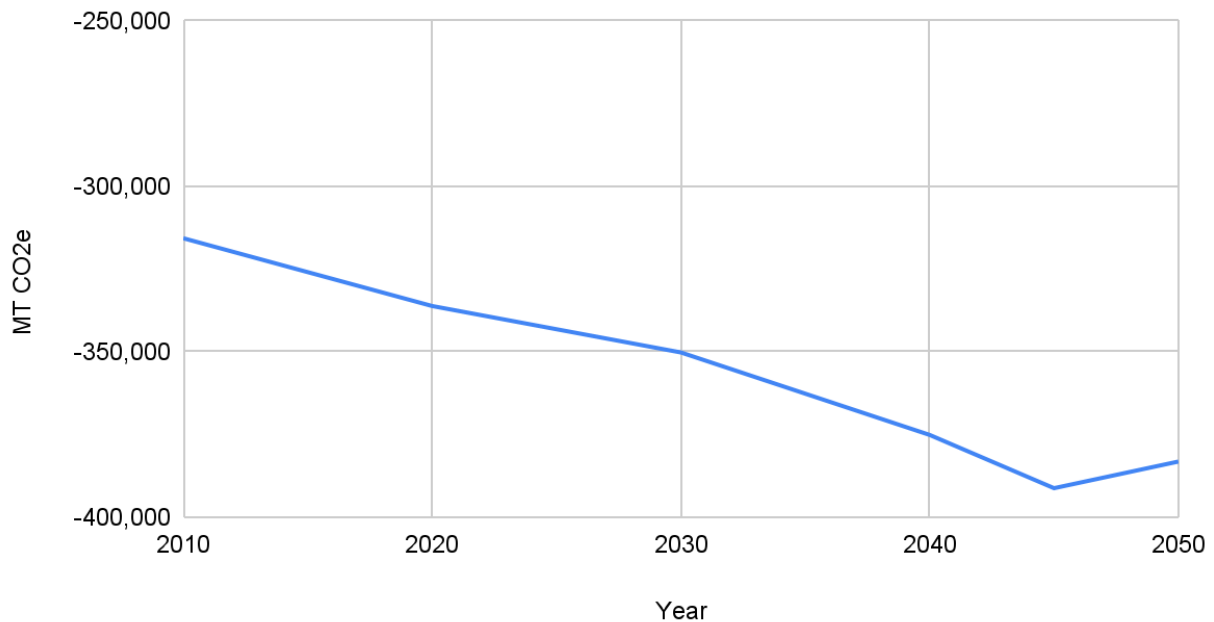


Fig. 4. Change in Maryland's Blue Carbon Sink over time. Negative values indicate a net removal of carbon from the atmosphere. The figure uses the 100 year GWP of methane.

Enhancement Opportunities

The Sea Level Affecting Marsh Model (SLAMM) has been completed for Maryland coastlines and is being actively used for a variety of wetland management practices including:

- Factoring climate change and resiliency into DNR's land acquisition scoring process.
- Developing new easement opportunities for landowners that own land within these wetland adaptation area transition zones.
- Factoring climate change into restoration design.
- Identifying the value of current and future wetlands for protecting communities and infrastructure from coastal flooding and shoreline erosion through DNR's Coastal Resiliency Initiative.

As mentioned previously, restoration of coastal wetlands has not been widely implemented in Maryland, apart from the large island creation projects where dredge material is used to build up islands that are partially composed of wetlands. While coastal wetlands are vital ecosystems that provide important ecosystem services like erosion prevention and wildlife habitat restoration of these systems is quite expensive, frequently exceeding \$50,000 per acre restored. Maryland DNR has partnered with The Nature Conservancy and ESA, Inc. to conduct a blue carbon feasibility study of several existing or potential wetland restoration projects in Maryland. The study is ongoing, but preliminary results indicate that the sale of blue carbon credits would not be able to support the costs associated with project implementation, even if the price of carbon were to rise dramatically. Under certain price points it is possible for the sale of credits to fund a portion of the cost of maintaining the project. Given project costs, it is likely that going forward projects

will be done for reasons other than blue carbon, like enhancing coastal resiliency or ensuring habitat for endangered species, but blue carbon will remain an important co-benefit of this work. A possible exception may be projects that reconnect freshwater systems to tidal waters and increase the salinity of a large area of wetlands, thus inhibiting methane emissions. Prior work by scientists from Duke University⁶ found limited opportunities for this type of restoration project on the Eastern Shore, but the impact to existing living resources in the freshwater system would need to be considered.

Protecting the migration corridor for coastal wetlands will help ensure that the modeled wetland expansion by 2045 will actually occur. Maryland DNR is piloting a Coastal Resilience Easement program as part of Program Open Space, that identifies land parcels where we expect wetlands to either persist into the future or migrate to. DNR develops a resilience plan with participating landowners to facilitate the transition to wetlands over time.

Funding

The Chesapeake and Atlantic Coastal Bays Trust Fund: In 2007, the Maryland General Assembly created the Chesapeake and Atlantic Coastal Bays Trust Fund (Trust Fund) to provide financial assistance to projects that advance Chesapeake Bay restoration. A large portion of this funding is targeted at local grants for counties and municipalities to reduce nutrient pollution to waterways which includes forested buffers, reforestation, wetland restoration, stream and floodplain restoration, stormwater retrofits and other bioremediation projects. In FY22, \$21.16 million was allocated for these projects.

Resiliency through Restoration Initiative: Since 2011, Maryland has experienced seven hurricane, tropical storm and flood events warranting presidential disaster declarations, resulting in more than \$145 million in federal public assistance. Recognizing that coastal habitats help buffer communities from these climate-related impacts, the Maryland Department of Natural Resources' Chesapeake and Coastal Service (CCS) launched a new Resiliency through Restoration Initiative. This Initiative provides technical and financial assistance to restore, enhance and create coastal habitat with the goal of protecting Maryland communities and public resources from extreme weather and climate-related events. To date, the Initiative has led to the design and/or construction of 29 living shoreline, coastal, and inland restoration projects around Maryland.

Coastal Wetlands Initiative (CWI): There are no dedicated funds currently allotted to CWI. Funding is typically acquired through a competitive grant process using state transportation and other federal funding sources.

Shoreline Conservation Services: This program is funded through the Shore Erosion Control Construction Loan Fund through DNR. One loan was issued in 2022.

Department of Natural Resources/Department of Transportation Memorandum of Understanding: The Maryland Department of Natural Resources has partnered with the State Highway Administration (SHA) in an effort to lead by example in restoring the Chesapeake Bay

⁶ Warnell et al. 2022. **Sea level rise drives carbon and habitat loss in the U.S. mid-Atlantic coastal zone.** <https://doi.org/10.1371/journal.pclm.0000044>

and local waters. State parks will provide opportunities for the State Highway Administration to implement restoration projects required by their Federal Stormwater Permit (MS4) and their nutrient and sediment reduction goals required under the Bay Total Maximum Daily Load (TMDL). A Memorandum of Understanding was signed in 2013 to initiate this program, which will increase the rate of restoration projects on state and public lands. In addition, there is a new agreement between DNR and MDOT that builds upon the SHA-DNR MOU but has a wider purview and an expanded scope of partnership. This new MOU applies to all MDOT transportation business units and supports common objectives including (but not limited to) Chesapeake Bay watershed restoration; climate resiliency, adaptation and mitigation efforts; and environmental compliance, stewardship and sustainability activities.

Challenges

While wetland restoration, in both inland, freshwater and tidal environments, are practices that significantly contribute to terrestrial carbon sequestration rates throughout the state, the highly variable rate of methane emissions has a marked effect on net greenhouse gas benefits. Research by state, regional, national and global entities continues to evolve and narrow in on more precise methods to evaluate the greenhouse gas benefits of wetland restoration.

There is a need to improve the design of Coastal Wetland Initiative projects to ensure success in future efforts. Ongoing monitoring is underway to measure the success of various methodologies.

Removing barriers to accessing federal funds could also incentivize landowners to participate in restoration projects. DNR is actively working with the Maryland Department of Agriculture and the United States Department of Agriculture on removing those barriers.

4. Biomass for Energy Production

Program Description

Maryland is working to promote the use of locally-produced woody biomass for the generation of thermal energy and electricity. Energy from forest byproducts can be used to offset fossil fuel-based energy production and associated GHG emissions. There are many end users in the United States that are successfully employing wood heating and cooling, and Maryland could benefit from such a program. For example, schools, hospitals, and municipalities could utilize local woody biomass for their energy needs. Creating a woody biomass fuel market would provide an incentive for harvesting low grade wood, a key component of healthy forest management.

