

# Maryland Department of Natural Resources

## Greenhouse Gas Reduction Programs

Prepared as required in the State Environment Article § 2-1305(c), HB 514, Chapter 429 in 2015  
and in accordance with § 2-1257 of the State Government Article, for the Governor and  
Commission

### **I.1<sup>1</sup> Managing Forests to Capture Carbon**

#### **Program Description**

Managing forests to capture carbon will promote sustainable forestry management practices in existing Maryland forests on both public and private lands. The enhanced productivity resulting from enrolling unmanaged forests into management regimes will increase rates of carbon sequestration in forest biomass, increase amounts of carbon stored in harvested, durable wood products which will result in economic benefits, and increased availability of renewable biomass for energy production. Enhanced forestry management in Maryland should contribute to a 1.8 MMtCO<sub>2</sub>e reduction in the State's GHG emissions by 2020. The goals of this program are to improve sustainable forest management on 30,000 acres of private land annually and on 100 percent of State-owned resource lands, and ensure 50 percent of State-owned forest lands will be third-party certified as sustainably managed. This program is performing as designed.

#### **Program Objectives**

##### **GHG Emission Reductions in 2020**

The potential emission reductions from the Managing Forests to Capture Carbon program in 2020 are estimated to be 1.80 MMtCO<sub>2</sub>e. This number represents a conservative estimate of the cumulative carbon sequestered through this program. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

#### **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 (SFI) and Forest Sustainability Certification (FSC) standards.
- DNR is working to develop similar sustainable forest management practices on State parkland and wildlife management areas.
- Dual Third Party Certification for Forest Sustainability on State Forests
- WMAs and Parks (e.g., early successional habitat)
  - Currently working with WHS on several projects.
  - Currently developing Forest Stewardship plans on several WMAs

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<sup>1</sup> Headings correspond to the Maryland Greenhouse Gas Reduction Plan Update (2015)

- Accelerated Pace of Silvicultural Activity
  - Audit Received: Savage River State Forest will increase the number of sales from 14 to 20. DNR is continuing to work to decrease the backlog of timber sales.
- State Forest Annual Workplans
  - Include a planned 2,611 acres of harvests for FY18, that will be naturally regenerated.

#### Private Lands:

- Since 2006-
  - **217,760** acres of Stewardship Plans,
  - **134,719** acres of Sediment Control
  - **93,476** acres of forest stand improvements (“Tree Planting”, “Timber Stand Improvements”, and “Wildlife Habitat”)
  - Total of **445,955** acres have been implemented on private lands.
- DNR is currently on track to meet their goal by 2020.

#### Technical Assistance – 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 (Currently working on developing the next round of projects)
- Backyard Buffer Program
- Environmental Quality Incentive Program
- Conservation Reserve Enhancement Program
- TAXMOD – expanded eligibility (as of 10/27/14, 3 applicants from the expanded eligibility)
- Forest Conservation and Management Program

- Woodland Assessment Program
- Development and application of the UMCP remote sensing capability for forest carbon assessment – Completed
- Launch of NASA, USDA and DOE 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. – Pending funding approval
- DNR with other partners, including USFS, UMCES and UMD Extension to release topic related fact sheets and technical guidance on woodland and climate change stewardship principles. – Completed

### **Estimated Emission Reductions for CY 2016**

Forest management on private land in Maryland reduced carbon emissions by 0.26 MMtCO<sub>2</sub>e.

Forest management on public land in Maryland reduced carbon emissions by 0.21 MMtCO<sub>2</sub>e.

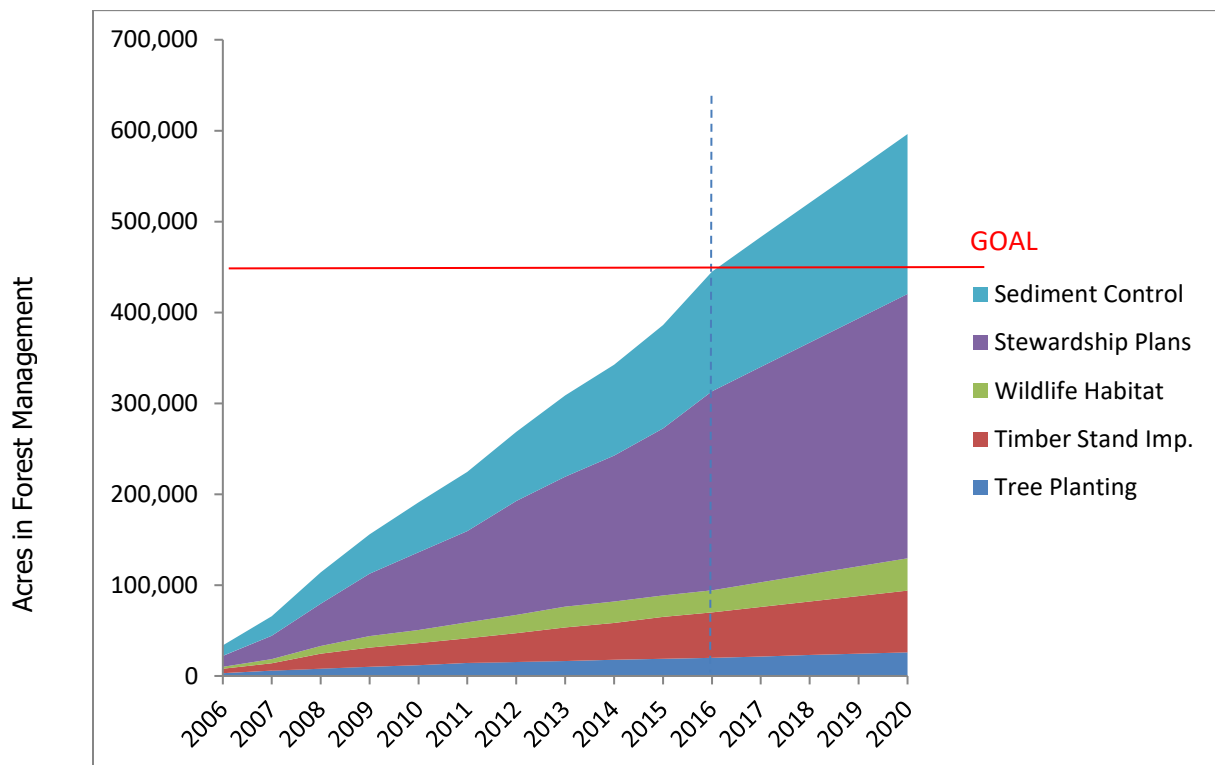
Both exceed yearly reduction goals.

