

Greenhouse Gas Reduction Programs

FY 2025

Environmental Article § 2-1305(c)

Maryland Department of Natural Resources

December 2025

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, with a particular focus on our most vulnerable communities. The department also leads the Maryland Commission on Climate Change Adaptation and Resiliency Working Group (ARWG), which recommends actions to prepare for sea level rise and more intense storms, among other anticipated impacts from climate change.

The Climate Solutions Now Act (CSNA) has set a goal of a 60% reduction of gross greenhouse gas emissions by 2031, and the state meeting 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 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 Pollution Reduction Plan, dated December 28, 2023, and the goals established in the department's 2024 Agency Climate Implementation Plan, in accordance with Governor Moore's Executive Order 01.01.2024.19. It also details our work to integrate environmental justice throughout our climate mitigation and adaptation work, providing guidance for climate adaptation, and what we have done to provide education and resources on how climate change will impact Marylanders.

Highlighted Facts and Figures

- Forest planting and management programs have exceeded the 2020 goal and are progressing towards the 2031 goals
- 36,502 Forest Acres Managed in 2024 - 81% of 5 year average.
- 955 Forest Acres Planted in 2024 - 138% of 5 year average.
- The Chesapeake and Atlantic Coastal Bays Trust Fund restored 295 acres of riparian buffer, 136.5 acres wetland restoration/enhancement, and 114.85 acres of tidal wetland restoration in FY25, and has funded the restoration of 3,566 acres of wetlands and 2,035 acres of riparian buffers since 2009.

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Planning for 2031 and 2045

The department will continue to track all the programs included in the 2009 Greenhouse Gas Reduction Act tracking for meeting Maryland's Climate Solutions Now 2031 and 2045 greenhouse gas (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.

DNR's ongoing efforts associated with Biomass for Energy Production, Geological Opportunities to Store Carbon, or Creating Ecosystems Markets may produce positive results in the upcoming 2024-2030 period, where the department lacked measurable benefits between 2006-2024. 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 10 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 (TREC)s 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 TREC)s. 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 U.S. 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.

Climate Implementation Plan

In June 2024, Governor Moore signed Executive Order 01.01.2024.19, "Leadership by State Government: Implementing Maryland's Climate Pollution Reduction Plan". This Executive Order called on every state agency to develop a Climate Implementation Plan (CIP) by November 2024 that details how they will be working towards implementing the actions required in Maryland's Climate Pollution Reduction Plan. DNR's CIP covers an expanse of projects and programs that will help mitigate climate change by both reducing emissions through implementation of renewable and alternative energy infrastructure and sequestering carbon by enhancing natural habitats.

DNR was asked to identify two measures that can be implemented in 2025 to help show progress. The measures chosen were Afforestation and Climate Smart Forestry Management since these activities have the greatest opportunity to support natural carbon sequestration. The Maryland Forest Service is also currently leading initiatives, including 5 Million Trees, that directly support these priorities, promoting carbon sequestration in forested landscapes. In 2025, DNR planted 116 acres of trees in developed areas and 742 acres in rural areas. DNR also recertified 216,000 acres of State Forests to FSC and SFI sustainability standards, incorporating Climate Smart Forestry practices built on adaptive forest management.

¹ Maryland Department of the Environment. Greenhouse Gas Emission Inventory Methodology. 2023. <https://mde.maryland.gov/programs/air/climatechange/pages/greenhousegasinventory.aspx>

CIP Action	2025 Update	Report Page
Renewable and Alternative Energy Infrastructure		
Solar	DNR has completed solar projects on buildings across multiple State Parks and will continue to implement solar across identified locations. Conversion of other areas such as parking lots, fisheries, and agrivoltaics are being explored.	46
Woody Biomass	A wood biomass supply sustainable analysis was completed in 2025, identifying the feasible sources and abundant supply of woody biomass in Maryland. Frostburg State University is designing a high-efficiency, low-emissions wood biomass heating system for a portion of their campus.	25
EV Chargers	DNR continued the construction of both fast chargers and Level-2 chargers at multiple locations. Several projects were completed along with planning and design for those slated for future implementation.	45
EVs	EV procurement continues to be budgeted for fleet conversion. DNR has been working to add EV trucks to the fleet to support more heavy duty uses needed across the agency.	46
Heat Pumps	DNR continues to analyze buildings for heat pump conversion. Design for the first building to be converted was completed this year with construction to begin next year.	46
Innovative Technology and Industries	In 2025, the Maryland Innovative Technology Fund provided Research and Design funds through Maryland Industrial Partnerships (MIPS) for two projects that seek solutions to mitigate GHG emissions.	42
Carbon Sequestration		
Afforestation	In 2025, DNR planted 116 acres of trees in developed areas and 742 acres in rural areas	14
Climate Smart Forestry Management	DNR recertified 216,000 acres of State Forests to FSC and SFI sustainability standards in 2025, incorporating Climate Smart Forestry practices built on adaptive forest management	8
Blue Carbon	In 2025, DNR restored or enhanced 152 acres of non-tidal	18

	wetlands and 115 acres of tidal wetlands.	
Regenerative Agriculture	In 2025, after the passing of the Chesapeake Legacy Act, DNR secured holdover legal agreements for the two existing regenerative agriculture pilot projects while lease agreements and official program expansion protocols are finalized. DNR is also identifying additional properties across the state for program expansion.	38

Environmental Justice Impacts and Initiatives

Environmental Justice (EJ) is at the forefront of DNR’s goals and objectives agency-wide. In 2024, DNR established a new EJ Officer position and adopted a Diversity, Inclusion, Justice, and Accessibility Statement, which reads “Maryland DNR commits to fostering a culture and workforce that is inclusive, equitable, and representative of the State’s diversity. We are committed to increasing accessibility to our public lands, waterways, and natural resources for all communities to enjoy. By engaging and understanding communities that have historically been left behind, we strive to address and remove systematic barriers that perpetuate environmental injustices. Through this work, we celebrate these values within nature, our partnerships, and the communities we serve.” DNR has several initiatives and programs that focus on increasing access to public lands and benefits of natural resource management for all communities including the Greenspace Equity Program, Community Forestry Catalyst Fund, Whole Watershed Act and Fund, Grants Gateways Program, Roots for Resilience, and partnerships like Envision the Choptank. DNR is also collaborating with other state agencies in implementing Governor Wes Moore’s new executive order, “Valuing Opportunity, Inclusion, and Community Equity (VOICE)” on environmental justice signed in July 2025. As part of the executive order implementation, DNR will develop an EJ policy and strategic plan.

In 2024, the Maryland General Assembly directed the Critical Area Commission (CAC) to update the Critical Area Program with respect to environmental justice, which includes considering the equitable distribution of the benefits and burdens of development, restoration, mitigation, conservation and adaptation to climate change; as well as ensuring equitable representation and participation in these processes. The Commission will promulgate regulations that specify how State agencies and local jurisdictions shall incorporate environmental justice considerations in their projects and local Critical Area programs. Once promulgated, all 64 local jurisdictions with Critical Area Programs will update their Critical Area ordinances to (1) identify underserved and overburdened communities within the Critical Area, (2) include measures to ensure the equitable distribution of the benefits and burdens of development, restoration, and mitigation within the Critical Area, (3) include measures to ensure equity in the public participation process, and 4) include measures to ensure public access to the water, shoreline, and other natural areas for underserved or overburdened communities. These regulations will address existing development and new development in the Critical Area. In October 2025, the CAC adopted the *Participation, Access, and Community Outcomes Policy* to direct the CAC in meeting goals related to

environmental justice and equity; it outlines the Commission's intentions when reviewing projects and program changes under its purview.

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, 2022 and 2023.