Maryland DNR recommends that sources of woody biomass for renewable energy production be consistent with the recommendations for qualifying biomass made by Woody Biomass sub-group of the Mitigation Working Group in 2022. This definition is as follows- a non hazardous, organic material that is available on a renewable or recurring basis including waste material derived from wood residues from manufacturing, climate smart forest management, natural wood waste, wood waste diverted from landfilling, and excluding any woody material sourced from old growth forests.

The goals of this program are to develop policies that recognize wood as a renewable energy source, the largest source of bioenergy production in Maryland, and offer incentives to utilize locally produced wood to meet thermal energy needs.

Program Objectives

While there have not been any biomass to energy facilities built in the state yet, Maryland continues to explore opportunities for new facilities.

Implementation Milestones

- In October 2023 the Regulatory Assistance Project (RAP) completed a study on a Clean Heat Standard for Maryland. The study recommends including certain sources of woody biomass as qualifying sources of Thermal Renewable Energy Credits.
- In 2022 the Maryland Commission on Climate Change Mitigation Working Group convened a Woody Biomass sub-group that produced a report on woody biomass authored by Tassew Mekuria, a postdoctoral fellow at UMCES, and recommended that the state modify the definition of woody biomass qualifying for renewable energy credits and adopt a Clean Heat Standard for thermal energy that would include qualifying woody biomass.
- DNR is actively working with partners including the Maryland Energy Administration, and the Maryland Department of Commerce to facilitate installation of wood energy systems and has committed to a pilot program on the Eastern Shore and in Western Maryland.
- The Maryland Energy Administration has an existing grant program for wood to energy systems that could be reinstated if adequate demand is demonstrated.
- A webinar series on the potential of woody biomass to energy in Maryland was presented in 2020. This series was sponsored by the Maryland Forestry Foundation and Maryland Clean Energy Center in partnership with DNR and the Sustainable Forestry Council. More information and recordings can be found at the Maryland Clean Energy Center website.
- The U.S. Department of Commerce Economic Development Administration awarded a grant to the Western Maryland Resource Conservation and Development Council, who partnered with DNR and the Maryland Department of Commerce to develop an Economic Adjustment Strategy for Maryland's forestry industry. The plan, which has been finalized, serves as a roadmap for capitalizing on new opportunities in the forest industry including biomass for energy production and creating jobs, particularly in Opportunity Zones.
- Recognizing the need for an analysis of "wood sheds" where available wood resources are quantified will help raise confidence in the feasibility of an area to support industrial scale biomass to energy. The Eastern Shore Regional GIS Center (ESRGC) at Salisbury University recently partnered with DNR, the Western Maryland Resource Conservation and Development Council, and the Maryland Department of Commerce to assist in determining feasibility of industrial scale biomass to energy. A Maryland Forest Inventory Resource Viewer (MFIRV) was also developed so potential investors and forestry-related businesses could have information on potential markets and market viability.

Estimated Emission Reductions for CY 2022

None.

Enhancement Opportunities

Allowing thermal renewable energy credits (TRECs) to be generated from combined heat and power systems using woody biomass would provide an additional incentive to use this type of system. Creation of a Clean Heat Standard accomplishing this would require statutory change.

Funding

See 'Challenges' section.

Challenges

Awareness of wood energy technology is the primary barrier to this program, in particular adequately informing the managers of commercial and institutional spaces of the opportunities to save money while improving environmental outcomes that are offered by the simple switch to wood fuels. Establishing some demonstration projects in Maryland would greatly assist with DNR's ability to showcase available technology.

The Maryland Energy Administration has temporarily discontinued its Commercial Wood Boiler grant incentive program; however, they have stated that the program could be reinstated if sufficient industry demand is demonstrated.

5. Increasing Urban Trees to Capture Carbon

Program Description

Trees in urban areas are important to Maryland's carbon budget because they help offset some of the greenhouse gas emissions from urban pollution sources such as power production and vehicle emissions, reduce heating and cooling costs and energy demand by moderating temperatures around buildings and slow the formation of ground level ozone as well as the evaporation of fuel from motor vehicles. Implementation is supported by several Maryland laws and programs that include outreach and technical assistance for municipalities to assess and evaluate their urban tree canopy goals and plant trees to meet those goals.

This program has tracked 6.1 million tree plantings in urban areas through the Forest Conservation Act, Marylanders Plant Trees, Tree-Mendous Maryland, and 5-103 State Highway Reforestation Act planting programs from 2006 through 2022. Trees planted through the Forest Conservation Act, required mitigation for forest loss, have comprised 85% of tree plantings through this program up to 2022.

Going forward, the long-term goal of this program is to plant an additional 2.65 million trees in urban areas through the Forest Conservation Act, Marylanders Plant Trees, Tree-Mendous Maryland and 5-103 State Highway Reforestation Act planting programs by 2031 from our 2020 tree planting progress. The 2021 Tree Solutions Now Act requires that 500,000 of the 5 million trees to be planted by 2031 be planted in urban underserved areas, as defined in the law.

This program is performing as designed.

Program Objectives and Carbon Accounting

From 2023-2031 we estimate that planting 56,000 trees per year on average in urban underserved areas will be necessary to meet the urban tree component of the 5 Million Trees goal.

Additionally, we anticipate an average of 209,000 trees will be planted through Forest Conservation Act and State Highway mitigation plantings. This will equate to 2.385 million total trees planted from 2023-2031. The low estimate of GHG benefit associated with these plantings is 0.0023 MMTCO₂e per year, and the high estimate is 0.0046 MMTCO₂e per year, with the expectation of 0.0035 MMTCO₂e per year of additional carbon sink in 2031.

Implementation Milestones

DNR's Maryland Forest Service (MFS) has developed tree planting assistance programs that reach landowners within the urban/suburban areas of Maryland. The programs target 1.1 million acres of turf statewide. Each program targets different lot sizes and available planting space.

- The "5 Million Trees for Maryland" program initiated by the General Assembly's passage of the Tree Solutions Now Act of 2021 has recorded 470,426 trees planted above baseline afforestation rates across the state since July 2021. Of the total, 35,403 (8%) have been planted in urban underserved areas and 321,388 (68%) are attributable to programs administered by Maryland DNR-Forest Service.
- The "Lawn to Woodland" program, a partnership with the Arbor Day Foundation, targets small lots with 1-5 acres of plantable space or turf. The Foundation does outreach while MFS handles the tree planting at no cost to the lot owner. In the spring of 2014, a pilot was done with 14 acres planted on 12 lots. In the spring of 2015, 100 acres were planted on 84 sites and in the spring of 2016, 60 acres were planted on 55 sites, totalling 174 acres planted on 151 sites.
- The "Marylanders Plant Trees" program is a \$25 coupon reimbursement program targeting individuals wishing to plant a tree through advertisements on the MD Forest Service portion of DNR's website and at participating nurseries. Landowners with small lots can purchase a tree valued at \$50 or more and reduce their cost by \$25. 85 nurseries across the state participate in the coupon reimbursement program. From the program's inception in FY09 to FY19, over 49,000 coupons have been reimbursed and 49,000 trees planted.
- Financial Assistance – Urban Lands: Public/Private Partnerships.
 - Tree-Mendous Maryland.
 - 1,865 trees planted in 2021.
- Marylanders Plant Trees/Private Nurseries.
 - Reimbursed coupons for 4,035 trees in 2020.
- Lawn to Woodland
 - Kicked off in spring 2014 with 4.3 acres planted.
 - 100.73 acres on 84 sites planted in spring 2015.
 - 60.33 acres on 55 sites planted in spring 2016.
- Maryland Urban and Community Forestry Committee Grants.
 - In 2023 this grant program was expanded through a partnership with the Maryland Department of Transportation and in FY 23 awarded \$47,126.50 to 29 projects.
- Small Community Urban Tree Canopy (UTC) Grants lead to the planting of 0 trees in 2020. Gatherings for tree planting were prevented due to COVID-19.

Estimated Emission Reductions for CY 2022

Urban tree plantings that were planted in excess of mitigation requirements are estimated to increase the carbon sink in Maryland by 0.008 MMTCO₂e in 2022. Plantings required for mitigating forest loss are not credited here because, while essential for maintaining Maryland's tree cover, the loss of mature forest will show up as a carbon loss in the state's GHG inventory and new plantings will not fully compensate for that loss for many years.

Table 4. Urban Tree Planting (number of trees).