**Table I.1 Forest Management Programs**

| <b>Year</b> | <b>Stewardship Plans</b> | <b>Sediment Control</b> | <b>Tree Planting</b> | <b>Timber Stand Imp.</b> | <b>Wildlife Habitat</b> | <b>Acres</b> |
|-------------|--------------------------|-------------------------|----------------------|--------------------------|-------------------------|--------------|
| 2006        | 12,106                   | 11,580                  | 3,082                | 4,796                    | 2,196                   | 33,760       |
| 2007        | 13,630                   | 9,799                   | 2,661                | 3,300                    | 2,456                   | 61,846       |
| 2008        | 20,657                   | 13,060                  | 2,286                | 8,519                    | 3,760                   | 48,282       |
| 2009        | 22,228                   | 9,037                   | 2,234                | 4,188                    | 4,327                   | 42,014       |
| 2010        | 16,895                   | 11,249                  | 1,497                | 3,542                    | 1,835                   | 35,018       |
| 2011        | 14,866                   | 10,479                  | 2,428                | 2,778                    | 3,149                   | 33,700       |
| 2012        | 24,640                   | 11,167                  | 1,151                | 4,607                    | 2,489                   | 44,054       |
| 2013        | 17,822                   | 13,252                  | 1,166                | 5,171                    | 2,627                   | 44,038       |
| 2014        | 16,580                   | 13,100                  | 1,292                | 3,073                    | 434                     | 34,479       |

|                |                |                |               |               |               |                |
|----------------|----------------|----------------|---------------|---------------|---------------|----------------|
| 2015           | 23,112         | 13,974         | 1,196         | 5,374         | 279           | 43,935         |
| <b>2016</b>    | <b>35,224</b>  | <b>18,022</b>  | <b>1,085</b>  | <b>3,802</b>  | <b>696</b>    | <b>58,830</b>  |
| 2017           | 18,000         | 11,000         | 1,500         | 4,500         | 2,800         | 37,800         |
| 2018           | 18,000         | 11,000         | 1,500         | 4,500         | 2,800         | 37,800         |
| 2019           | 18,000         | 11,000         | 1,500         | 4,500         | 2,800         | 37,800         |
| 2020           | 18,000         | 11,000         | 1,500         | 4,500         | 2,800         | 37,800         |
|                |                |                |               |               |               |                |
| <b>Total</b>   | <b>289,760</b> | <b>178,719</b> | <b>26,078</b> | <b>67,150</b> | <b>35,448</b> | <b>631,156</b> |
| Average Annual |                |                |               |               |               | <b>43,632</b>  |

(Red indicates projections)



**Figure I.1** Managing Forests to Capture Carbon. DNR is promoting sustainable forestry management practices in Existing Maryland forests on Public and private land through a suite of efforts, policies and programs.

## **Enhancement Opportunities**

Current programming appears to be meeting targeted goals.

## **Funding**

The Woodland Incentive Fund is the progenitor of much of the activity on private lands. This Fund receives revenues from a number of sources, including revenues collected by the Department from the payment of charges imposed for Department assistance in implementation of an approved practice, money distributed from the Chesapeake and Atlantic Coastal Bays 2010 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 the Department, but particularly important is the portion received from property tax transfer of forest lands (up to \$200,000 per year). However, the property tax transfer allocation for the Woodland Incentive Fund has been \$0 for the last several years and a new source needs to be identified to make up this gap in program funding.

## **Challenges**

See Funding section above.

## **Relevant Information**

Towson's Regional Economic Studies Institute (RESI) 2015 Study estimated that the Managing Forests to Capture Carbon program, once fully operational, would support a total of 268 jobs by 2020, \$28,564,453 in net economic output and \$28,137,209 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.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, and supplemental planting, to ensure optimum conditions to support forest growth. By 2020, the implementation goal of this program is to achieve the afforestation and/or reforestation of 43,030 acres in Maryland. Achieving the 43,030 acre target should reduce GHG emissions in the State by 1.79 MMtCO<sub>2</sub>e by 2020. This program is performing as designed.

### **Program Objectives**

The potential emission reductions from the Planting Forests in Maryland program in 2020 are estimated to be 1.79 MMtCO<sub>2</sub>e. This represents a conservative estimate of the cumulative sequestration achieved through this program. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

### **Implementation Milestones**

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

Public Lands:

- State Forest System Annual Workplan Implementation

Private Lands:

- Technical Assistance
  - Forest Stewardship Plan Implementation
  - FCA Implementation

This program is performing as designed.