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, U.S. 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-
 - Stewardship plans for 421,993 acres
 - Sediment control on 255,804 acres
 - 129,757 acres of forest stand improvements (eg., timber stand improvements, wildlife habitat)
 - Forest management planning activities for 807,555 acres of private lands
- DNR has met the 2020 goal and is on track for 2031.

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 percent pines: 30-50 percent 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 U.S. 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
2023	20,914.7	17,174.6	2,144.5	623.1	209.4	41,066.2
2024	21,518.2	13,068.6	1,508.1	340.3	66.9	36,502.1
Total	421,993.6	255,804.3	38,074.0	64,325.8	27,357.2	807,554.8
Average Annual	22,210.2	13,463.4	2,003.9	3,385.6	1,439.9	42,502.9

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

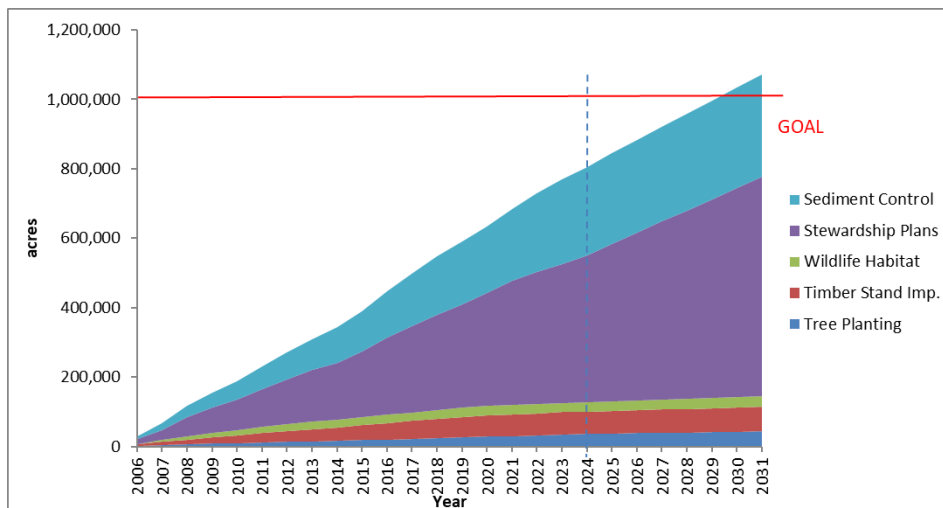


Figure 1: Managing Forests to Capture Carbon. The Maryland Department of Natural Resources is promoting sustainable forestry management practices in existing forests on public and private land through a suite of efforts, policies and programs. The dotted line indicates current progress through 2024.

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 2025 a total of 34 landowners have enrolled a combined 3,287 acres in the program.

Funding

The USDA Urban and Community Forestry Program provides funding for boosting the nation's tree cover in urban, suburban and rural communities nationwide, with significant additional funding made available through the Inflation Reduction Act. In 2022 DNR was awarded \$5 million through this program to support urban tree planting, and in 2023 partner groups throughout the state received over \$34 million through this program.

DNR provides cost-share for sustainable forest management through the Woodland Incentive Fund, with approximately \$200,000 per year for 2,000 acres of forest practices, and technical assistance covering 400+ landowners and more than 20,000 acres annually in Forest Stewardship Plans designed to maintain healthy forest cover. 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 awarded \$10 million for a four-year Natural Resources Conservation Service (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. The award includes over \$700,000 of funding over five years for climate-smart forest management. These are practices that increase carbon sequestration over time or lower the risk of disturbances, such as wildfire or insect outbreaks.

The Maryland/DC Chapter of the Nature Conservancy was awarded \$50 million by the Environmental Protection Agency (EPA) through the MD/NC/SC/VA Climate Pollution Reduction Grant (CPRG) award. Each state's chapter was awarded \$50 million. In Maryland these funds will be dedicated to climate smart forest management and strategic land conservation, targeted in Western 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 (inclusive of natural regeneration, no longer tracked in this report). 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.² 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. A recent update from the Chesapeake Conservancy of the Chesapeake Bay watershed land-use and landcover³ found a decrease of 17,000 acres of forest (0.74%) and ~11,000 acres of tree canopy cover (0.36%) from 2018-2021, an acceleration in loss rate from the prior period.

Program Objectives and Carbon Accounting

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 5 million tree goal, ~11,000 acres will need to be planted over the next eight years (2024-2031). 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 5,000 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, Watershed and Climate Services, and various non-profit environmental stewardship groups reforested approximately 284 acres of parkland in 2023 and an additional 402 acres in 2024. An additional 92 acres were put into early successional meadow habitat in 2023 and 19 acres in 2024 as well. The majority

² Chesapeake Conservancy, 2022. Maryland Forest Technical Study.

<https://www.chesapeakeconservancy.org/projects/maryland-forest-technical-study>

³ <https://www.chesapeakeconservancy.org/projects/cbp-land-use-land-cover-data-project>

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 2024

Cumulative plantings since 2006 increase Maryland’s forest carbon sink by approximately 0.10 MMTCO₂e in 2024.

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
	2023	309.2	417.9	116.0	843.1
	2024	454.4	168.1	332.9	955.4
	Total	7,364.4	14,928.2	4,810.7	27,103.3
	Average Annual	387.6	785.7	253.2	1,426.5
(1).	From the Maryland Forest Service PMAS report where a calendar year is defined as Quarters 3 and 4 of the preceding year, and Quarters 1 and 2 of the current Fiscal Year. For example, the number for 2006 represents the reported values from PMAS for Q3 and 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.				

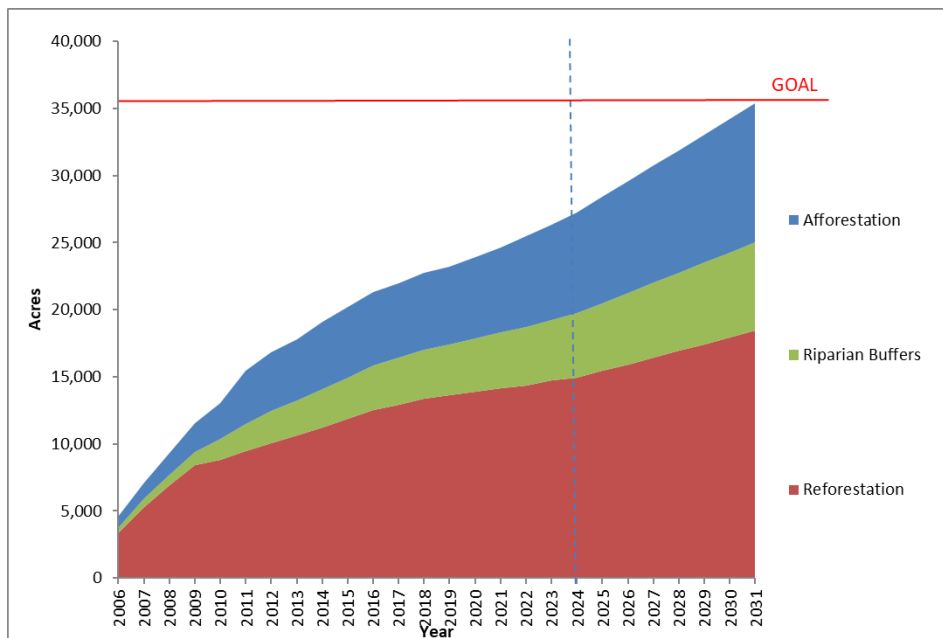


Figure 2 Planting Forests in Maryland. Riparian buffers are tracked separately from afforestation, but together they represent progress towards the 5 Million Tree goal, whereas reforestation acres are not. The dotted line represents progress through 2024.

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 target 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 \$1,000 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 HB 991 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 legislatively defined target 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.

Funds from both the EPA Climate Pollution Reduction Grant will support tree planting in Maryland over the next five years. The CPRG will support 500 acres of tree planting on the lower Eastern Shore of Maryland, targeting priority Atlantic White Cedar habitat, with \$5 million in funding.

