Maryland Chapter

State and District of Columbia Analyses

CHESAPEAKE BAY COMPREHENSIVE WATER RESOURCES AND RESTORATION PLAN

STATE CHAPTER

State of Maryland

June 2018

US Army Corps of Engineers®

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SECTION 1

INTRODUCTION

1.1 Introduction

The goal of the *Chesapeake Bay Comprehensive Water Resources and Restoration Plan* (CBCP) is to provide a single, comprehensive, and integrated restoration plan that would assist with implementation of the *2014 Chesapeake Bay Watershed Agreement* (2014 Bay Agreement). The CBCP provides a "roadmap" of implementation actions to protect, restore, and preserve the Chesapeake Bay and actions that adopt and align with what other organizations are doing without duplicating ongoing or planned actions. Additionally, the CBCP maximizes the use of existing information and identifies projects that can be implemented in each jurisdiction in the Chesapeake Bay watershed.

The CBCP aligns with the vision established in the 2014 Bay Agreement:

> "*We envision an environmentally and economically sustainable [and resilient] Chesapeake Bay watershed with clean water, abundant life, conserved lands and access to the water, a vibrant cultural heritage, and a diversity of engaged citizens and stakeholders."*

To identify implementation actions to protect, restore, and preserve the Chesapeake Bay, geospatial analyses were conducted at a 1) baywide, 2) jurisdiction or state, and 3) watershed scale. The baywide analysis characterized problems, needs, and opportunities at a hydrologic unit code 10 (HUC 10) scale, hereafter referred to as subwatershed. CBCP analyses were based on a core set of questions formulated from the 2014 Bay Agreement goals and outcomes as well as stakeholder input. The baywide analysis resulted in a set of recommended implementation strategies that included locations (subwatersheds), potential management measures, a range of potential costs, benefits, potential project implementation agencies, and any sequencing or dependences that could affect implementation. The full results of the baywide analysis are described in the CBCP main report. The CBCP state analyses are the result of the baywide analysis "clipped" per each jurisdiction in the Chesapeake Bay Watershed (New York, Pennsylvania, West Virginia, Virginia, Maryland, Delaware, and the District of Columbia). The results of State of Maryland analysis are described in this section of the report. The portion of the Chesapeake Bay Watershed within Maryland is referred to as Pennsylvania throughout this chapter.

The CBCP state-selected watershed analysis contains a more detailed investigation in each jurisdiction, with the goal of identifying more site-specific project-scale opportunities (with priorities defined by each jurisdiction) for implementation. The Choptank River watershed was identified as the state-selected watershed by the State of Maryland for stream restoration, wetland creation, agricultural best management practices (BMPs), and blue/green infrastructure. A number of agencies have identified the Choptank River watershed as a priority including the National Oceanic and Atmospheric Administration's (NOAA) (Choptank Habitat Focus Area Group), Ducks Unlimited, the National Fish and Wildlife Foundation (NFWF), The Nature Conservancy (TNC), and the U.S. Fish and Wildlife Service (USFWS). Additionally, the Upper

Choptank River Strategic Watershed Restoration Action Plan, dated May 2003 (available at: http://dnr.maryland.gov/waters/Documents/WRAS/ucr_strategy.pdf), is a strategic plan previously developed for assisting in the restoration of the Upper Choptank River watershed in Caroline and Talbot counties, Maryland.

The following are reference maps displaying the boundaries, name (Figure 1), and number (Figure 2) of each HUC 10 subwatershed in Maryland. Table A1 (all tables are provided following the report content) provides the number, name, size (acres), and other drainage states of each Maryland HUC 10 subwatershed. Hereafter, HUC 10 subwatersheds are referred to simply as subwatersheds.