- Financial Assistance – Rural Lands: State and Federal Cost Sharing
  - Woodland Incentive Program (WIP –MD Forest Service)
  - TAXMOD (MD Forest Service; as of 10/27/14, 3 applicants from the expanded eligibility)
  - Environmental Quality Incentive Program (EQIP – Federal/NRCS)
  - Conservation Reserve Enhancement (CREP – Federal/NRCS)
- Financial Assistance – Urban Lands: Public/Private Partnerships
  - Tree-Mendous/Arbor Day
    - 4,800 trees (48 acres) planted in 2016
  - Marylanders Plant Trees/Private Nurseries

- Reimbursed coupons for 3,998 trees (39.9 acres) in 2016
- Lawn to Woodland (e.g. National Arbor Day Foundation, etc.)
  - 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 & Community Forestry Committee Grants
  - Small Community UTC Grants
  - This program is performing as designed.

### **Estimated Emission Reductions for CY 2016**

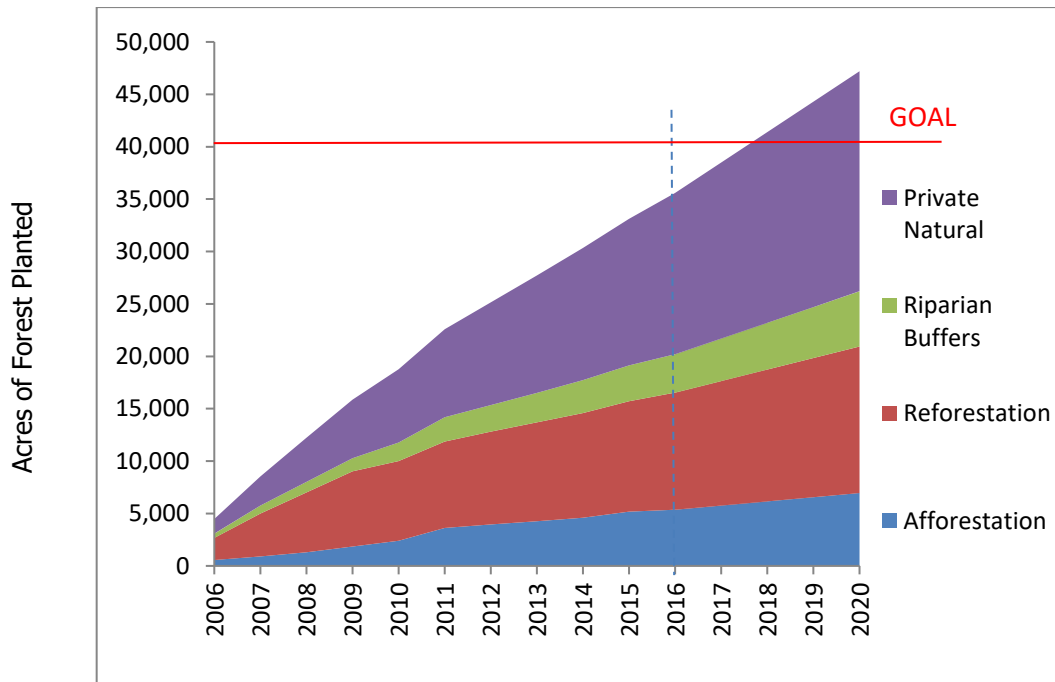
On track with previous years, reductions totaled 0.10 MMtCO<sub>2</sub>e for 2016.

**Table I.2** Acres of Forest Planted in Maryland

| <b>Year</b> | <b>Afforestation</b> | <b>Reforestation</b> | <b>Riparian Buffers</b> | <b>Private Natural</b> | <b>Total (acres)</b> |
|-------------|----------------------|----------------------|-------------------------|------------------------|----------------------|
| 2006        | 558                  | 2,104                | 420                     | 1,400                  | 4,482                |
| 2007        | 334                  | 1,991                | 336                     | 1,400                  | 4,061                |
| 2008        | 415                  | 1,596                | 275                     | 1,400                  | 3,686                |
| 2009        | 531                  | 1,497                | 206                     | 1,400                  | 3,634                |
| 2010        | 566                  | 403                  | 528                     | 1,400                  | 2,897                |
| 2011        | 1,231                | 639                  | 558                     | 1,400                  | 3,828                |
| 2012        | 330                  | 607                  | 214                     | 1,400                  | 2,551                |
| 2013        | 286                  | 602                  | 278                     | 1,400                  | 2,566                |
| 2014        | 410                  | 559                  | 322                     | 1,400                  | 2,692                |
| 2015        | 294                  | 633                  | 268                     | 1,400                  | 2,596                |
| 2016        | 180                  | 639                  | 266                     | 1,400                  | 2,485                |
| 2017        | 400                  | 700                  | 400                     | 1,400                  | 2,900                |
| 2018        | 400                  | 700                  | 400                     | 1,400                  | 2,900                |
| 2019        | 400                  | 700                  | 400                     | 1,400                  | 2,900                |
| 2020        | 400                  | 700                  | 400                     | 1,400                  | 2,900                |

|              |              |               |              |               |               |
|--------------|--------------|---------------|--------------|---------------|---------------|
|              |              |               |              |               |               |
| <b>Total</b> | <b>6,735</b> | <b>14,070</b> | <b>5,271</b> | <b>21,000</b> | <b>47,076</b> |

(Red indicates projections)



**Figure I.2** Planting Forests in Maryland.

### **Enhancement Opportunities**

Provide dedicated staff to identify landowners interested in participating in programs like “Lawn to Woodland” and “Marylanders Plant Trees”.