Year	Forest Conservation Act (FCA)⁽¹⁾	Reforestation 5-103⁽¹⁾	Tree-Mendous & Marylanders Plant Trees Programs	Total Trees
2006	623,700	33,750	8,178	665,628
2007	473,400	27,000	6,057	506,457
2008	499,500	9,900	2,160	511,560
2009	450,900	13,950	39,020	503,870
2010	337,950	308,250	23,000	669,200
2011	481,050	15,750	17,200	514,000
2012	42,300	68,850	21,700	132,850
2013	119,250	23,850	23,800	166,900
2014	140,580	24,615	21,500	186,695
2015	142,875	6,251	8,435	157,561
2016	341,640	37,557	8,798	387,995
2017	412,300	8,388	12,545	433,233

2018	256,050	5,913	7,718	269,681
2019	158,535	10,697	10,166	179,398
2020	262,971	2,560	5,900	271,431
2021	200,579	27,183	7,364	235,127
2022	232,916	66,560	12,226	311,702
Total	5,176,496.0	691,024.5	235,767.0	6,103,287.5
Average Annual	304,499.8	40,648.5	13,868.6	359,016.9
(1).	Assumes 450 trees planted/acre. Plantings are for mitigation and do not contribute towards 5 million Tree goal			

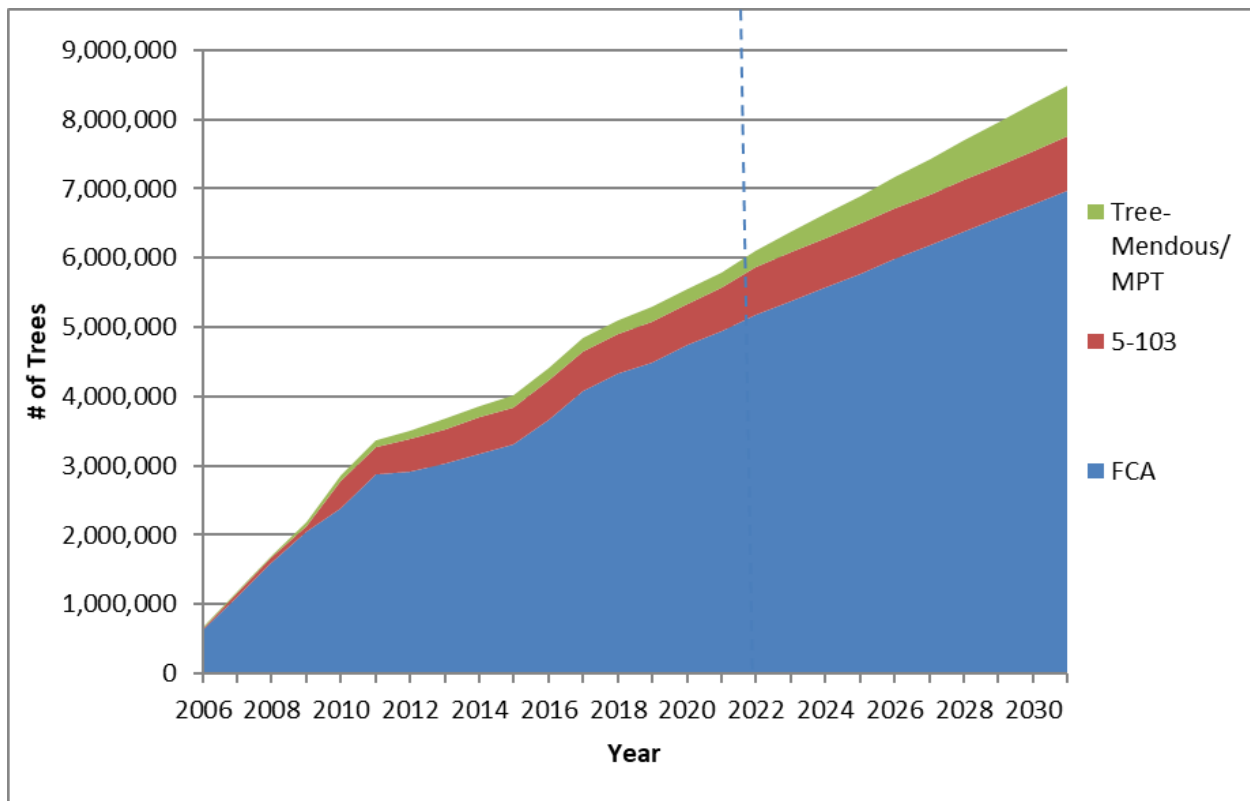


Figure 3. Increasing Urban Trees to Capture Carbon.

Enhancement Opportunities

The Tree Solutions Now Act includes a goal of planting 500,000 trees in urban areas by 2030. Efforts to expand and diversify buffer and urban tree canopy plantings related to Chesapeake Bay restoration will also benefit greenhouse gas reduction efforts. Additional funding mechanisms are being explored, from revolving loan funds repaid through purchase of MS4 credits or local government climate resilience bonds. The quantification of carbon sequestration for tree planting, soil carbon sequestration, and forest management estimates could form the basis for aggregating private forest management and tree planting for the voluntary carbon credit market.

Funding

Year to year variability in program availability and funding levels creates a challenge in building program awareness in the public and perception of programs as reliable funding sources

The “Lawn to Woodland” and the “Marylanders Plant Trees” programs are both funded through forest mitigation funds received as a result of highway construction projects complying with Reforestation Law (NRA 5-103). This makes the funding variable from year to year, and for the past several years the “Lawn to Woodland” program was on hold due to limited available funds. Identifying an alternative funding source when mitigation funds are limited or not available would allow for these programs and others to be consistently offered to the public. Options are being pursued through 5 Million Trees programs and other fund sources, such as federal funds from the Infrastructure Investment and Jobs Act.

Challenges

See Funding section above.

6. Geological Opportunities to Store Carbon

Program Description

Geological carbon sequestration differs from other discussed sequestration methods because it captures carbon at the source and transports it to a sequestration site. Maryland, through DNR's Maryland Geological Survey, is one of eight partner states in the Midwest Region Carbon Sequestration Partnership whose role is to identify, locate, and characterize potential geologic storage opportunities. This has evolved into the MidWest Region Carbon Initiative which is a coordination of over 12 states, the nonprofit Battelle Memorial Institute, and the U.S. Department of Energy. More than 10 gigatonnes of storage capacity has been identified within the terrestrial portion of Maryland (103 years of storage capacity at current CO₂ estimated production rate of 97 million metric tons per year). In the offshore region ranging from Maryland to New York, an estimated 450 gigatonnes of geologic capacity has been calculated.

The goal of this program is to identify and assess geologic storage opportunities. The program is performing as designed, however, no quantification target has been assigned.

Program Objectives

The potential emission reductions from the Geological Opportunities to Store Carbon program have been aggregated with the estimated emission reductions from the Terrestrial Sequestration bundle (Forestry and Wetlands).

Implementation Milestones

Previous Geological Carbon Sequestration funding has come from the US Department of Energy through the nonprofit Battelle Memorial Institute. Research funds for geologic carbon sequestration ceased in 2020 with a refocusing of DOE funds into implementation of geologic carbon sequestration. Maryland is funded at \$28,000 per year to assist in educating policymakers and other interested parties about geologic carbon sequestration opportunities. An additional twenty thousand dollars per year is provided through the state's Environmental Trust Fund.

The Department of Natural Resources' Resource Assessment Service (RAS) has completed or is currently working on the following implementation milestones.

- Total organic carbon content in Maryland black shales (e.g., Marcellus) has been evaluated as a precursor for determining the viability of these as storage units for carbon dioxide. This data is incorporated into regional and national databases for various integration projects. This project is completed.
- The potential for offshore carbon sequestration has been evaluated in partnership with Harvard University, Battelle, U.S. Department of Energy, Rutgers University, University of Texas and the surrounding Mid-Atlantic States. Focus areas of this study included geologic characterization, capacity evaluations, injectability and risk analyses. This project has provided foundation knowledge and an assessment of potential for carbon sequestration offshore in the Baltimore Canyon Trough. Projections from this study state

over 450 gigatonnes of carbon sequestration are possible within our region using offshore sequestration targets. This project is completed.

- In the offshore environment, the state has identified the need for the U.S. Bureau of Ocean Energy Management to balance renewable energy development with future geologic carbon sequestration opportunities
- The potential of saline aquifers located under the Coastal Plain in Maryland as a target for carbon sequestration is being evaluated in cooperation with multiple state Geological Surveys. There is currently no funding for this research and saline aquifers remain a potential, but unvalidated, sink for the greenhouse gas carbon dioxide (CO₂).
- Baseline data has been collected to provide the foundation for conducting risk analyses for the potential development of stray gas migration into potable aquifers. This project is complete.
- Research is ongoing to assess the CO₂ chemical adsorption capacity of power plant combustion by-products and the organic shales and clays in the closest geologic formations.
- Research has been completed to assess the possibility of CO₂ sequestration as both structural and chemical storage within triassic rift basins. The exposed Gettysburg-Culpepper basin has been characterized and documented as a proxy of the buried rift basins located throughout Maryland. Further research is planned to study the collected cores through the Taylorsville Basin, however those cores are currently difficult to access and located out of state. Phase I of this project is complete. Phase II is still pending the availability of collected cores.
- Research is being performed in the Western Maryland retired gas fields to understand the current abandoned well bores. Documentation of this is necessary as a precursor to evaluation of this area as a CO₂ sequestration site. Discussions are occurring between Lehigh Cement, Warrior Run Power Plant, Battelle, and the Maryland Energy Administration to determine if this site could be a pilot site for Maryland to evaluate geologic carbon sequestration.