Challenges

The Maryland Department of Planning (MDP) projects the state's population to grow by 800,000 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 natural carbon sinks. 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. 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 2006-2024 and Estimated Carbon Benefit

For this initial estimate we only consider tidal wetlands restored from 2006 to 2025 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 U.S.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.

Table 3 Carbon Sequestration Estimate from Coastal Wetlands

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

Funding Source	Acres Restored	Carbon Sequestration MT CO2e per year
Coastal Wetland Initiative	505.6	0
DNR Trust Fund	118.7	257.0
DNR Resiliency through Restoration	16.6	36.0
Federal Partners	2096.9	3292.1
Total	2737.8	5931.2

Implementation Milestones

On the ground wetland and waterway restoration projects:

The Natural Filters Program restored 5 acres of wetlands on state and public land and planted 8 acres of streamside forest buffers on state and public lands in state fiscal year 2024. 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 SFY25.

The Chesapeake and Atlantic Coastal Bays Trust Fund has, as of the end of state fiscal year 2025, funded the restoration of 295 acres of riparian buffer, 136.5 acres wetland restoration/enhancement, and 114.85 acres of tidal wetland restoration and has funded the restoration of 3,566 acres of wetlands and 2,035 acres of riparian buffers since 2009. These totals include restoration gains from the Natural Filters Program, as documented above, and projects that have occurred on private lands. Implementation tracking includes both public and private land restoration projects that are funded through the Trust Fund.

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 of wetlands. 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 2024, 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 2025, a total of 15.52 acres of Living Shoreline have been created or restored.

The Resiliency through Restoration program has constructed 16.16 acres of wetlands to date.

Wetland restoration and enhancement by federal agencies: The U.S. 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 U.S. Army Corps of Engineers has created, restored, or enhanced 1,875 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 641 acres have been restored by the state and 2,096 acres restored by federal agencies since 2006. However, over 100 acres were restored in the past year and several hundred will be restored in the next four years through CPRG funding.

Wetlands Over Time

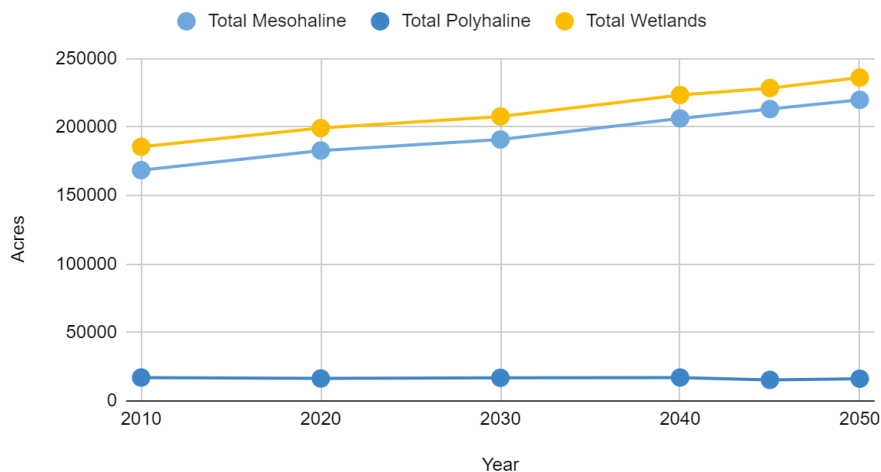


Fig 3. Change in Maryland's mesohaline and polyhaline wetlands over time under a 1.4 feet of SLR by 2050 scenario

According to the Sea Level Affecting Marsh Model (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

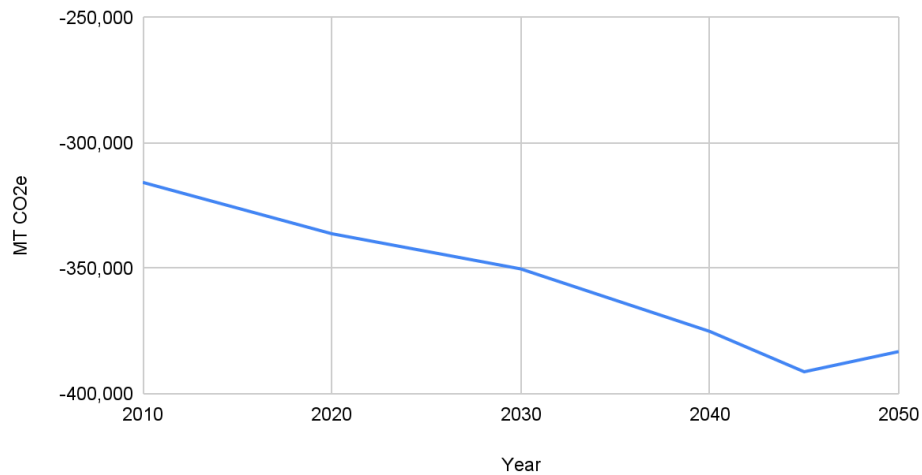


Fig. 4. Change in Maryland's Blue Carbon Sink over time. Negative values indicate a net removal of carbon from the atmosphere. The figure uses the 100-year GWP of methane.

Enhancement Opportunities

The 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 Environmental Science Associates (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 will develop resilience plans with participating landowners to facilitate the transition to wetlands over time.

Funding

The EPA CPRG Award: This funding will support marsh restoration, tidal connectivity, living shorelines to protect marshes, and marsh migration through Coastal Resilience Management Plans. Over five years the award includes \$17 million for living shorelines, \$9 million for marsh restoration, \$2.5 for resilience easement plans, \$4 million for tidal reconnection, and \$140k for community support to help make sure the projects best serve residents of these areas. DNR anticipates GHG reductions of approximately 367,700 mt CO₂e by 2050 from these efforts.

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 FY24, \$32.57 million was allocated for these projects and to support adaptive management.

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' Watershed and Climate Services (WCS) 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 37 living shoreline, coastal, and inland restoration projects around Maryland, with 14 of those projects implemented with Resiliency through Restoration funds.

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>

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.

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 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 the 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

- Frostburg State University is proceeding with engineering design to install a high-efficiency, low-emissions wood biomass heating system for a portion of their campus, part of a strategy of diversified renewable fuel sources. Work is partially supported by a USFS Wood Innovations Grant.
- A detailed wood biomass supply sustainable analysis was completed in 2025 With MD Clean Energy Center and contractors, identifying the feasible sources and abundant supply of woody biomass in Maryland.
- Continued declines in regional pulp and paper production have raised concerns about forest health, inability to afford forest thinning, and increasing wildfire risk, especially as nearby states struggle with more severe wildfire in unmanaged forests (e.g. NJ loss of more than 15,000 acres in Jones Road Fire, April 2025) and sudden, extensive carbon loss.
- Woody biomass is now used as part of the heating at Cypress Branch State Park, delivering low-cost renewable fuel grown and processed on the Eastern Shore. A tour to Vermont illustrated the variety of options, community benefits, and forest health improvements that come with adoption of clean modern wood heat systems.
- 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 the University of Maryland Center for Environmental Science (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 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 2024

None.

Enhancement Opportunities

Allowing thermal renewable energy credits (TREC's) 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 6.3 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 2024. Trees planted through the Forest Conservation Act, required mitigation for forest loss, have comprised 85% of tree plantings through this program up to 2024.

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 target areas, as defined in the law.