### **Funding**

See below.

### **Challenges**

Important challenges faced by this program include locating and obtaining funding to continue and build upon the “Lawn to Woodland” and “Marylanders Plant Trees” programs.

### **Relevant Information**

RESI’s 2015 Study estimated that the Planting Forests in Maryland program, once fully operational, would support a total of 92 jobs by 2020, \$11,077,882 in net economic output and \$14,862,060 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

### **I.3 Creating and Protecting Wetlands and Waterway Borders to Capture Carbon**

#### **Program Description**

In addition to forests, wetlands and marshlands are known to be very efficient at sequestering carbon. Therefore, DNR is planting forested stream buffers and pursuing the creation, protection and restoration of wetlands to promote carbon sequestration through several means, including undertaking on-the-ground wetland restoration projects through its Natural Filters Program which restores wetlands and buffers on state and public lands to meet its water quality goals, the Chesapeake and Atlantic Coastal Bays Trust Fund which provides funding for public and private land restoration projects, the Coastal Wetlands Initiative whose objective is to restore natural tidal marsh hydrology to coastal wetlands through ditch plugging practices, the development of a terrestrial carbon sequestration protocol, and the Sea Level Affecting Marshes Model.

The goals of the Natural Filters Program are restoring 1,142 acres of wetlands on state and public land and planting 645 acres of streamside forest buffers on state and public lands based on the State's Watershed Implementation (WIP) Goals for state and public lands.

The Chesapeake and Atlantic Coastal Bays Trust Fund allows Maryland 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.

In addition, DNR is including another best practice for terrestrial carbon sequestration through its Shoreline Conservation Service projects to install Living Shorelines. These are additional coastal wetland restoration practices that function to sequester carbon.

#### **Program Objectives**

The potential emission reductions from the Creating and Protecting Wetlands and Waterway Borders to Capture Carbon program in 2020 are estimated to be 0.43 MMtCO<sub>2</sub>e.

#### **Implementation Milestones**

On the ground wetland and waterway restoration projects:

Natural Filters Program: As of 2016, 1,486 acres of wetlands have been restored and 868 acres of streamside buffers planted. The Natural Filters Program has exceeded the established goals for public land restoration.

The Chesapeake and Atlantic Coastal Bays Trust Fund has, to date, funded the restoration of 1,730 acres of wetlands and 1,128 acres of riparian buffers. These totals include restoration gains from the Natural Filters Program, as documented above, and projects that have occurred on private lands. From this point onward, implementation tracking will be expanded to include both public and private land restoration projects that are funded through the Trust Fund to more accurately reflect potential carbon sequestration gains.

Coastal Wetlands Initiative Program: To date, 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: To date, 12.21 acres of Living Shoreline have been implemented since 2006.

**Table I.3** Shoreline and Marsh Creation in Maryland

| <b>Year</b>  | <b>Linear Feet of Shoreline</b> | <b>Square Feet of Marsh Created/Restored</b> | <b>Acres Created/Restored</b> |
|--------------|---------------------------------|----------------------------------------------|-------------------------------|
| 2006         | 2,901                           | 55,779                                       | 1.28                          |
| 2007         | 2,920                           | 119,210                                      | 2.74                          |
| 2008         | 2,485                           | 87,670                                       | 2.01                          |
| 2009         | 8,935                           | 46,660                                       | 1.07                          |
| 2010         | 1,944                           | 37,871                                       | 0.87                          |
| 2011         | 2,100                           | 31,497                                       | 0.72                          |
| 2012         | None                            |                                              |                               |
| 2013         | 2,000                           | 24,000                                       | 0.55                          |
| 2014         | 3,000                           | 63,115                                       | 1.45                          |
| 2015         | None                            |                                              |                               |
| 2016         | 3,100                           | 66,000                                       | 1.52                          |
| <b>Total</b> | <b>29,385</b>                   | <b>531,802</b>                               | <b>12.21</b>                  |

### *Studies and Protocols*

A Tidal and Seagrass protocol has been developed in partnership with Restore America's Estuaries and the Verified Carbon Standard Program. The protocol provides a default value of 1.46 MG Carbon sequestered/hectare/year for tidal wetland restoration projects if more detailed and precise accounting methodologies are not applied.

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

- Targeting DNR's land acquisition efforts to areas that may provide a future wetland benefit through inland marsh migration resulting from sea level rise.
- Developing new easement opportunities for landowners that own land within these wetland adaptation area transition zones.
- Identifying the value of current and future wetlands for protecting communities and infrastructure from coastal flooding and shoreline erosion through the Department's Coastal Resiliency Initiative.

Future work will address using the SLAMM model to determine the potential loss of tidal wetlands, and the potential gain to provide input to the GGRA plan in understanding the effect of sea level rise on carbon storage pools in current and future wetlands.

## **Estimated Emission Reductions for CY 2016**

The Verified Carbon Standard has accepted default values for carbon sequestration for tidal wetland restoration. Restoration gains from both the Coastal Wetland Initiative and the Shoreline Conservation Service total 517.81 acres since 2006. However, more information is needed before applying this default value. A significant factor in determining the net greenhouse gas benefit of tidal wetland restoration is the quantification of methane emissions. Methane emissions vary according to salinity levels. Current research (pers. communication, Brian Needelman, University of Maryland) is ongoing and may soon be ready in form that the State can use to more accurately reflect the greenhouse gas benefits once methane emissions are considered.

## **Enhancement Opportunities**

The new protocol for Tidal and Seagrass restoration opens up opportunities to account for the greenhouse gas benefits of carbon sequestration through Submerged Aquatic Vegetation restoration and re-establishment.