Other Resources Assessment Service program notes include:

- Site testing (carbon capture, transport and storage) continues in Michigan and Ohio (regional partners to Maryland in CO₂ sequestration projects) and has been completed in Kentucky. A large-scale project is currently being performed in Illinois capturing 6.5 million tonnes of CO₂ annually. These programs are being evaluated at a national level and the results continue to be favorable at this time.
- Depleted gas fields present the most immediate option for permanent storage of carbon dioxide in Western Maryland. Maryland Geological Survey is currently working on identifying the site characteristics of individual wells to assist MEA in determining a pilot project injection site.
- A methane emissions study of the Deer Park Anticline by the Western Maryland Regional GIS Center has ruled out using this Anticline for structural storage of CO₂ due to observed methane leaks primarily from the old Mountain Lake Park Gas Field. It could still have potential for chemical adsorption of CO₂.
- In collaboration with Maryland Energy Administration, a CO₂ Sequestration conference was held in November 2019. MEA recorded the talks and are using these talks as educational material for legislators and their staff.

- The Maryland Geological Survey is working with NASA to identify technologies that would assist in identifying methane emitters such as transmissive geologic faults, poorly abandoned wells, fissures, etc. There is presently no funding for this activity; this project is in its infancy.
- The Maryland Geological Survey is working with DOE, Battelle, and Heidelberg Materials for the capture and sequestration of CO₂ from the cement manufacturing process. This project has been proposed to DOE and is awaiting a decision for award

Estimated Emission Reductions for CY 2023

None.

Enhancement Opportunities

A federal, regional, or state action to put a cap on carbon emissions would potentially create a demand for geologic sequestration, if it is cost-competitive with other options to offset emissions. If the price of carbon offsets reaches parity with the cost to do geologic sequestration this would also spur action.

A pilot project currently being discussed at the Maryland Energy Agency will allow Maryland to understand the execution of a geologic carbon sequestration program.

The Maryland Geological Survey, through the MRCI partnership and relationships with the Illinois Geological Survey, are working together in evaluation of the Illinois Carbon Sequestration pilot project that has currently sequestered over 4 million metric tons of CO₂. This relationship and the lessons learned throughout its development and operations provide vital knowledge for Maryland should the state proceed with geologic carbon sequestration.

Funding

Previous Geological Carbon Sequestration funding has come from the US Department of Energy through Battelle. Research funds for geologic carbon sequestration ceased in 2019 with a refocusing of DOE funds into implementation of geologic carbon sequestration. Twenty thousand dollars per year is provided through the state's Environmental Trust Fund.

Challenges

The cost of capturing CO₂ using current technologies involves a parasitic loss of approximately 8-20 percent at the generation site depending upon the source. This cost has decreased over the last 10 years by 30-40 percent due to developing methods to capture the CO₂ and the concentration of the CO₂ in the smokestack. However, the IRS has created a section 45Q tax credit incentive that allows businesses that geologically sequester carbon to receive a significant offset which is \$85 per metric ton for geologically sequestered carbon beginning in 2022. This tax incentive significantly offsets the cost of carbon capture and geological sequestration, allowing for profit making business plans using current technology.

A significant, but often overlooked cost for sequestration, is transportation of the CO₂ from its source to the sequestration site. Ideally, the sources would be located on top of the sequestration site making this cost minimal. However, it is likely that pipelines will need to be created to efficiently pipe the CO₂ from the production location to the sequestration location. Significant

legislative support has occurred in the last year supporting CO2 pipelines and a nationwide plan is being developed.

Retrofitting equipment onto existing power plants and industrial processing plants is often cost and space prohibitive. CO2 capture will need to be part of the design of new power generation plants and industrial processing plants (cement, fertilizer, steel).

7. Creating Ecosystems Markets to Encourage Greenhouse Gas Emission Reductions

Program Description

Establishment of ecosystem service markets, particularly for carbon, has the potential to increase carbon sequestration or avoid additional emissions. Maryland's Forest Conservation Act and Critical Area Act require mitigation for natural resource impacts generated through land development, and mitigation banking are examples of ecosystem markets that help avoid additional GHG emissions through land-use conversion. The Conservation Finance Act (CFA) of 2022 signifies a large step forward for the state in fostering conditions conducive for ecosystem market development.

The goal of this program is to foster the establishment of ecosystem markets, create a tracking mechanism and develop protocols to assess/quantify GHG benefits of ecosystem credit trading in Maryland. No quantification target has been assigned in terms of carbon because it is anticipated that GHG benefits gained through participation in ecosystem markets will be captured through existing programs, and ultimately through the GHG inventory.

Program Objectives

The objective of this program is to increase ecosystem credit trading in Maryland. The Conservation Finance Act charges Maryland DNR with establishing two carbon projects on state lands, one blue carbon project and one upland project, by June of 2024.

Implementation Milestones

- The Nature Conservancy and the American Forest Foundation have expanded their Family Forest Carbon program into western Maryland. This program allows small forest landowners to generate revenue from selling carbon credits based on implementing sustainable forest practices. As of October 2023, 31 landowners have enrolled a total of 3,164 acres in the program
- Ecosystem co-benefits from existing and areas of potentially restorable forests and wetlands, have been spatially quantified across Maryland. Spatial models for co-benefits have been completed and are available on Maryland GreenPrint.⁷
- The Nontidal Wetlands Mitigation Banking bill removes barriers to mitigation banking in Maryland, with the goal of reducing the cost for meeting mitigation requirements in an ecologically beneficial way.
- Under FCA banking, several counties in Maryland allow offsite mitigation for forest loss through purchasing credits in a forest bank. Over 2,000 acres of forest loss have been mitigated in this way over the past 15 years.

⁷ Maryland GreenPrint Map. www.geodata.md.gov/greenprint/

Enhancement Opportunities

Enhancement opportunities include the expansion of voluntary, market-based approaches for carbon offset and streamlining the verification and certification process for existing carbon markets available to Maryland landowners. The CFA allows for the state to function as an aggregator of ecosystem credit projects, and this may present an opportunity to lower the barrier of entry for small landowners. In the mitigation sector, banks for forests and wetlands could prioritize habitat types that have high potential for carbon sequestration, like higher salinity coastal wetlands, forested wetlands, or deciduous forests on productive soils. Increasing investment in the conservation and restoration of natural lands, and projects that promote co-benefits will create a positive trend in the ecosystem services provided, including the sequestration of carbon.

Funding

See “Challenges.”

Challenges

Working within the boundaries of currently functioning ecosystem marketplaces for wetlands, forests and habitat presents limited opportunities for generating net carbon reductions. RGGI does allow for carbon emissions offsets to be generated through forest planting or management activities, but at this time there have not been any offsets generated in this way because they are not currently cost-competitive with emission allowances on the RGGI market. The Conservation Finance Act specifically allows for landowners that receive state dollars for restoration projects to participate in ecosystem markets, but in most cases projects that have already been paid for through existing funding sources would not qualify for credit generation because they would not be considered additional to existing action. The CFA also allows for the state to produce credits from projects on state lands, but there is a conflict between selling the credits to a third party and the state claiming credit for the project towards its own GHG reduction goals, as outlined in this report and Maryland mitigation plan.

Adaptation, Resiliency, Education, and Outreach

Overview

The Department of Natural Resources participates actively and continually in a variety of state and regional efforts to collectively address climate change. Many of the specific projects and programs highlighted in this report directly support goals, outcomes and milestones of those commissions, working groups, partnerships, and collaboratives.

1. Maryland Coast Smart Council

The Coast Smart Council (CSC) was created in 2014 with the passage of HB615 for the purposes of adopting specific Coast Smart siting and design criteria to address impacts associated with sea level rise and coastal flooding on future capital projects. The council is chaired by the DNR Secretary and staffed by DNR employees. The original Coast Smart Construction Program (CSCP) Siting and Design Guidelines (Guidelines) were published in 2015. The CSCP Guidelines were [updated](#) in September of 2020 following the passage of HB 1350 and HB 1427 in 2018 and 2019 respectively. The updates expanded the applicability of the guidelines and provided a new boundary for determining flood risk, the Coast Smart Climate Ready Action Boundary (CS-CRAB⁸).