Program Objectives and Carbon Accounting

From 2024-2031 we estimate that planting 56,000 trees per year on average in legislatively defined urban 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 2024-2031. 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 892,491 trees planted above baseline afforestation rates across the state since July 2021, as of November 2024. Of the total, 57,799 (6.5%) have been planted in urban target areas and 673,282 (75%) 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 MFS 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 (program no longer active)
 - 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 2024

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 2024. 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 and Marylander 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	210,150	66,560	12,226	288,936
2023	232,916	3,328	5,186	241,430
2024	261,765	6,861	6,488	275,114
Total	5,648,410.5	701,213.5	247,441.0	6,597,065.0
Average Annual	297,284.8	36,906.0	13,023.2	347,213.9
(1).	Assumes 450 trees planted/acre. Plantings are for mitigation and do not contribute towards 5 million Tree goal			

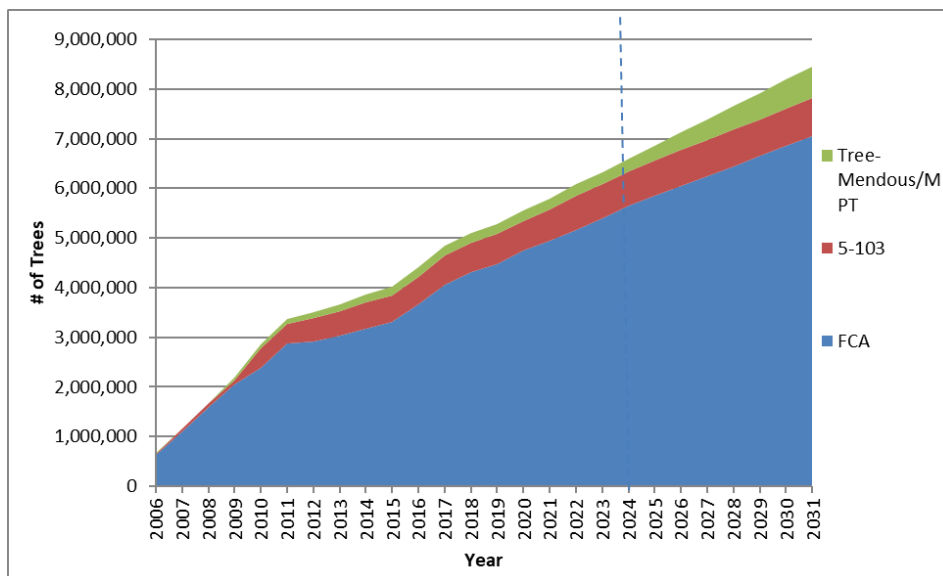


Figure 3. Increasing Urban Trees to Capture Carbon. Current progress and projections to 2031.

Enhancement Opportunities

The Tree Solutions Now Act includes a goal of planting 500,000 trees in urban areas by the end of 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

<u>Program</u>	<u>Description</u>
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 Mid West 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 gigatons 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 gigatons 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.

<u>Program</u>	<u>Objectives</u>
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).	

<u>Implementation</u>	<u>Milestones</u>
Previous geological carbon sequestration funding has come from the U.S. Department of Energy through the nonprofit Battelle Memorial Institute. Research funds for geologic carbon sequestration ceased in 2020 with a refocusing of Department of Energy (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 gigatons of carbon sequestration are possible within our region using offshore sequestration targets. This project is completed.

- Refinement of the offshore carbon sequestration focus areas has continued through participation in the Explore Atlantic Carbon Storage (Explore ACS) project exploring potential long-term offshore regional Atlantic carbon storage which is focused on addressing infrastructure challenges, analyzing geologic data, and understanding societal considerations.
- 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 tons 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 the Maryland Energy Administration (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 MEA, 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 National Aeronautics and Space Administration (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 2025

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 Administration 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 U.S. 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 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

- Maryland DNR partnered with The Nature Conservancy and ESA, Inc. to produce a Blue Carbon Offset feasibility study⁷, as part of meeting the requirements of the Conservation Finance Act.

⁷MD Department of Natural Resources, The Nature Conservancy, ESA. 2022. Maryland Blue Carbon and Resilience Credit Feasibility Study. <https://dnr.maryland.gov/ccs/Documents/Maryland-Blue-Carbon-Resilience-Credit-Feasibility-Study-2023-12-22.pdf>

This study showed that it is not likely for the sale of blue carbon offsets to pay for restoration projects.

- Maryland DNR produced a tree planting carbon offset feasibility study, released in 2024. This study also indicates that carbon offsets are not likely to pay for tree planting projects in Maryland. DNR will be monitoring the carbon sequestration on 118 acres of tree planting on Tuckahoe State Park as part of this project.
- 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 2025 34 landowners and 3,287 acres of Maryland forests are enrolled 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.⁸
- 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.

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 decision was recently made to remove forest carbon offsets as an option under RGGI as of 2027. 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

⁸ Maryland GreenPrint Map. <https://geodata.md.gov/greenprint/>

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.

8. Regenerative Agriculture and Agroforestry

Program Description

In partnership with the Maryland Department of Agriculture (MDA), DNR provides funding for best management practices on agricultural lands that both improve water quality and sequester carbon through the Healthy Soils and Cover Crop Programs.

DNR leases approximately 10,000 acres of land for agriculture to Maryland farmers, and the vast majority of these areas are in traditional, high-intensity corn/soybean row crop rotations. DNR is currently engaged in a pilot project with Beauty Blooms Farm for implementing regenerative agriculture practices at Patuxent River State Park, and anticipates expanding this initiative once a site suitability analysis and replicable legal framework for implementation are established. Regenerative agriculture is a term that was introduced by Dr. George Washington Carver, a professor at Tuskegee Institute and one of the most prominent Black scientists of the early 20th century. It is a form of land management and stewardship approaches that draws on traditions and innovations from African, Indigenous, and original land stewards; promotes culturally important food, climate justice programs and initiatives to provide the greatest community benefits. Regenerative agriculture improves soil health and water quality, enhances ecosystem biodiversity, sequesters carbon in the soil, and reduces fossil fuel consumption in the production process. These practices include multi-species cover crops, crop rotation, low to no-till, mulching, roller-crimping, silvopasture and composting. Many agroforestry practices can also be considered regenerative agriculture, such as multi-story food forests.

Program Objectives

Expand implementation of regenerative agriculture practices on land owned by Maryland DNR but leased for agricultural activities. Expand implementation of agroforestry practices on DNR lands, where deemed appropriate.

Implementation Milestones

The MFS has helped create a demonstration food forest at White Marsh Park in Queen Anne's Co. and federal funding awarded to the MDA will be available in coming year to support agroforestry practices on private lands. These practices both mitigate carbon emissions and help to increase the resilience of agricultural land to climate impacts like increased frequency of droughts and high intensity rain events.⁹ Regenerative agriculture has a longer return-on-investment than traditional agriculture, and soil health restoration takes several years to show results. Therefore, to pursue regenerative agriculture, DNR is examining the potential for longer-term lease agreements for these properties.

⁹ [Study in Preparation for a Maryland Agriculture Climate Vulnerability Assessment, Harry R. Hughes Center for Agro-Ecology](#)

In 2025, after the passing of the Chesapeake Legacy Act, DNR secured holdover legal agreements for the two existing regenerative agriculture pilot projects while lease agreements and official program expansion protocols were finalized. DNR is also identifying additional properties across the state for program expansion.

Enhancement Opportunities

Increase the availability of training available to farmers on regenerative agriculture practices. Farmers leasing land from DNR could be required to implement certain regenerative agricultural practices as a condition of their lease.

Funding

The Healthy Soils and Cover Crop programs with the Maryland Department of Agriculture provide funds for many practices that could be part of regenerative agriculture. The CPRG award will provide \$5 million over the next five years for agroforestry practices, with the funds administered by MDA.

Challenges

The vast majority of Maryland farmers grow corn and soybeans, and while some regenerative agricultural practices can be used with these crops, a continuous corn/soybean rotation would not likely qualify as being truly regenerative agriculture.

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 following the passage of HB 1350 in 2018, HB 1427 in 2019, and SB 299 in 2024. The 2024 update codified exemptions and gave the Council the ability to recommend regulations.