Restore America's Estuaries and the Verified Carbon Standards program will be pursuing additional carbon sequestration accounting protocols for tidal wetland conservation. This protocol will provide justification for projects that prevent the degradation of tidal wetlands. Living Shorelines projects will prove to yield greater benefit through this new protocol as a result of the protection these buffers provide to tidal wetlands landward from the shoreline restoration project.

## **Funding**

The Atlantic Coastal Bays Trust Fund: In 2007, the Maryland General Assembly created the Chesapeake and Atlantic Coastal Bays Trust Fund (Trust Fund) to provide the financial assistance necessary to advance Chesapeake Bay restoration. A portion of this funding is targeted to Local Solicitation and Natural Filters which includes best management practices for reducing nutrient pollution to waterways which includes forested buffers, reforestation, wetland restoration, stream and floodplain restoration, stormwater retrofits, and other bioremediation projects. In FY18, \$29.72 M was allocated for Local Solicitation and Natural Filters (\$6 M of which is Natural Filters).

Resiliency through Restoration Initiative: Over the past ten years, Maryland has experienced seven weather-related events warranting Presidential Disaster declarations, including five coastal flood events totaling approximately \$103 million in economic damage. Recognizing that coastal habitats help buffer communities from these climate-related impacts, the Maryland Department of Natural Resources' Chesapeake and Coastal Service (CCS) launched a new *Resiliency through Restoration Initiative*. This Initiative, funded through the State Capital Budget, 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.

Year one of the Initiative will lead to the design of six living shoreline and coastal restoration projects in five jurisdictions.

Coastal Wetlands Initiative (CWI): There are no dedicated funds currently allotted to CWI. Funding is typically acquired through a competitive grant process which in the past have used State transportation and other federal funding sources.

Shoreline Conservation Services: This program is funded through the Shore Erosion Control Revolving Loan.

DNR/SHA Memorandum of Understanding: The Maryland Department of Natural Resources has partnered with the State Highway Administration in an effort to lead by example in restoring the Chesapeake Bay and local waters. State Parks have initially been targeted to provide opportunities for SHA 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 and is currently being updated to provide additional guidance. This MOU will increase the rate of restoration projects on state and public lands.

## **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 at state, regional, national and global scales continues to evolve and narrow in on more precise methods to evaluate the greenhouse gas benefits of wetland restoration.

Measures of success for the various Coastal Wetland Initiative projects are currently being monitored. In some cases, ditch plugging has been very effective in establishing sheet flow across the marsh and allowing sediment to naturally fill the plugged ditches. In other areas, the ditch plugging has resulted in excessive water pooling, creating a drowned marsh effect. Ongoing monitoring of these projects will improve the design, best practices and success of future efforts.

## **Relevant Information**

RESI's 2015 Study estimated that the Creating and Protecting Wetlands and Waterway Borders to Capture Carbon program, once fully operational, would support a total of 62 jobs by 2020, \$28,717,043 in net economic output and \$15,045,166 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.4 Biomass for Energy Production**

### **Program Description**

Maryland is working to promote the use of locally produced woody biomass for generation of thermal energy and electricity. Energy from forest by-products can be used to offset fossil fuel-based energy production and associated GHG emissions. There are many end users that could potentially benefit from such a program, including Maryland's public schools which could enjoy wood heating and cooling; hospitals which could utilize wood as primary heating/cooling source; municipalities which could utilize local fuel markets as key component of their urban tree management programs; and all rural landowners which would have access to a wood fuel market.

The goal of this program is to develop policies that recognize wood as a preferred renewable energy source, recognize wood as the largest source of energy consumption in Maryland, and offer incentives to utilize locally produced wood to meet thermal energy needs.

This program is no longer performing as designed.

### **Program Objectives**

#### **Revised 2016 Estimate**

The potential emission reductions from the Biomass for Energy Production program in 2020 are estimated to be 0.33 MMtCO<sub>2</sub>e. Appendix C of this report provides a more detailed description of the process used to quantify GHG reductions

### **Implementation Milestones**

- Working with partners MES, MEA, COMMERCE and US Forest Service to facilitate installation of wood energy systems
- MEA has discontinued offering grant opportunities supporting wood energy at commercial and institutional settings.

### **Estimated Emission Reductions for CY 2016**

None.

### **Enhancement Opportunities**

An analysis of "woodsheds" where the available wood resource is quantified would help to raise confidence in the ability of an area to support industrial scale biomass to energy would help to raise confidence in the feasibility of industrial scale biomass to energy. Additional educational

outreach on the feasibility of biomass to energy to state agencies, academic institutions, and the business community would likely help to establish this program.

## **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 switching of wood fuels

MEA has opted to discontinue its Commercial Wood Boiler grant incentive program. This removes \$1 million of leverage in accelerating the adoption of carbon displacing wood energy. This makes it unlikely the projected reductions in carbon emissions through this program will be achieved.

Actions that still need to be implemented include:

1. Educate State agency leadership
2. Develop policy supporting THERMAL energy
3. Recognize wood as a preferred renewable energy source, on par with solar, geothermal, and wind

## **Relevant Information**

RESI's 2015 Study estimated that the Biomass for Energy Production program, once fully operational, would support a total of 51 jobs by 2020, \$24,871,827 in net economic output and \$12,756,348 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.6 Increasing Urban Trees to Capture Carbon**

### **Program Description**

Trees in urban areas directly impact Maryland's carbon budget by absorbing GHG emissions from power production and vehicles, reducing heating and cooling costs and energy demand by moderating temperatures around buildings, and slowing the formation of ground level ozone as well as the evaporation of fuel from motor vehicles. Implementation is supported by several other Maryland laws and programs that include outreach and technical assistance for municipalities to assess and value their urban tree canopy goals, and plant trees to meet those goals.