2. Adaptation and Resiliency Working Group of the Maryland Commission on Climate Change

DNR is a member of the Maryland Commission on Climate Change (Commission) and the chair of the Adaptation and Resiliency Working Group (ARWG). The ARWG is chaired by the DNR secretary and staffed and coordinated by DNR employees. The ARWG supports the Commission by hosting quarterly meetings and coordinating the development of a comprehensive strategy aimed at reducing the vulnerability of Maryland to climate change impacts and providing tools to state and local governments. ARWG's membership is composed of a working group of representatives from state agencies, including three DNR employees, General Assembly members, and public sector representatives.

3. Chesapeake Bay Program, Management Board and Work Groups

DNR employees from across the agency participate actively in the Chesapeake Bay Program, the regional partnership aimed at achieving set goals for Chesapeake Bay Health. DNR staff serve on the Management Board, as chairs for multiple Goal Implementation Teams (GIT), and participate actively in a number of the working groups including Sustainable Fisheries, Habitat Goal, and Climate Change Resiliency.

In 2019, Maryland's Phase III WIP to reduce nutrients and sediment entering the Chesapeake Bay devoted a chapter to climate change. The plan identifies nutrient and sediment control strategies that can assist in mitigating the increase in GHGs and adapting to anticipated climate

⁸ Maryland Department of the Environment. <https://mdfloodmaps.net/CRAB/>

impacts. The Plan acknowledges Maryland's role in helping to understand how nutrient control practices might be impacted by climate change. It also affirms Maryland's partnership with the Chesapeake Bay Program to estimate the effects of climate change on future nutrient and sediment loads to the Bay. In addition to the Phase III WIP, Maryland includes climate change mitigation and adaptation strategies within its two-year milestone strategy.

2023 Project and Program Updates

1. Practice and Place

Maryland Climate Change Adaptation & Resiliency Framework (Framework) and Next Generation Adaptation Plan: In 2021, the Adaptation and Resiliency Working Group of the Maryland Commission on Climate Change, completed the initial phase of evaluating and updating the state's adaptation strategy. Through sector and focus group working sessions, co-led by sector appropriate leaders on adaptation, a draft Framework document was put together identifying key goals, strategies and activities needed to move adaptation and resiliency efforts forward. In 2022 and 2023, the Adaptation and Resiliency Working Group started to use the resilience strategies identified in the draft framework to begin developing a Next Generation Adaptation Plan which will span a 10-year roadmap to resilience and help meet the state's GHG reduction goals. To be completed in early 2024, this effort is included in the Adaptation and Resiliency Working Group 2024 annual work plan and is a climate milestone in Maryland's Phase III WIP.

Targeted Resiliency Areas: The Chesapeake and Coastal Service Unit continued efforts to develop "Targeted Resiliency Areas" (previously referred to as *Resiliency Opportunity Zones*) to demonstrate how restoration and conservation projects can work together synergistically to generate area wide resiliency benefits to protect natural resource based economies, high value ecosystems, public lands and at-risk communities. In 2021, the team worked to refine the scope, approach and criteria used to determine the TRA's and map out next steps to incorporate these areas into the development of "Comprehensive Water Quality and Climate Resiliency Project Portfolios" that reduce climate risks in vulnerable areas and also generate water quality, carbon sequestration, and habitat co-benefits. These area-specific plans for resiliency will provide the basis for robust funding partnerships and long-term financing strategies. In 2022, the City of Hagerstown and the lower Pocomoke River region, including Pocomoke City, were selected as pilot geographies. This effort is included as a climate milestone in Maryland's Phase III WIP. In 2023, the Chesapeake and Coastal Service worked with a contractor and subcontractors to engage with the two chosen pilot geographies and progress an analysis of potential restoration and conservation projects. This analysis included the estimation of the co-benefits of each potential project, and will culminate in the design of one final recommended project for each geography chosen.

Innovative Technology Fund: Maryland's Innovative Technology Fund (ITF) expanded its scope of eligible techniques and technologies to include consideration of climate impacts. In addition to the traditional technologies focused on nutrient and sediment reductions, the state will also invest in the research, development, and commercialization of solutions addressing climate mitigation to help accelerate the adoption of climate resiliency and GHG mitigation. In 2023, a research and

development grant was awarded to BTU Insight to refine their modular solar heating system, the first self-powered, direct-solar space heater for small homes and other structures. Furthermore, in 2023, the program invested in N5 Sensors to refine their wildfire monitoring and adaptation platform; AquaLith to increase production of their new material chemistries for EV batteries; and JumpLights to increase manufacturing of their agricultural lighting system which utilizes less energy resulting in decreased GHG emissions. In addition, the program is currently under due diligence to invest in a technology that will reduce emissions by increasing accessibility to electric vehicles.

Chesapeake and Atlantic Coastal Bays Trust Fund (Trust Fund): Since its inception in 2009, the Trust Fund has provided more than \$700 million in support of over 3,327 projects, including wetland restoration, stream buffer planting, stream restoration, and bioretention facilities. Wetland restoration and forest buffer planting practices are very efficient at sequestering carbon. Establishing broad riparian buffers along stream corridors also allows for channel migration resulting from increased precipitation. The Trust Fund invests in stream restoration practices that enhance and restore wetlands by reconnecting the stream to its floodplain, which also helps to spread and slow flood waters. Bioretention projects have been identified in federal and state vulnerability studies as a recommended best management practice for water quality improvement, increasing stormwater retention capacity, and tidal flooding resiliency. With the passing of the Conservation Finance Act of 2022, the Trust Fund can now strategically invest in co-benefits, including carbon sequestration, resilience, habitat and DEIJ. In effect, the Trust Fund managers can broaden the myopic focus on cost per pound of nitrogen, phosphorus and sediment reduced, and include other desirable environmental outcomes in investment decisions.

Coast Smart Council and CSCP: Following the 2020 update to the Coast Smart Construction Program Siting and Design Guidelines, the Coast Smart Council worked with MDP and DBM to incorporate the Siting and Design Guidelines into the review processes for capital project proposals in the state. The Coast Smart Climate Ready Action Boundary (CS-CRAB) and the updated Siting and Design Guidelines were also used in an effort to design a new ranger station at Assateague State Park through a partnership between DNR Chesapeake and Coastal Service and the University of Maryland School of Architecture through the PALS program. The Siting and Design Guidelines and additional information can be found at the Coast Smart Councils website.

Community Resilience Grants/Resiliency through Restoration: DNR solicited and funded community-based resilience projects in 2023 through DNR's Grants Gateway. These projects leverage federal dollars with state "Resiliency through Restoration" capital funding to promote and support comprehensive, holistic planning and implementation projects that address both water quality and quantity issues. Through these projects, DNR is helping Maryland communities become more resilient to flood risks, and enhance the protection and management of the state's resources including the bay and the ocean. Examples of some projects funded in 2023 include; developing a Community Flood Resilience Plan to guide policy and future resilience projects in the City of Greenbelt; developing a master plan for Ice House Park to address flood and stormwater impacts in the Town of Perryville; completing a watershed and flood analysis to identify flood control projects in the Town of Elkton; designing green infrastructure practices to reduce stormwater flooding at a community church in Anne Arundel County; and constructing a 975 linear foot living shoreline to protect community infrastructure

and implement the Talbot County Green Infrastructure Plan on Tilghman Island. This work continues a decade-long effort to provide support to local communities to assess risk, plan risk-reduction efforts and implement projects. This effort is included as a climate milestone in Maryland's Phase III WIP.

Maryland GreenPrint Update and Co-Benefits of Ecological Restoration: Maryland DNR partnered with the Chesapeake Conservancy to update Maryland's GreenPrint network, showing the connections across the landscape of intact habitat hubs. The project also mapped opportunities for tree plantings, coastal and inland wetland restoration, and stream restoration across Maryland and the projected associated ecosystem service benefits that would be gained should those areas be restored. These data products will be used to prioritize conservation and restoration opportunities and are in the process of being uploaded to Maryland iMap and the Greenprint web map.

Beneficial Use of Dredged Material: Once approved by DNR senior leadership, DNR's policy and supporting processes will proactively identify environmentally and economically sound beneficial use of dredged material practices to improve coastal resiliency. Through the development and maintenance of tools and resources including a mapping tool - Beneficial Use: Identifying Locations for Dredge (BUILD) - project managers are able to quickly identify beneficial use opportunities as well as support counties and communities with beneficial use planning efforts. DNR is funding or partnering on several coastal resiliency projects plan to utilize dredged material in 2023. Additionally, in 2024 DNR plans to conduct a Statewide Dredging Assessment to evaluate current shallow navigation channel conditions, upcoming dredging needs, and identify opportunities for beneficial use. Dredging projects funded by the state Waterway Improvement Program special funds utilize beneficial use opportunities, when possible, for placement of dredge material. Collaboration in the planning phase is occurring regularly in order to align scheduled maintenance dredging with beneficial use of material.