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 (CBP), 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, Watershed Technical, Urban Stormwater, Water Quality Goal, Agriculture, and Climate Change Resiliency. These workgroups allow for DNR staff to communicate and coordinate efforts with other Chesapeake Bay Watershed states as a continuation towards achieving goals set by the 2014 Chesapeake Bay Watershed Agreement. DNR also maintains a role in the Chesapeake Executive Council providing background and support for Maryland's representative and current chair, Governor Wes Moore.

The Chesapeake Bay Program is currently in the Beyond 2025 process with outcomes and goals being reviewed and revised. CBP partners have developed a draft of the revised Agreement which underwent extensive review by workgroups, in addition to a public review period during the summer (July 1-September 1). Feedback was reviewed and a revised version was approved by the Principal Staff Committee on October 28, 2025. The final draft of the revised Agreement was approved by the Executive Council on December 2, 2025.

In 2019, Maryland's Phase III (Watershed Implementation Plan) 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 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. Under the current federal Administration, the Bay Program writ large has removed references to "climate change," but retains a strong focus on accounting for the impacts of "changing environmental conditions," which include not only rising temperatures but also changing weather patterns, water chemistry, species populations, developmental pressures, and more. In addition to the Phase III WIP, Maryland therefore continues to include climate change mitigation and adaptation strategies within its two-year milestone strategy, but also references other changing environmental conditions.

4. Whole Watershed

In 2024, Maryland passed the Whole Watershed Act (SB 969/HB 1165) establishing a highly collaborative, science-based approach to watershed restoration across the state. The legislation coordinates existing state funds through a new Whole Watershed Fund supporting a five-year pilot program that targets five Maryland watersheds that best represent the state's diverse land uses, geographies, and impairments. A direct response to the Chesapeake Bay Program's Scientific and Technical Advisory Committee's Comprehensive Evaluation of System Response (CESR) report, the pilot projects will address multiple restoration and conservation benefits.

In 2025, five watersheds were selected as pilot areas, including: Antietam Creek, Baltimore Harbor, Upper Choptank River, Newport Bay and the Severn River. The State Management Team and Project Sponsors worked throughout the spring and summer of 2025 to select year 1 (FY2026) projects. The diverse array of projects approved will address multiple benefits, including: water quality, increased public access, wildlife habitat, fisheries improvement, environmental justice and climate resiliency. Additional goals for 2025 include the co-development of Watershed Monitoring Plans, Finance and Implementation Plans, and efforts towards improving permitting efficiency.

5. Great Maryland Outdoors Act

The Great Maryland Outdoors Act (SB0541/HB0727) was passed in 2022 to support equitable access to green space, in part by providing Maryland State Parks with the resources needed to promote long-term capacity and safety, as well as to increase access to parks through acquisition and development. The bill calls on the Maryland Department of Natural Resources to develop and implement a critical maintenance strategy and fund, expand public access and recreation, address

overcrowding, and hire new staff. It also provides significant funding for historic preservation, transportation improvements, increasing water access, acquiring new parcels, promoting outdoor recreation and supporting climate mitigation on state lands.

The bill provides \$5 million for, “infrastructure projects that mitigate the effects of climate change, including flood barriers, forest buffers, green spaces, building elevation, stormwater infrastructure, and wetlands restoration”. The Department is strategically using this funding to address both coastal and inland climate hazards. In doing so, the Department aims to model climate adaptive practices on state lands that can be broadly implemented across the state.

2025 Project and Program Updates

Practice and Place

Maryland Climate Change Adaptation and 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, The Maryland Adaptation Framework was put together identifying key goals, strategies and activities needed to move adaptation and resiliency efforts forward. Beginning in 2022, the Adaptation and Resiliency Working Group used the resilience strategies identified in the framework to develop the Next Generation Adaptation Plan which spans a 10-year roadmap to resilience and helps meet the state’s GHG reduction goals. This work was completed in August of 2024. In 2025, DNR began developing a system for tracking progress using the program SmartSheets.

Targeted Resiliency Areas

The Watershed and Climate Services 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 2024, WCS worked with a contractor to finalize the project portfolios for the Hagerstown and Lower Pocomoke River TRAs. These two portfolios included the ranked prioritization of numerous potential projects within each TRA based on project co-benefits, ability to improve resilience to Climate Change induced flooding, and likelihood of implementation.

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 mitigation of GHG emissions. In 2025, the program provided research and design funds through Maryland Industrial Partnerships for Zero Net Energy Systems to develop a cutting edge solar/thermal heating system, and Wooden Boat Restorations to prototype a conversion for boats from gas and diesel engines to clean renewable electric drives for propulsion.

Chesapeake and Atlantic Coastal Bays Trust Fund (Trust Fund)

Since its inception in 2009, the Trust Fund has provided more than \$850 million in support of over 3,600 projects, including wetland restoration (non-tidal and tidal), 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 diversity, equity, inclusion, and justice. 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.

Environmental Protection Agency Funding Chesapeake Bay Implementation Grant (CBIG)

DNR receives annual funding from the U.S. Environmental Protection Agency (EPA) to advance the outcomes and goals in the *2014 Chesapeake Bay Watershed Agreement* through the Chesapeake Bay Implementation Grant (CBIG). This grant supports a variety of outcomes including projects that improve resiliency and adaptation to changing weather conditions through planning, design, implementation, and post-construction monitoring. For example, CBIG supports funding local stormwater and flood management plans, tree planting projects, water quality Best Management Practice (BMP) design projects, living shoreline research and implementation, and performs monitoring of project sites. Funding for 2025 will support water quality monitoring including stream temperatures, tree plantings, agricultural BMPs, and water quality BMP design and implementation.

Following the passing of the Bipartisan Infrastructure Law (BIL), DNR began receiving five years of funding to support green infrastructure projects from federal fiscal year 2022 - 2026. DNR is selecting competitive projects from the fourth year of funding, which may include stream restoration, urban tree plantings, and living shorelines. All project proposals that are considered for funding under BIL are reviewed for water quality benefits, sustainability, and their ability to serve local communities.

Coast Smart Council and Construction Program Regulations

In 2024, a bill was passed that gave the Coast Smart Council the ability to recommend regulations for adoption to the Secretary of DNR. In 2025, the Council submitted its first set of regulations that seek to establish the applicability of and process for complying with the Coast Smart Construction Program requirements and define essential terms used throughout the program. These regulations are currently pending approval as part of the Administrative, Executive, and Legislative Review process.

Community Resilience Grants/Resiliency through Restoration

DNR solicited and funded community-based resilience projects in 2025 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 2025 include: updating a zoning ordinance for the Town of Chestertown to integrate climate resilience; developing a Climate Resiliency and Adaptation Plan for the Town of Berlin; designing living shorelines to address erosion and marsh migration in Anne Arundel and Somerset counties; designing stormwater practices to address community flooding in Cecil County; designing a living shoreline for the first public beach access site and future home of Popes Creek Waterfront Park in Charles County, and constructing a living shoreline with wetland enhancements to enhance the coastal protection benefits of Tizzard Island in the Maryland Coastal Bays. 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 Habitat Connectivity Network and Co-Benefits of Ecological Restoration

DNR partnered with the Chesapeake Conservancy to update Maryland's GreenPrint network, renamed the Habitat Connectivity Network. This map shows the connections across the landscape of intact habitat hubs in Maryland. 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 now available on the Greenprint web map¹⁰ and the new Restoration and Resilience Map¹¹

Beneficial Use of Dredged Material

In 2025, DNR is advancing beneficial use (BU) as a key strategy for addressing climate-driven coastal challenges such as sea level rise and more frequent flooding. Work is underway to reconvene an internal BU working group to review and update the Department's draft BU policy and related resources, ensuring they reflect current needs and opportunities. The Beneficial Use: Identifying Locations for Dredge (BUILD) tool has also been migrated into ArcGIS Experience Builder, improving accessibility and functionality for project managers, counties, and communities planning coastal resilience efforts.