The goals of this program are to plant 12.5 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.

This program is performing as designed.

### **Program Objectives**

#### **Revised 2015 Estimate**

The potential emission reductions from the Increasing Urban Trees to Capture Carbon program in 2020 are estimated to be 0.02 MMtCO<sub>2</sub>e. This number represents a conservative estimate of the cumulative carbon sequestered through this program. Appendix C of this report provides a more detailed description of the process used to quantify GHG reductions.

### **Implementation Milestones**

To date, 5,734,006 trees have been planted from 2006 to 2016 (total for this program and Planting Forests in Maryland).

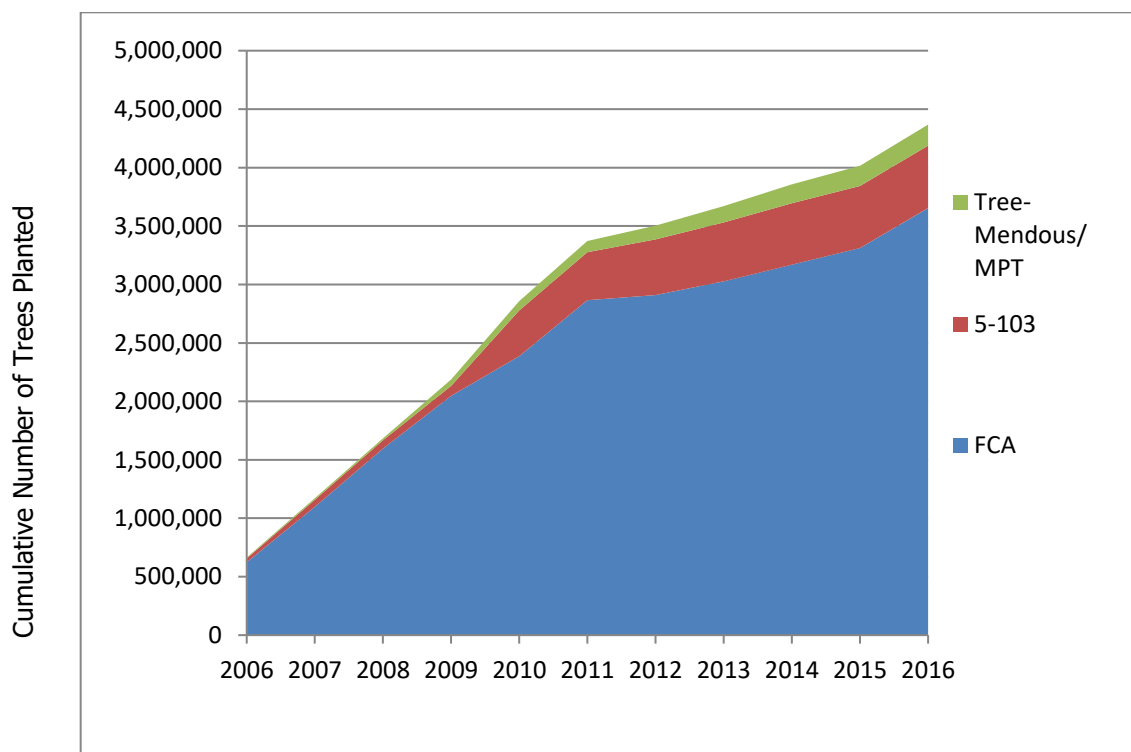
### **Estimated Emission Reductions for CY 2016**

Urban tree plantings are estimated to sequester 0.002 MMtCO<sub>2</sub>e in 2016.

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

| <b>Year</b> | <b>FCA</b> | <b>5-103</b> | <b>Tree-Mendous/MPT</b> | <b>Totals</b> |
|-------------|------------|--------------|-------------------------|---------------|
| 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        |
| <b>2016</b> | <b>341,640</b> | <b>2,705</b> | <b>8,798</b> | <b>353,143</b> |
| Totals      | 3,653,145      | 534,871      | 179,848      | 4,367,864      |



**Figure I.3** Increasing Urban Trees to Capture Carbon.

### **Enhancement Opportunities**

The MD Department of Natural Resources – Forest Service (MD Forest Service) developed two new tree planting assistance programs that reach landowners within the urban/suburban areas of Maryland. The new programs target the 1.1 million acres of turf statewide. Each targets different lot size and different available planting space.

- The “Lawn to Woodland” program, a partnership with the Arbor Day Foundation, targets the small lot with 1-5 acres of plantable space or turf. The Foundation does outreach while MD Forest Service handles the tree planting at no cost to the lot owner. In Spring of 2014, a pilot was done with 14 acres planted on 12 lots. In Spring of 2015, the program planted 100.73 acres on 84 sites statewide.
- The other program, the “Marylanders Plant Trees” program, is a \$25 coupon reimbursement program targeting individuals wishing to plant a tree. It enables very small lot owners to purchase a tree valued at \$50 or more, and reduce the cost by the use of the \$25 coupon. There are 85 participating nurseries across the state. From the program’s inception in FY09 to FY15, 33,324 coupons have been reimbursed.

### **Funding**

The “Lawn to Woodland” program utilized all of its funding with the 2016 spring planting. No future funding source has been identified.

The “Marylanders Plant Trees” program funding source is limited and expected to end in the next year.

### **Challenges**

Identification of a future funding source for the “Lawn to Woodland” program.