Clean and Resilient Marinas and Waterway Improvement Projects: The Maryland Clean Marina Initiative provides climate change and severe weather resiliency information to marinas via workshops, on line, and via newsletters. Updated resources related to adaptation and resiliency have also been added to the Maryland Clean Marina website. In addition, beginning in 2021, the state Waterway Improvement Fund Program began incorporating climate vulnerability information into the application, Waterway project manual, review process, and grant issuance processes. Early coordination with grant recipients is taking place to assure that site owners are aware of specific projections related to climate vulnerability. CCS staff are actively providing guidance as to what can be incorporated into planning and design of public boating facility projects to ensure longevity of public investments in infrastructure.

Maryland Park Service (MPS) Strategic Management Planning: MPS is actively engaged in a methodic park-by-park strategic management planning effort. These plans identify specific threats to park resources (such as storm-related flooding) and identify tasks to address those threats.

Building resilient landscapes: MPS is working with Land Acquisition and Planning and Chesapeake and Coastal Service staff to identify marginal agricultural lands on park properties

that can be converted to more resilient, natural landscapes such as wetlands, meadows and forests. This has resulted in the protection of sensitive resources (e.g., hydric or highly erodible soils) while also improving park aesthetics and addressing identified erosion concerns. Maps were created for Kings Landing, Merkle NRMA, Tuckahoe SP, and Wye Island to highlight agricultural areas impacted by sea level rise. Ecological and stormwater restoration implementation is planned at Tuckahoe and Elk Neck State Parks in winter/spring 2024.

Electric Vehicle (EV) Charging: DNR has an internal EV Charging Task Force with representatives from several units who work together on EV charging-related projects. Over the past year, Task Force members representing MPS have developed a regional assessment of potential locations for charging infrastructure installation. MPS has completed the fleet charger buildout in the southern region and has active projects in the western, central and eastern regions of the state. Expected completion of fleet chargers in all facilities is expected in early 2024. Acquisition of new EV fleet vehicles will begin once EV's are made available under contract. Key Task Force initiatives have also included working with utility companies on the evaluation of DNR owned lands for charging infrastructure through the Public Service Commission's EV Pilot Program, developing right of entry agreements for pilot program projects, and coordinating with DGS on the installation of two charging projects at the Tawes complex.

Energy upgrades at existing park buildings: Two parallel efforts are being made to improve energy efficiency at existing park facilities. First, all park sites are being analyzed for the potential installation of solar panels on existing park buildings. A successful installation has been made at Sandy Point State Park. MPS is now under contract with MES to coordinate 15 solar projects at five state parks, including Assateague Island State Park, Merkle NRMA, Sandy Point State Park, Fair Hill NRMA and Deep Creek Lake State Park. Anticipated completion of all projects is expected by summer 2024.

Targeted climate change acquisitions: In recognition of the increasing frequency of flooding and storm events and the resulting impacts on park operations and visitors, MPS is working with Land Acquisition and Planning to identify potential sites for relocating popular campgrounds and day use areas if the time comes where "retreating" from flooded or flood prone areas is the only viable option. While some level of further investment in existing facilities is likely, catastrophic storm events are not out of the realm of possibility. Planning ahead and ensuring sites meet the needs of our visitors will ensure visitor enjoyment despite flooding events..

Nuisance Flood Plan Guidance: DNR and MDP met to create a nuisance flood plan guidance timeline and identify immediate next steps. Together they drafted a letter to all former nuisance flood plan authors and stakeholders and encouraged everyone to attend the grants gateway webinar. Another follow up letter from DNR, MDP and MEMA will be sent out detailing the timeline and to support the work on nuisance flood plans and ensure that there is cross coordination and consideration of all planning documents for the counties.

Climate and Fisheries Coastal Management Fellow: A 2022-2024 Coastal Management Fellow has been working with DNR to support work advancing climate adaptation priorities related to natural resources management with a focus on fisheries. Thus far, the fellow has identified climate hazards for fisheries, worked with DNR staff to identify adaptive management needs,

engaged in regional Fishery Management Council climate scenario planning, and co-lead the development of the ARWG's Next Generation (NextGen) Adaptation Plan. Current work is focused on developing guidance for integrating climate change into fisheries management plans and advancing fisheries and natural resources adaptation items from the NextGen Plan.

Saltmarsh Sparrow Habitat Prioritization: CCS staff continue to work with state, local and federal partners towards prioritization of saltmarsh restoration and protection areas with the goal of protecting habitat for the Saltmarsh sparrow, a tidal marsh obligate songbird of Conservation Concern. The habitat is threatened by sea level rise and marsh degradation. Maryland Saltmarsh Restoration Priorities for the Saltmarsh Sparrow document was updated in April of 2022 and will continue to be updated as progress and projects continue. An online spatial tool⁹ was created based on this information in October 2022. CCS is working with various partners on the Chesapeake and Coastal Bays SMARTeam to support saltmarsh restoration projects identified through this work with technical assistance and funding support.

Climate Change Adaptation and Resilience Planning on State Lands: CCS continued to collaborate with the Maryland Park Service, Maryland Forest Service, and the Wildlife and Heritage Service to update climate change adaptation and resilience plans on state lands and identify areas in need of future plans. A plan was developed for the Chesapeake Forest Lands to meet new climate standards ahead of an annual audit. On-the-ground projects were discussed with various land unit managers and a drone survey was initiated to monitor sand movement at Assateague State Park. CCS partnered with the Maryland Partnership for Action Learning in Sustainability (PALS) program to initiate surveys of the public on their climate change experiences at 20 state parks. Other adaptation planning initiatives through PALS include the development of stormwater adaptation management graphics for urban small businesses.

Centering Equity and Community-Led Climate Adaptation Planning: The Nature Conservancy (TNC) and Maryland Department of Natural Resources (MDNR) are leading initiatives to protect and restore coastal landscapes to ensure the long-term resilience of critical habitats and coastal communities. Working with both organizations, Sabine Bailey, NOAA Digital Coast Fellow 2022-2024, is playing an integral role in facilitating cross-agency conversations to reform land protection activities with equity-oriented implementation and to promote community-supported marsh migration and community resilience. Specifically the fellow is (1) leading landowner engagement on the Lower Eastern Shore to ensure local perspectives are driving the design of a the Resilient Protection Framework initiative with TNC, (2) developing an engagement plan with local indigenous communities to understand how TNC can support their goals, (3) drafting an outreach plan for DNR's Land Acquisition and Planning Service to incorporate considerations for ecosystem services and equity and justice, (4) drafting policy recommendations for long-term adaptation strategies that align with a climate justice community on the Eastern Shore, (5) bringing expertise to MDNR's Targeted Resilience Area Implementation Team on equitable community engagement and land protection, (6) supporting IRA proposal development for the Pocomoke Sound.

⁹ Atlantic Coast Venture. Saltmarsh Sparrow.. <https://acjv.org/saltmarsh-sparrow/>

2. Community Engagement and Communication

2023 Mid-Atlantic Climate Change Education Conference: The 2023 Mid-Atlantic Climate Change Education Conference (MACCE-C) was a unique convening of formal and non-formal educators to share and learn about the latest trends in climate change education. In its fourth year, the conference was hosted virtually June 21-22. There were 180 registered participants, and four session tracks for the conference: Teaching Climate Action; Building Climate Resilience; Exploring Climate Resources and Starring In Solutions. The conference was made possible through partnerships and collaboration with the following agencies: CBNERR-MD, National Oceanic and Atmospheric Administration (NOAA) Chesapeake Bay Office, DE Sea Grant, DE NERR, and Jacques Cousteau NERR (NJ), Earth Force, Communitopia, and teachers from Thomas Stone High School in Waldorf, Maryland, and The University of Wisconsin-Stevens Point, Reach Cyber Charter School the conference fee remained affordable to participants (\$25).

Mid-Atlantic Climate Change Education FORUM: In 2021, the planning team of the MACCE Conference considered how to expand beyond an annual conference, and began seeking ideas to transform the multiple avenues of education into the ambitious action needed to build a healthy, livable, just future. The team invited bold ideas from around the Mid-Atlantic to lead this conversation, share lessons and leverage lessons learned, scale and celebrate successes, network across sectors, and engage together. Seeking a strategy centered in equity and justice, they co-created a regional forum to advance education for climate action.