¹⁰ Maryland GreenPrint Map. <https://geodata.md.gov/greenprint/>

¹¹ Maryland Restoration and Resilience Map. <https://dnr.maryland.gov/ccs/Pages/Restoration-and-Resilience-Mapping.aspx>

This year, DNR is continuing to fund and partner on demonstration projects, including thin-layer placement at the Chesapeake Bay Environmental Center and marsh restoration connected to the Price Creek dredging project, to showcase how dredged material can be reused to strengthen wetlands and buffer communities. The Shallow-Draft Channel Dredging and Restoration Assessment (SDCDRA), initiated in 2024, is being adjusted in scope due to changes in available federal and state funding; however, DNR is leveraging existing work and partnerships to continue advancing the assessment's original goals in new ways.

Dredging projects funded through the Waterway Improvement Fund remain a critical opportunity for beneficial use, with DNR coordinating closely with partners to align routine maintenance dredging with restoration priorities. In addition, 2025 marked the launch of Is BU4U?, a new workshop series developed with The Nature Conservancy, which introduced local planners and practitioners to BU concepts, shared case studies, and provided permitting and funding guidance. Together, these efforts reflect DNR's ongoing commitment to making beneficial use an integral part of Maryland's coastal resilience strategy.

Clean and Resilient Marinas

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.

Waterway Improvement Projects

Since 2021, the state Waterway Improvement Fund Program has incorporated 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. DNR 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 WCS 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 Natural Resource Management Area, Tuckahoe State Park, and Wye Island to highlight agricultural areas impacted by sea level rise. Ecological and stormwater restoration implementations were completed at Tuckahoe and Elk Neck State Parks in 2024. A FY 2026 Grant with Ducks Unlimited will design and create 5 acres of wetlands at North Point State Park and will add 15 acres of wetlands at both

LeCompte and Browns Branch Wildlife Management Areas in partnership with Wildlife and Heritage.

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, central and eastern regions and has five active projects in the western region of the state. All projects are complete with the exception of four outstanding Level-2 fleet chargers that are expected to be completed in December 2026. 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 and developing right of entry agreements for pilot program projects. MFS is in the process of constructing three DC fast charger projects at Pleasant Valley Office (WR), Madonna Ranger Station (CR), and Powellville Work Center (ER). Forestry is also installing a Level-2 charger at the Pasadena Office location when it was determined a DC fast charger was prohibitively expensive. Design and permitting for these projects was completed in FY25 and construction and commissioning of the Madonna and Pasadena sites will be completed in FY26. Two Level-2 chargers have been installed in Baltimore at the Weaver building in 2025.

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. MPS has completed 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.

Energy Upgrades at other DNR facilities

The 30,000 sq. ft. Kenneth Weaver building in Baltimore is having a traditional 125 Ton chiller/boiler system replaced by Heat Pump technology, automated building system installed, all lights retrofitted to LED, and an insulation package to tighten up the building envelope on this historic building. Design is complete with a construction commencement date of summer of 2026.

PALS projects on Climate Adaptation Planning in Maryland State Parks

Partnership for Action Learning in Sustainability (PALS) is a partnership between Watershed and Climate Service and the University of Maryland. This year, WCS funded a PALS project to assess the stability of the dunes at Assateague State Park using Ground Penetrating Radar and Magnetometry scans to assess the ability of the dune to resist the effects of erosion from wind, rain, and wave damage. Additionally, WCS funded a project to develop a masterplan for Point Lookout State Park to build resilience to sea level rise. The plan includes designs for five locations in the park. These designs include 3D renderings which can be viewed with Virtual Reality goggles as an educational tool to be used with park visitors.

Land Conservation and Climate Resilience

Program Open Space (POS) Stateside fee and easement acquisitions are evaluated and scored for coastal resilience benefits. Properties are assessed for the presence of future wetland habitat and resilience benefits important for protecting coastal communities together with other ecological and land management criteria. In addition, Land Acquisition and Planning (LAP) and WCS work together to identify potential conservation easement candidates ideal for coastal resilience elements. POS Stateside easements with coastal resilience elements offer an opportunity to expand land conservation, support adaptation of vulnerable communities, and engage new communities in conservation efforts.

Targeted climate change acquisitions

In recognition of the increasing frequency of flooding and storm events and the resulting impacts on facilities and visitors, land management units work with Land Acquisition and Planning to identify potential sites for relocating facilities and recreational areas where "migration inland" from flooded or flood prone areas to higher ground may become 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.

Maryland Coastal Flood Explorer

In July 2025, Maryland released the Maryland Coastal Flood Explorer: a new tool to visualize and assess current, historic, and future flood risk throughout Maryland's Coastal Zone. The Maryland Department of Natural Resources partnered with the Eastern Shore Regional GIS Cooperative, UMD Sea Grant and Sea Grant Extension to leverage funding from a National Oceanic and Atmospheric Administration (NOAA) Project of Special Merit to create the new tool. The tool is available at mdfloodexplorer.org and has been well received by communities, county and municipal staff, Non-Governmental Organizations, and partner state agencies. DNR staff have presented or assisted in presenting information about the tool at 6 meetings since the tool's release, and two in depth trainings are scheduled for Fall 2025.

Nature-Based Solutions and Adaptive Management Fellow

A 2024-2026 NOAA Coastal Management Fellow contributed to a project with DNR to support Maryland's Climate Adaptation Workforce and building capacity for nature-based solutions and adaptive management. The first year was completed, focusing on developing data-led adaptive management approaches based on site-level project success to guide state investments in resilient, nature-based restoration projects and advancing support for adaptation industries by helping to build Maryland's coastal natural resource-based workforce. Based on restoration site information and recent literature review, the fellow developed an adaptive management process flow chart and working definition, and drafted a department-wide adaptive management structured decision-making framework.

Saltmarsh Sparrow Habitat Prioritization

WCS is working with various partners on the Maryland Coastal Restoration Alliance to support saltmarsh restoration projects identified through this work with technical assistance and funding support. This collaboration has led to a Trust Fund Grant to design (two) and implement (three)

saltmarsh restoration projects (FY 25 funding). Additional projects may be funded through Federal grants (see the EPA CPRG work referred to in the mitigation sections).

Climate Change Adaptation and Resilience Planning on State Lands

Units across DNR including Watershed and Climate Services, Maryland Park Service, Maryland Forest Service, and the Wildlife and Heritage Service continued to collaborate to discuss climate change adaptation and resilience on state lands. In addition to the PALS projects from this year detailed above, WCS continued to work with Point Lookout staff and the Alliance for the Chesapeake Bay on a living shoreline design for the causeway. WCS staff also participated in an advisory committee for an update to the state's Land Preservation and Recreation Plan.

Climate Change Adaptation and Resilience Planning for Fisheries

Fishing and Boating Services is expanding upon a 2022-2024 Coastal Management Fellowship project focused on investigating climate adaptation and resilience strategies for fisheries management. The fellow catalyzed climate resilience planning in Maryland's fisheries sector by hosting workshops and small group discussions with biologists and managers, coordinating with interjurisdictional partners, engaging with fishing community members, and synthesizing climate change data. That information was synthesized in the Climate-Ready Fisheries Planning Menu, which describes the impacts of climate change on Maryland's fisheries and provides management strategies for adapting to these challenges and opportunities.¹² The fellow garnered unprecedented support from the recreational and commercial communities to advance climate resilience action. This support enabled the project team to assist with the development of Governor Moore's Chesapeake Bay Legacy Act that was passed by the Maryland General Assembly and signed into law in 2025. This law allows the Maryland Department of Natural Resources to manage the state's fisheries using climate resilience principles.¹³ Fishing and Boating Services is now beginning a series of staff workshops to prioritize the menu of strategies and prepare for an official adaptation and resilience planning process.