Identification of a future funding source for the “Marylanders Plant Trees” program.

### **Relevant Information**

RESI’s 2015 Study estimated that the Increasing Urban Trees to Capture Carbon program, once fully operational, would support a total of 375 jobs by 2020, \$288,146,970 in net economic output and \$93,017,577 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **I.7 Geological Opportunities to Store Carbon**

### **Program Description**

Geological carbon sequestration differs from other discussed sequestration methods as it captures carbon at the source, transports it to the sequestration site, and then sequesters it. 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. More than 10 gigatonnes of storage capacity has been identified to be available within the terrestrial portion of Maryland (103 years of storage capacity at current CO<sub>2</sub> estimated production rate of 97 million metric tons per year). An unquantified, but estimated larger in magnitude potential amount of storage is located in the offshore of Maryland.

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

This program is performing as designed.

### **Program Objectives**

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

### **Implementation Milestones**

DNR's 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) is being 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. Projected completion date is December 2019.
- The potential for offshore carbon sequestration is being evaluated in partnership with Harvard University, Battelle, US Department of Energy, Rutgers University, University of Texas, and the surrounding Mid-Atlantic States. Focus areas of this study include geologic characterization, capacity evaluations, injectability, and risk analyses. This project will provide foundation knowledge and an assessment of potential for carbon sequestration offshore in the Baltimore Canyon Trough. Initial publication identifying cap rocks and storage intervals has been completed. The multi-State effort is focusing on larger potential reservoirs offshore of New Jersey and New York. Projected completion date is December 2017.

- 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.
- The potential to store carbon dioxide in rift basins is currently being explored. Using the exposed Gettysburg-Culpepper basin as a proxy for the buried rift basins such as the Taylorsville and DelMarVa, potential for storage is being assessed.
- Baseline data has been collected to provide the foundation for conducting risk analyses for potential development of stray gas migration into potable aquifers.
- Research is ongoing to assess the CO<sub>2</sub> chemical adsorption capacity of power plant combustion by-products and the organic shales and clays in the closest geologic formations.

Other RAS program notes include:

- Site testing (Carbon capture, transport, and storage) continues in Michigan and Ohio (Regional partners to Maryland in CO<sub>2</sub> sequestration projects) and has been completed in Kentucky. These programs are being evaluated at a national level and the results are positive at this time.
- Depleted gas fields present the most immediate option for permanent storage of carbon dioxide in western Maryland.

### **Estimated Emission Reductions for CY 2016**

None

### **Enhancement Opportunities**

The Taylorsville Formation is closest to the majority of Maryland's coal and gas fired power plants. An investigation focused on the CO<sub>2</sub> chemical adsorption capacity of this formation could best serve the Maryland electric power industry. RAS is leveraging funds from Battelle to analyze the exposed Gettysburg-Culpepper Basin as a proxy for the Taylorsville Basin. This study was begun in 2016.

### **Funding**

Most of the funding for Geological Carbon Sequestration is coming from the US Department of Energy, organized and administered through Battelle. Twenty thousand dollars per year is provided through the State's Environmental Trust Fund.

### **Challenges**

The cost of capturing CO<sub>2</sub> using current technologies involves a parasitic loss of approximately 25% at the generation site. This cost has decreased over the last 5 years by 5%. It is anticipated

this will decline to an 18% parasitic loss unless a vastly improved technology is identified. This cost, under the current carbon economic climate is cost-prohibitive for implementation at a grand scale. Thus, regardless of location and method of CO<sub>2</sub> sequestration, there must be an order of magnitude reduction in its cost of capture or development of sequestration methods or a change in carbon policy.

### **Relevant Information**

RESI's 2015 Study estimated that the Geological Opportunities to Store Carbon program, once fully operational, would support a total of 217 jobs by 2020, \$312,011,719 in net economic output and \$62,194,826 in wages over the lifetime of the program. Chapter 6 and Appendix K of this report provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

## **J. Ecosystems Markets**

### **J.1 Creating Ecosystems Markets to Encourage GHG Emissions Reductions**

#### **Program Description**

Increased attention to the benefits and cost efficiencies that ecosystem markets could provide has spurred evaluation of the potential its programs and policies may have for fostering carbon market development. Maryland's Forest Conservation Act and Critical Area Act require mitigation for natural resource impacts generated through land development, and mitigation banking is an option to address these mitigation requirements

The goal of this program is the establishment of ecosystem markets, creation of a tracking mechanism and the development of protocols to assess/quantify GHG benefits of individual markets. However, no quantification target has been assigned.