The inaugural Mid-Atlantic Climate Change Education Forum was held August 15-17, 2022 at NorthBay Adventure Camp in Maryland. The Forum aimed to: Convene and build a community of active climate education stakeholders; Learn and share about the state of climate action education in the region; Create a strategic framework and map the strategies for advancing and funding climate action education; Identify catalysts and influencers essential for building capacity in education for climate action; and, Develop a set of key actions and identify teams willing to work on these actions. The Key Actions and Teams developed:

1. Schools as resource and community hubs
2. Supporting student-led action
3. Systems-level advocacy
4. Career education and workforce development
5. Strengthening strategic networks and supporting climate action plans
6. Intergenerational and community based solutions
7. K-12 and College Programming

In 2023, The teams continued to learn, connect, create and engage monthly to prioritize the development and implementation of the resulting climate change education vision. In August 2023, the MACCE collaborative submitted a Letter of Intent for the NOAA Regional Climate Resilience Challenge (Earth Force as a partner and as PI on the LOI). The project – *Resilience Education as a Strategy In Leading Inclusive, Equitable and Networked Community Engagement* (RESILIENCE) The vision for RESILIENCE is to leverage the work of the MACCE Collaborative to expand and embed climate resilience education into the formal education

systems of the Mid-Atlantic. RESILIENCE will improve K-12 climate resilience education to support coastal communities in becoming more climate resilient. Community climate resilience requires that climate education be considered among the myriad of pathways to both mitigation and adaptation strategies. There are three primary components of the proposed project:

1. Network Building – Expand Climate Resilience Education Networks: By further developing and resourcing MACCE with the addition of a full time Network Coordinator, RESILIENCE will advance an inclusive and engaged impact network that drives transformational change within schools systems and communities.
2. Risk Reduction – through strategies to Enhance School System Capacity to Increase Climate Resilience on school grounds and in the community
3. Education policy – Develop Climate Education Policy Frameworks inspired by existing models

The Project was not awarded the opportunity for a full proposal but has provided meaningful mapping of actionable pathways for the MACCE Collaborative to continue growing.

Teachers on the Estuary: The 2023 Teachers on the Estuary (TOTE) program, offered through a partnership with CBNERR-MD, the Chesapeake Bay Foundation, and NOAA Chesapeake Bay Office, featured a hands-on learning experience for both students and environmental science professionals. Participants collected real data throughout the watershed to address questions about climate change. Participants learned to integrate data into the classroom through cross-disciplinary, hands-on field activities, and online resources. This dynamic course enhances the learning experience by conducting investigations of participants' local environments. This course is designed to model a Meaningful Watershed Educational Experience (MWEE) through participant-driven field experiences and hands-on research. Both the 2022 and the 2023 course focused on merging pillars of Social Emotional Learning with the actionable steps of the MWEE. Participants for both courses met with community members from coastal island communities (Hoopers Island, 2022, and Deal Island 2023) to discuss impacts of changes to cultural heritage resources, natural resources and community values. Visits included on site presentations about the science of restoration efforts and subsequent monitoring of projects within these communities.

Shoring Up Resiliency Through Education (SURE): This project aims to support Somerset County Public Schools in addressing regional vulnerability to climate impacts and building community resilience through understanding how environment, science and cultural heritage work together to strengthen a community. Students in fifth, seventh and ninth grades experience, study and analyze trends in local conditions such as weather and water quality that affect the natural resources upon which much of their local economy depends. Participating teachers receive professional development annually, through which they are supported in writing lessons to support this project. Partners include the Maryland Department of Health, Chesapeake Bay Trust, and Somerset County Public Schools.

Maryland Forest Service: In 2023, Maryland Forest Service State Forest managers and Forest Resource Planning staff worked with DNR Chesapeake and Coastal Services staff to develop the Chesapeake Forest Lands climate Impact and Adaptation Plan. DNR staff cooperated with the Northern Institute of Applied Climate Science (NIACS) to develop the plan, which included a

workshop in February to identify climate risks and potential solutions. A similar plan was developed for the neighboring Pocomoke State Forest in 2022. The Chesapeake Forest Lands climate Impact and Adaptation Plan identifies risks and actions that can be taken to mitigate or adapt to changing climate conditions on the Eastern Shore of Maryland. State Forest staff can utilize the plan to inform and prioritize management decisions for the state forest that are indeed 'climate smart'. The plans can be accessed from the Chesapeake and Coastal Services web page.

Communicating Risk to the Public: Public trainings were offered throughout the Coastal Zone to over 15 communities and local organizations to encourage the use of the MyCoast MD flood documentation app and website. MyCoast MD can be used to track tides, submit photos of flooding, and identify areas for adaptation strategies. MyCoast MD saw an increase of 330 users in 2023. Staff also participated in conferences for teachers, including the Maryland Association for Environmental and Outdoor Education (MAEOE) where staff presented lessons for understanding climate. Lastly, staff also facilitated climate communication training to natural resource planners in Delaware, as well as interpreters participating in the Maryland Master Naturalist regional courses, and the National Park Service's Storytellers of the Chesapeake program. These training sessions varied from three hours to two days. In all, approximately 125 individuals were trained in communicating about climate science and solutions.

Equitable Community Engagement in Climate Action and Resiliency Planning: DNR provided funding to support Defensores de la Cuenca in the development and promotion of their second and third cohorts of a Spanish-taught watershed steward academy. The purpose of this academy is to engage people in the Latino/a community in environmental stewardship and awareness of flooding issues in Maryland's Coastal Zone. The class focuses on best management practices for stormwater management, ways to address runoff by incorporating native plantings and encouraging tree growth, and environmental communication. The program was expanded this year to teach people to become tree ambassadors as well. Over 1000 people were engaged throughout the year at various events in 2023.

A DNR Chesapeake Conservation Corps member created a guide titled *How to Translate and Interpret into Spanish* which was developed to make the process of translating environmental materials from English to Spanish easier for both non-Spanish and Spanish speakers. This guide provides the current process to translate environmental materials provided by DNR, tools for translating and interpreting, and a vocabulary of environmentally focused words. This guide makes the information accessible to all DNR employees and will foster better communication with Spanish-speaking members of the public.

Building Capacity in Under-Engaged Communities for Resilient Infrastructure Projects: Through a Coastal Management Bipartisan Infrastructure Law funding opportunity, DNR is partnering with the Chesapeake Bay Trust for a second year on the 'Community Based Organization Capacity Building Initiative (CBO-CBI).' Through five years of funding, the Department will be working to address capacity needs across the coastal zone in historically under-engaged communities that have not previously participated in core community resilience grant programs. This CBO-CBI partnership will build meaningful connections with historically under-engaged community-based organizations (referred to as "connector" groups) that focus on reaching out to and engaging new and under-engaged groups to identify resilient infrastructure

projects. The second type of partner organization - “technical assistance providers” - provide support with green infrastructure design, engineering, and grant proposal writing. Both types of organizations will work closely together to build the capacity of community-based organizations interested in applying to and advancing resilient natural- and nature-based projects.

Climate Impacts in Maryland: Understanding the training and education opportunities across the coastal zone: In Fall 2023, CCS completed a market analysis and needs assessment of climate-focused education and training opportunities in Maryland. CCS contracted with Responsive Management to conduct two surveys and a series of in-depth interviews and focus groups. The first survey focused on service providers to gauge the breadth and scope of existing training and education programs and services in Maryland. The second survey was distributed to stakeholders to determine the gaps in education and training programs and unmet needs of stakeholders. The next steps are to disseminate the results of the study across DNR. Moving into 2024, CCS will use the results of this study to identify where CCS should invest in developing education, training, and technical assistance programs and services to meet stakeholder needs and avoid duplicating the efforts of existing programs.

3. Advancing the Science

Margaret A Davidson Fellowship: The Margaret A. Davidson Graduate Fellowship is a fellowship program that places a graduate student in each of the 30 NERRs to address key coastal management questions through cross-discipline research projects. The 2022-2024 fellow, Sylvia Jacobson, began in fall 2022, and has focused her research on analyzing existing CBNERR-MD elevation, plant and water quality data collected from 2008 onwards, as well as newly collected soils data to determine how tidal wetlands in the Reserve have changed over that time. The outcome of this project aims to determine if there are underlying drivers of these changes that could be assessed in other tidal wetlands in Maryland as they respond to climate change. In 2023, Sylvia conducted analyses on CBNERR collected vegetation data in order to inform new field data collection for her project. Sylvia then (with NERR staff support) collected soils and water level data from all three CBNERR components. Sylvia will spend collecting additional water level data as well as begin data analysis of her collected soils data in order to relate those data to existing CBNERR data for her thesis.

Ecological Effects of Sea Level Rise: DNR partnered with George Mason University and The Nature Conservancy to complete Maryland’s Ecological Effects of Sea Level Rise Project to monitor and model the wave attenuation and flood reduction benefits of marshes, submerged aquatic vegetation and other nature-based features. This four-year project quantified the protective characteristics of Maryland’s natural features and predicted how those characteristics may change as sea levels rise. Wave, water level, and current sensors were deployed in the summer of 2020 and 2021, and the department engaged state, federal and local partners through a Management Transition Advisory Group. In 2022, statewide hydrodynamic and marsh migration modeling was completed for different sea level rise and storm scenarios. In 2023, partners completed site level modeling to investigate the benefits of different nature-based features. Work is underway to integrate results into existing spatial tools for conservation and restoration decision-making. This study expands on previous monitoring conducted in Somerset

County and will assist managers with identifying restoration needs and priorities in areas where natural features can enhance community resiliency to climate change impacts.