Centering Equity and Community-Led Climate Adaptation Planning

The Nature Conservancy (TNC) and DNR 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, played 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 (1) led landowner engagement on the Lower Eastern Shore to ensure local perspectives were driving the design of a the Resilient Protection Framework initiative with TNC, (2) developed an engagement plan with local indigenous communities to understand how TNC can support their goals, and developed a background document for use in onboarding and education for staff (3) drafted policy recommendations for long-term adaptation strategies that align with a climate justice community on the Eastern Shore, (4) provided expertise to DNR's Targeted Resilience Area Implementation Team on equitable community engagement and land protection, (6) supported IRA proposal development for the Pocomoke Sound. In August of 2024, DNR hired Bailey to continue her work with indigenous community engagement and policy. In

¹² Climate-Ready Fisheries Planning Menu: dnr.maryland.gov/climateresilience/Documents/Climate-Ready-Fisheries-Planning-Menu.pdf

¹³ Chesapeake Bay Legacy Act. 2025. Chapter 430 (HB0506), Laws of Maryland.

February 2025, she drafted DNR's Indigenous Strategic Framework and in September of 2025, she formed a DNR Indigenous Matrix Team to increase opportunities and support for Indigenous engagement at DNR. The results of the Resilient Protection Frameworks are being drafted as a peer-reviewed journal article for publication in 2026.

Community Engagement and Communication

2025 Mid-Atlantic Climate Change Education Conference

The 2025 Mid-Atlantic Climate Change Education Conference (MACCE-C) was another successful convening of formal and non-formal educators to share and learn about the latest trends in climate change education. In its sixth year, the conference was hosted for the first time in person, June 25th at two locations – hosted in VA and MD at the Chesapeake Bay Foundation Phillip Merrill Center and Brock Center. There were 212 registered participants. The conference was made possible through partnerships and collaboration with the following agencies: Chesapeake Bay National Estuarine Research Reserve Maryland (CBNERR-MD), DE NERR, Earth Force, Climate Central, teachers from Thomas Stone High School in Waldorf, Maryland, Smithsonian Environmental Research Center, Youth Climate Institute, and Reach Cyber Charter School. The conference fee remained affordable to participants (\$35). Highlights focused on How Climate Storytelling can be another way to make meaning of the issue and the science, included a collaborative art exhibit, Climate Anxiety and mental health, and youth-led climate action. Participants screened two documentary films for use in the classroom – *Underwater Projects* (via the HipHop Caucus) about flooding in the Hampton Roads area of Virginia as a case study in how different communities are impacted based on the socioeconomic access to resources, and *The Making Of...Stories to Save Us: the Saltmarsh Sparrow* a film that looks at how our historic values surrounding marshlands has impacted a specific species of bird that depends on coastal salt marshes for its nesting habitat, pushing it to an inevitable extinction.

Teachers on the Estuary

The 2025 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. The past three TOTE courses focused on merging pillars of Social Emotional Learning with the actionable steps of the MWEE. Participants met with community members from Cambridge Maryland (Hoopers Island, 2022, and Deal Island 2023 and 2024) to discuss health impacts of climate change within unsheltered populations, connecting regional climate data to local health trends. Visits included on site presentations from the Cambridge Health Department, as well as student action projects that support the unhoused populations, through local MWEE projects in partnership with Pickering Creek Audubon Center, and ShoreRivers.

Shoring Up Resiliency Through Education (SURE)

This ongoing 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 seventh 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.

Communicating About Climate Change with Confidence

Trainings continue throughout the region for the informal education community (MD Master Naturalists, State Parks Interpretation, Chesapeake Bay Trust Chesapeake Conservation and Climate Corps Orientation and the Maryland Climate Corps) on tools for building confidence in communicating about climate change. In 2025, approximately 150 individuals received this in-person training.

Building Capacity in Under-Engaged Communities for Resilient Infrastructure Projects

WCS, through Coastal Management and Environmental Protection Agency Bipartisan Infrastructure Law funding, worked with the Chesapeake Bay Trust to support a fourth year of the Community-Based Organization Capacity Building Initiative (CBO-CBI). By leveraging five years of targeted capacity funding, the Department is supporting project identification and development needs with under-engaged communities to identify and develop flooding and resilience projects. 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 groups to identify resilient infrastructure projects. The second type of partner organization - “technical assistance providers” - provides support with green infrastructure design, engineering, and grant proposal writing. The organizations work together to build the capacity for advancing resilient natural- and nature-based projects.

Climate Impacts in Maryland: Understanding the training and education opportunities across the coastal zone

Trainings in 2025 focused on nature based solutions and helping DNR’s constituents utilize the tools and resources DNR provides. In 2025, WCS was able to host two trainings (Nature Based Solutions for Coastal Hazards, NBS, and the Chesapeake Bay Landscaping Professionals-Living Shoreline Certification for Maryland, CBLP) from last year again, to meet increasing requests for these trainings. The NBS training focused on educating participants on how to identify and plan for nature based solutions projects. This year it included new case studies and included a section on adaptive management with respect to changing conditions. The CBLP certification will focus on Southern Maryland. New this year, WCS partnered with The Nature Conservancy to host a one day workshop on beneficial use of dredge material. This workshop, titled “Is BU4U?”, was directed towards local and county planners interested in learning how to plan for a beneficial use project in their community from identifying placement locations, to permitting, to post implementation monitoring. The workshop was hosted at Chesapeake Bay Environmental Center, providing the opportunity to highlight one of DNR’s recent beneficial use projects.

In partnership with Maryland Sea Grant and Maryland Sea Grant Extension, WCS will be hosting two virtual trainings on using the new Maryland Coastal Flood Explorer. The explorer is a brand new tool for visualizing sea level rise and high tide flooding. The goal of this training is to give participants the opportunity to practise applying the tool to real world case studies and increase use of this tool in local planning processes. In addition to the official webinars, WCS has developed a webpage with video tutorial, case studies, and additional resources. WCS will also be supporting a Critical Area Commission training on the tool for their local government partners in the Fall.

Outdoor Recreation

DNR's Office of Outdoor Recreation is committed to demonstrating the connections between climate and recreation and increasing educational programming and access to nature initiatives in order to better prepare communities for climate change. This approach helps foster a connection to nature, encouraging communities to see themselves as part of natural solutions rather than separate from them. Examples of this work in the past year include:

- Partnering with the Maryland Park Service to launch the Track Your Trails program, which engages visitors in participatory science to collect data and track the impacts of climate change on public land trails.
- Holding the inaugural Outdoor Recreation Summit in October 2024. This event brought together more than 170 outdoor recreation leaders, professionals, and enthusiasts from around the state, and included a session about the impacts of climate change on recreation opportunities across the state, and how public lands and outdoor businesses such as ski resorts and outfitters are adapting. The second Outdoor Recreation Summit was held October 2025 in Baltimore City. Sessions included themes of stewardship and explored interconnectedness of recreation and environmental/climate health.
- Working to increase community engagement and expand access to outdoor recreation through the Maryland Outdoor Equity Program. In 2025, OOR is providing a total of \$64,590 to 11 different organizations for initiatives that actively promote inclusion and diversity in outdoor recreation in Maryland. These outdoor experiences will foster connections with nature, which lays the foundation for climate stewardship.
- Coordinating workforce development programs through the Greater Baltimore Wilderness Coalition's Climate Crew Network. This network provides funding, training, and industry exposure opportunities coupled with planting and maintenance projects so that participants can earn a wage while improving their community and gaining the skills and experience necessary to participate in the growing green workforce. Since fall 2023, Climate Crew Network participants have planted more than 7,740 trees (many in overburdened communities) and 5,668 live stakes, and received training and certifications on topics such as understanding and communicating climate change, stormwater management best practices, and invasive species removal.
- Co-leading and providing translation services for Spanish programs centered around the effects of climate change, such as flooding and invasive species, at the Es Mi Parque (EMP) programs. EMP is an umbrella term for a cross-unit initiative hosting bilingual programs and events at Maryland state parks to provide education and recreation opportunities to the Spanish-speaking community. Since May of 2024, OOR has provided translation support for four Es Mi Parque events, engaging over 250 individuals by expanding their understanding of the climate crisis and providing them the tools to be climate stewards.