#### **Program Objectives**

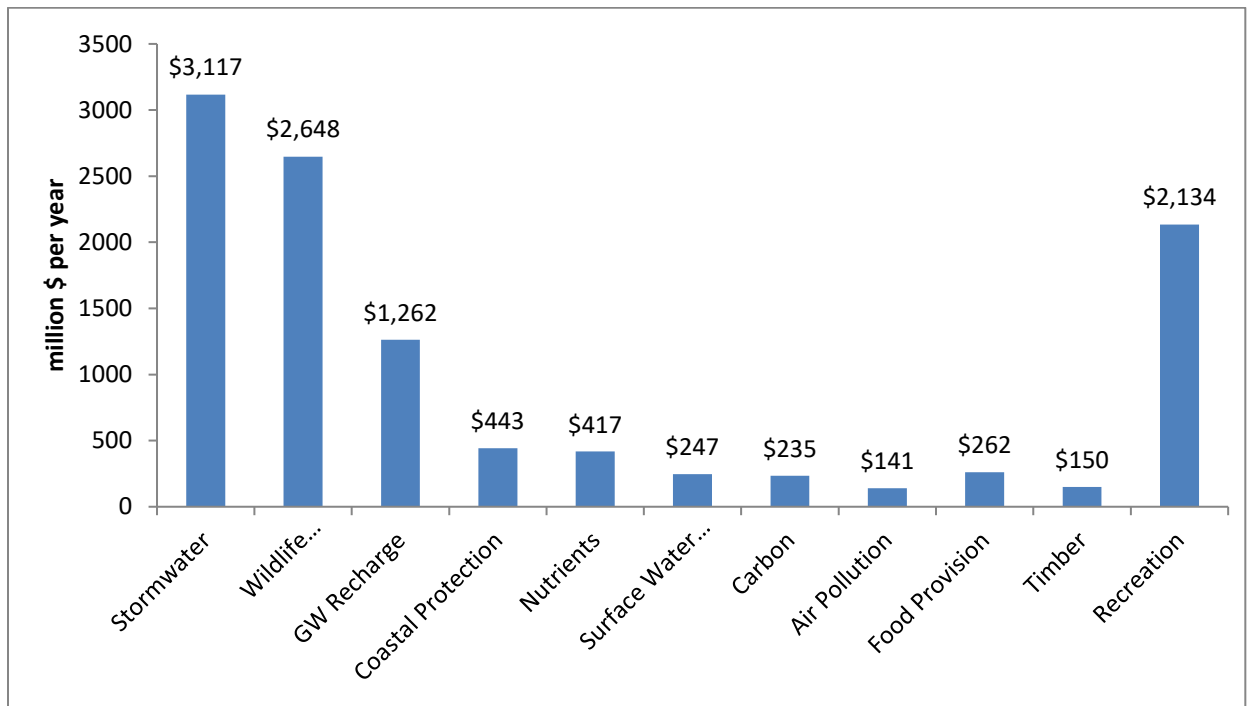
Revised 2016 Estimate

The potential emission reductions from the Creating Ecosystems Markets to Encourage GHG Emission Reductions program in 2020 are estimated to be 0.11 MMtCO<sub>2</sub>e. Appendix C of this report provides a more detailed description of the process used to quantify GHG reductions.

#### **Implementation Milestones**

- DNR has initiated a study to economically value a suite of ecosystem services for select habitats along an urban to rural gradient.
- The net effect will be conservation of natural lands and reduction of GHG emissions.
- Ecosystem services from forests, wetlands, cropland, and pasture land have been spatially quantified across the state of Maryland.
  - Spatial models for coastal ecosystem services have been initiated, to be completed in FY2017
- Ecosystem service assessment of Charles County, Maryland has been completed, indicating that ecosystems provide over \$500 million of value every year to county residents.
- The preliminary assessment for the State of Maryland estimates a total value of \$11 billion of benefits from natural lands provided every year (see figure).

- The Nontidal Wetlands Mitigation Banking bill passed in 2016 removes barriers to mitigation banking in Maryland, with the goal of reducing cost for meeting mitigation requirements in an ecologically beneficial way.
- Forest Conservation Act (FCA) banking. Several counties in Maryland allow off-site mitigation for forest loss through purchasing credits in a forest bank. Over 2000 acres of forest loss have been mitigated in this way over the past 15 years.



**Figure J.1.** Creating Ecosystem Markets to Encourage GHG Emission Reductions Preliminary Results.

### **Enhancement Opportunities**

As currently functioning ecosystem markets in Maryland are not designed to meet the goals of climate change mitigation. Banking for forests and wetlands could prioritize habitat types that have high potential for carbon sequestration, like forested wetlands or deciduous forests. If mitigation were to be required on more acreage than is impacted it is likely there will be net carbon sequestration. Adoption of ecosystem service valuation for restoration activities, state land acquisition, or best management practice implementation (i.e. to meet WIP water quality goals) would optimize for the greatest net ecosystem service benefit. In particular, the GHG impact of certain BMP's could be calculated and preference given to practices with greater GHG reductions but similar cost per quantity of nutrients reduced. A cap-and-trade program for carbon would stimulate a carbon market in the state.

## **Funding**

Were the state to require, or exhibit preference for, forest and wetland mitigation activities or nutrient reduction BMP's with greater carbon sequestration potentials this may be more costly. If it proves to be cost effective when compared to other GHG reduction alternatives, the state could subsidize this additional cost. Results from the Accounting for Maryland's Ecosystem Services assessment indicate that investing in preservation or restoration of green infrastructure is often more cost effective than "grey" infrastructure alternatives, when factoring in the multiple benefits of green infrastructure, including sequestering carbon. This has potential implications for funding of various state programs and is currently the subject of a state funded study by the University of Maryland's Environmental Finance Center.

## **Challenges**

Without a cap and trade program on the national level the voluntary carbon market in the United States has largely failed. Working within the boundaries of currently functioning ecosystem marketplaces for wetlands, forests, and habitat presents limited opportunities for generating net carbon reductions. While economically valuing ecosystem services in Maryland is an important first step, we must translate these values to greater investment in conservation and restoration of natural lands to create a positive trend in ecosystem services provided (including the sequestration of carbon).

## **Job Creation and Economic Benefits**

RESI's 2015 Study estimated that the Ecosystem Markets program, once fully operational, would support a total of – 1,758 jobs by 2020, \$423,431,394 in net economic output and \$358,169,556 in wages over the lifetime of the program. Chapter 6 and Appendix K provide more detail on the RESI studies and the job creation and economic benefits associated with this program.