Resource Assessment Service Monitoring: Based on climate change projections, Maryland's streams are likely to become warmer and the flows are likely to become more extreme. Some coastal streams could also become inundated as a result of sea level rise. These changes may alter the ecology, water quality and physical habitat of streams. The Maryland Biological Stream Survey (MBSS) tracks trends in factors such as aquatic species distributions, water temperature, and erosion that are indicators of potential climate change influences on Maryland's streams. Based on temperature and species distribution information, the MBSS has specifically identified stream animals that prefer cold water and, as a result, may be particularly sensitive to stream temperature increases. Detailed stream temperature information from the MBSS may also help identify streams with cold and stable water temperatures (often due to substantial groundwater influence), and thus are likely to be resilient to temperature increases.

In addition to a representative sampling of Maryland's streams, the MBSS has been monitoring a network of "Sentinel" streams since 2000 to specifically examine for potential influences of factors such as climate and weather on Maryland's stream ecology, temperature, water quality and physical habitat. A report on 20 years of Sentinel Site monitoring was recently completed and will be uploaded to the DNR website in late November.

The Chesapeake Bay Sentinel Site Cooperative (CBSSC): The Chesapeake Bay Sentinel Site Cooperative (CBSSC) is a regional collaboration between government agencies, research institutions, nonprofits, and land managers based in coastal Maryland (MD) and Virginia (VA) (i.e. the Chesapeake Bay and coastal bays, "CB region") that integrates science findings from local observations and ecological knowledge across the CB region to improve planning and management decisions regarding sea level rise (SLR) and other effects of changing climate conditions.

Timing of Striped Bass Spawning in Relation to Changing Water Temperatures: The Chesapeake Bay is the largest spawning area along the Atlantic coast for striped bass and the dominant environmental cue for spawning is water temperature. Since the 1960s, increases in water temperature have been observed in the Chesapeake Bay and climate change projections estimate that water temperatures will increase 2-6°C by the end of the 21st century. This analysis examined data from the striped bass spawning stock survey which has been conducted on the Potomac River and Upper Bay since 1985 using experimental drift gill nets. The analysis focused on the first day of the survey when specific water temperature milestones were reached throughout the time series, specifically 14°C as the water temperature when striped bass spawning begins and 20°C as the water temperature where striped bass egg survival is diminished. The spawning stock data were also analyzed for the day of the year across the time series that 25%, 50%, 75%, and 100% of the female striped bass catch per unit effort (CPUE) was observed as well as the date of the last observed pre-spawn female. In addition to the spawning stock survey data, water temperature data from ichthyoplankton surveys conducted on the Choptank River and Nanticoke River were also analyzed for the first day each year that the same temperature milestones described above occurred over time.

The results of these analyses will soon be published in Marine and Coastal Fisheries. Based on peer review, the analytic methods were updated from the previous report. While the 14°C water temperature milestone did not shift significantly since 1985 in the spawning stock survey data, both the 20°C temperature milestone and date of last pre-spawn female observed on the spawning grounds has shifted to occur earlier over time. All of the percentages of female CPUE were observed earlier in the year when water temperatures were warmer. The water temperature data from the ichthyoplankton surveys suggested no change over time on the Choptank River for the first date of either the 14°C or 20°C temperature milestones while the Nanticoke River only showed a significant change over time for the 14°C temperature milestone with it now occurring earlier in the year.

While these results suggest striped bass spawning generally occurs earlier in the year in recent years than in the first years of the spawning stock survey, the interannual variability resulted in many of the differences not being statistically significant. It is not clear yet how these shifts in spawning season may affect recruitment of striped bass. It is possible that it could be affected by either direct mortality on eggs due to higher temperatures being reached earlier at the end of the spawning season or indirect mortality due to changes in the timing of spring zooplankton blooms which are needed to feed larval striped bass. With the interannual variability, managers need to maintain a robust spawning stock so that when environmental conditions are favorable, strong year classes can be produced.

Tracking conditions on the Choptank River during Striped Bass spawning season: The Fishing and Boating Services Fish Habitat and Ecosystem Program has monitored basic conditions in Striped Bass spawning areas since 2013 as part of a study trying to determine impacts of urbanization. The Choptank River served as a reference system because of its rural watershed and record of successful year-classes. In addition, a historic record of egg abundance or presence and water temperature stretched back to 1954. Similar records existed for the adjacent Nanticoke River that could be combined with Choptank River records to fill in gaps.

We examined four spawning milestones that were reasonably straightforward to interpret: date that the first egg was collected, and the dates when 12°C, 16 °C, or 20°C were consistently met. We compared these milestones during two time periods: 1954-1999 and 2000-2021. We selected 20°C as an upper temperature boundary (>99% of eggs in historic surveys were collected by then); 16°C represented the midpoint of the range and was a temperature where larval cohort survival was expected to be high. Most eggs in historic surveys (> 83%; N ~ 200,000 eggs) were collected between 12 and 16°C.

Early milestones appeared to be the least affected. While analysis of the average first date that eggs were collected indicated that date had shifted about three days earlier between time periods, earlier attainment of 12°C in 2000-2021 was not fully supported. As the milestones progressed in magnitude, average dates of occurrence progressed between 1954-1992 and 2000-2021 (on average 7 days earlier at 16°C and 10 days for 20°C). The portion of the spawning period when most eggs were collected (days from 12°C to 16°C) shortened and high temperatures (indicated by days to 20°C) were being reached earlier. In addition to these general changes, 3 years during 2000-2021 (of 9 available) had very short spans between 12°C and 16°C (2 days).

We continued sampling in 2022 and 2023. The date that the first egg was present in 2022 in the Choptank River, March 22, was the earliest on record. The 16°C milestone was reached on a more normal date, April 18, but two periods of lethally low temperatures occurred before and after that date. The 2023 spawning season was a short, temperature driven spawning season that ran less than 19 days. The 20°C milestone was reached on April 17, 2023, and is tied with 2002 for the earliest this milestone was reached in Choptank River. There were other short seasons earlier in the time-series, but they appear to have become more common since the early 2000s.

Historically anomalous temperature patterns since the beginning of the 21st century have been coupled with dryer springs since 2012. Temperature and river discharge during late winter–spring are major influences on year-class success. Temperature impacts year-class strength through direct mortality of eggs and larvae due to lethally low or high temperatures and indirectly via its influence on the timing of zooplankton blooms for first-feeding larvae (match-mismatch hypothesis), while flow may be associated with zooplankton dynamics, nursery volume, advection, water quality, and toxicity of contaminants.

Water temperature and spawning changes were similar to expectations described by MD Sea Grant. Mismatches between the occurrence of larvae and environmental conditions favorable for their survival were considered likely under projected warming scenarios. Higher temperatures during spring could have a negative effect on larval survival due to a more rapid spring to summer transition that reduces when temperatures are most favorable for larval survival.

Maryland Blue Carbon Resilience Credit Feasibility Study: Maryland DNR has partnered with The Nature Conservancy (TNC) and Environmental Science Associates (ESA) to support the assessment of blue carbon and resiliency crediting feasibility at five project sites throughout Maryland. The feasibility study has gathered existing data and information to inform whether market project development is viable and to provide recommendations for next steps. The final report from ESA will include detailed assessment of technical, organizational, landscape, legal and social feasibility factors. The project is planned to be completed by December, 2023.

Resiliency through Restoration Monitoring: The Chesapeake Bay National Estuarine Research Reserve developed and implemented monitoring protocols at select restoration sites to track restoration success and inform adaptive management needs. Staff partnered with the University of Maryland Center for Environmental Science (UMCES) to expand monitoring efforts across a portfolio of shoreline projects. In 2023, DNR and UMCES partners monitored two pre-restoration sites and five post-restoration sites.



Wes Moore, Governor
Aruna Miller, Lieutenant Governor



Joshua Kurtz, Secretary
David Goshorn, Deputy Secretary

Prepared by
Elliott Campbell, PhD
Director, Office for Science and Stewardship
elliott.campbell@maryland.gov
and
Ryland Taylor
Coastal Climate Coordinator
ryland.taylor@maryland.gov

Chesapeake and Coastal Service
580 Taylor Ave., D-2
Annapolis, MD 21401

Toll free in Maryland: 877-620-8367
Out of state call: 410-260-8702
TTY Users call via the MD Relay 711

dnr.maryland.gov

The facilities and services of the Maryland Department of Natural Resources are available to all without regard to race, color, religion, sex, sexual orientation, age, national origin or physical or mental disability.

This document is available in alternative format upon request from a qualified individual with disability.

XXXX | DNR 01-111723-2