- Hosting a Chesapeake Conservation and Climate Corps member, who will work with the office for a year starting in August of 2025. The Corps Member will have the opportunity to both lead and support programs and projects that focus on engaging and educating communities on stewardship and nature. A key component of their role will be to design and implement a project that uses recreation as a tool to engage individuals and communities in environmental stewardship. OOR will use this and other projects to highlight the connection between skills and supplies useful for both outdoor recreation and storm/emergency response, such as outdoor cooking, water filtration and more.
- Establishing, in partnership with the Office of Communication Management (OCM), a #OutdoorsInAllFourSeasons social media campaign that highlights outdoor recreation throughout the year and around Maryland with a focus on stewardship. The pieces of media provide the public with beginner-friendly tips on how to care for the environment, including climate change mitigation strategies, while enjoying time outdoors.

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, completed her fellowship in August 2024, and is preparing her results for the completion of her doctoral dissertation. 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. Jacobson will continue engaging with Reserve staff during the remainder of her PhD program through 2027.

The 2024-2026 fellow, Allyson Kido, began in fall 2024, and will focus her research on the impact of land cover changes on the distribution of Submerged Aquatic Vegetation (SAV) in all three Reserve components; Otter Point Creek, Jug Bay and Monie Bay. Using both historical Reserve-collected and newly-collected data, Kido's project will measure how changes in land cover impact the distribution and diversity of SAV habitat in the Reserve. The results of this project will help determine best practices for the restoration and preservation of SAV in the Chesapeake Bay region. In the spring and summer of 2025, Kido has begun collection of SAV and habitat data at all Reserve components.

Effects of Sea Level Rise - Technical Assistance

Through the NOAA Effects of Sea Level Rise Program, the Department is providing technical assistance to a Chesapeake Bay community experiencing flooding and other coastal hazards, while informing grant applications for implementation of climate adaptation projects. DNR collaborated with George Mason University, Resources for the Future, and The Nature Conservancy to provide modeling support and technical assistance to the Town of Pocomoke City. This work is building off of DNR's Targeted Resiliency Area work to aid in green infrastructure decision making. Results will support future applications to federal grant programs for implementation of nature-based climate adaptation projects.

Resource Assessment Service Monitoring

Based on climate change projections, many of 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 more 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. During 2025, temperature monitoring was not able to be conducted. However, it is likely to be added back into sampling, with the exception of some western Maryland streams, in 2026.

Results in a recently completed report investigating changes in stream conditions over time indicated apparent regional patterns in stream temperature. Western Maryland and central Maryland reference streams did not appear to have changed significantly in temperature over the 14-year period examined. Other regions showed increases, these results can be found on the MBSS website. Annual trends in individual reference streams over more than 20 years were examined in another report from the fall of 2023 which can be found on the DNR website.

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) Virginia (VA) and Delaware (DE) (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. The CBSSC is coordinated by Maryland Sea Grant. In 2025, CBNERR-MD staff attended CBSSC meetings in order to further knowledge on wetland health and resilience in the face of water level changes. Outcome from these meetings included the initial drafting of a white paper on rates of wetland elevation change across the Bay watershed.

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 UMCES to expand monitoring efforts across a portfolio of shoreline projects. In 2025, DNR and UMCES partners monitored one pre-restoration site and seven post-restoration sites.

Assess land use and aquatic habitat change effects on recreationally important fish populations in tidal tributaries to Chesapeake Bay and establish and confirm habitat reference points

The Fishing and Boating Services Ecosystem Assessment Division assesses environmental factors that impact recreationally important fish populations in Chesapeake Bay tributaries. The division conducted field surveys in 2025. Their 2024 report is in development. The 2023 report is available.¹⁴

Estuarine Yellow Perch Larvae - The division conducted presence-absence sampling for yellow perch larvae in the agricultural upper tidal reaches of the Choptank River in 2024 during late winter through early spring. The proportion of tows containing yellow perch larvae (L_p) provided a measure of egg production and survival through the early postlarval stage. Calculation of L_p begins when the first larva is detected and the end point is when the water temperature reaches 18°C. Average winter air temperatures measured in Baltimore, an indicator of winter intensity, increased from 1963 to 2024. This increase was modestly and negatively related to the date the 18°C end point was reached and to L_p in both the Nanticoke and Choptank rivers. Winter temperature was positively and moderately correlated with the North Atlantic Oscillation (a major climate feature), which is influenced by climate warming. This analysis provided some support for the hypothesis that reproductive success declines following short, warm winters. Yellow perch require a period of low temperature for reproductive success.

Striped Bass Eggs and Larvae - The division investigated habitat conditions in the Choptank River for striped bass eggs and larvae that contributed to poor year classes during 2019 to 2024. Temperature is a major driver of egg survival and the availability of zooplankton (food for larvae). High mortality of the youngest life stages (eggs and prolarvae; the latter rely on the yolk passed from the egg for nutrition) due to unsuitably low or high temperatures provided the best explanation for recent poor year classes. Spawning stock status (indicated by the proportion of survey samples with eggs) and feeding by postlarvae were adequate, and survival of postlarvae (feeding stage following prolarvae and preceding juvenile) was good. Temperature milestones that marked the beginning, peak, and end of spawning from 1955 to 2024 have been reached earlier since 2017. Early spawning has become less synchronized with its temperature trigger, resulting in increased peak spawning at lethally low temperatures. The remainder of the spawning period has shortened. Warming winters could underlie long-term changes in temperature milestones for spawning and prolarval survival. Under projected warming scenarios, a more rapid increase in spring temperatures may reduce the period when larval survival is favorable.

Assessing winter temperatures and spring river flows as limiting factors for Striped Bass recruitment

The Chesapeake Bay is the primary production area for the Atlantic Striped Bass population. While striped bass spawn in the spring, previous studies have shown that both winter temperatures and spring river discharge play a role in determining the strength of each year's spawning success, as measured by the Maryland Department of Natural Resources' juvenile index survey. Colder winters and wetter springs generally boost reproductive success, while warmer and drier conditions lead to the opposite. However, predicting the average year-class strength based solely on climate

¹⁴ 2023 Performance Report. Marine and Estuarine Finfish Ecological and Habitat Investigations. dnr.maryland.gov/fisheries/Documents/FHEP-F-63-R-11_2023.pdf

data is unreliable because many other unknown or unmeasured factors also contribute to these outcomes. To address this, researchers are developing a predictive framework based on Liebig's Law of the Minimum, which focuses on limiting factors. Using quantile regression techniques, models are being developed to estimate the maximum potential year-class strength by considering winter temperatures and spring river flows as key constraints. This framework will enable fishery managers to use climate data to estimate the potential productivity of the striped bass stock under current and future climate conditions. Ultimately, this approach aims to enhance the management of striped bass by offering more accurate predictions of reproductive success, allowing better planning and conservation efforts in the face of changing environmental conditions. The framework is currently under development.

Brook Trout Annual Monitoring Network

Fishing and Boating Services developed a brook trout annual monitoring network in 2023 to improve coldwater resource data collection and track long-term population and temperature trends. The network includes 51 monitoring stations throughout the state that will be annually surveyed for brook trout population data, temperature data, and habitat data. Stations were selected to broadly represent both brook trout populations and the range of stressors that influence population success. The impacts of climate induced elevated stream temperatures on brook trout populations will be included in the analysis. This will be an ongoing monitoring effort that was recently initiated, so results are not currently available.

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