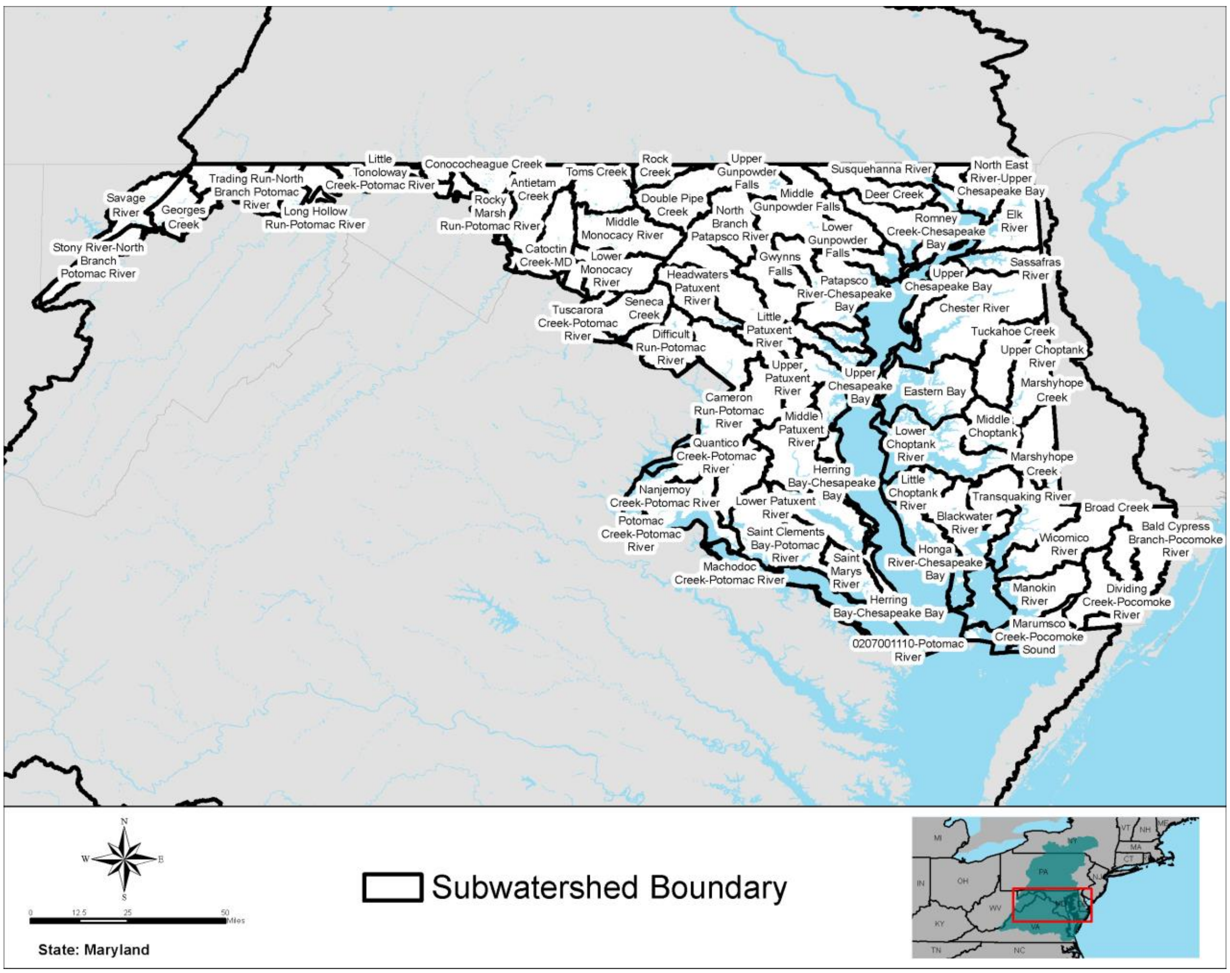

Figure 1. Hydrologic unit code 10 subwatershed names for Maryland

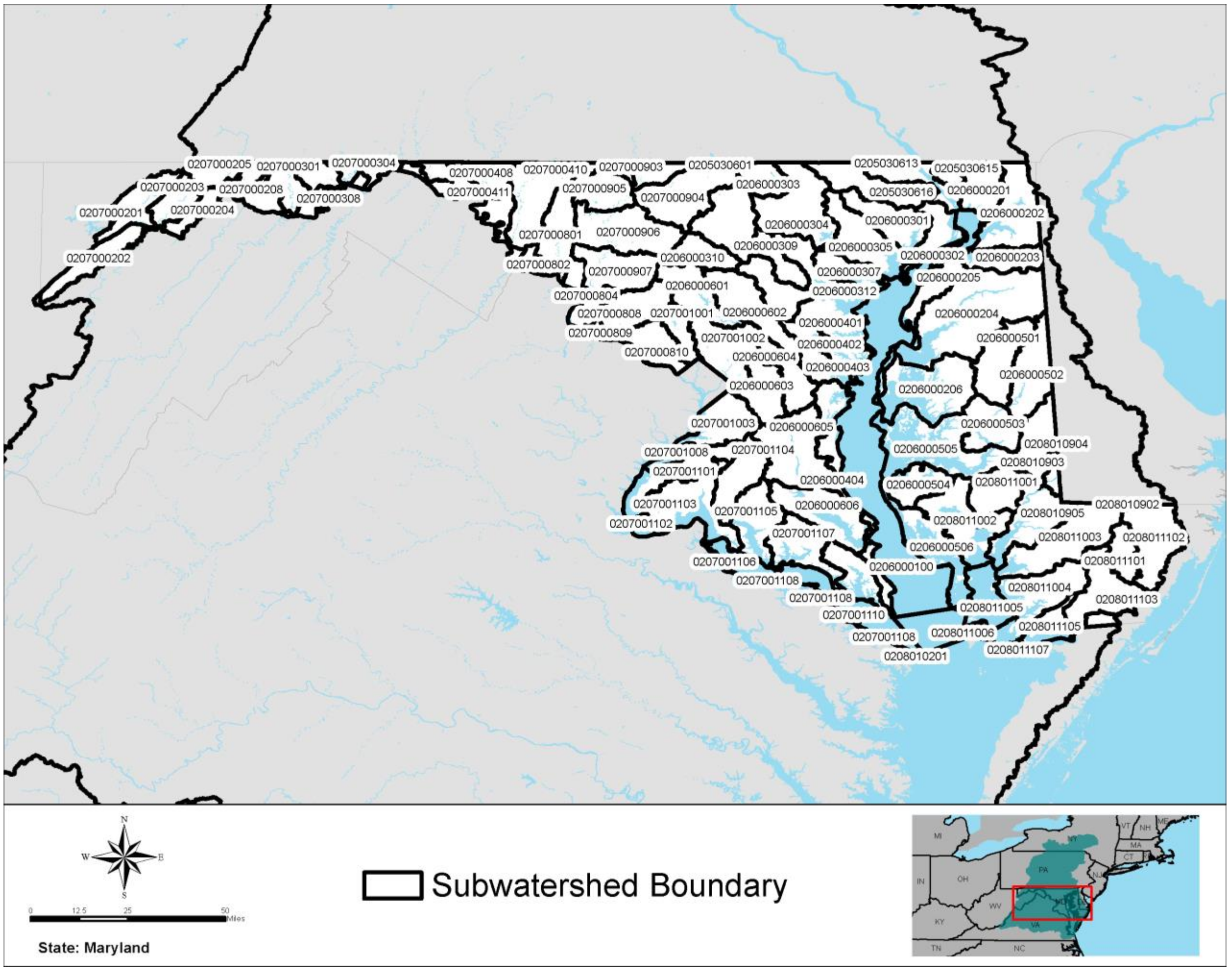

Figure 2. Hydrologic unit code 10 subwatered numbers for Maryland

1.2 Watershed Stressors

The Watershed Stressors Analysis evaluated the presence of stressors in each subwatershed based on six metrics listed below. See the Planning Analysis Appendix for more details on the data used.

- *Percent impervious cover* (Chesapeake Conservancy 2016)
- *Percent forest cover* (Chesapeake Conservancy 2016)
- *Percent of stream network with forested riparian buffers* (Environmental Protection Agency (EPA) 2010)
- *303(d) impaired waterways list* (EPA)
- *Benthic Index of Biotic Integrity (B-IBI)* (Chesapeake Bay Program (CBP))
- *Nitrogen and phosphorous yields* (as predicted by Spatially Referenced Regressions on Watershed (SPARROW) modeling)

Results of the Watershed Stressors Analysis for each subwatershed in the Maryland portion of the Chesapeake Bay Watershed are shown on Figure 3 and in Table A2. Subwatersheds that contain the least watershed stressors resulted in a high watershed stressor score, and subwatersheds that contain the most watershed stressors resulted in a low watershed stressor score. The healthiest watersheds are areas that, if not already protected, would be good candidates for protection. The areas that are less healthy indicate areas that may benefit from restoration actions aimed at increasing the overall health of the subwatersheds. In general, the pattern of watershed stressors typically follows that of development, with the greater the amount of development and industrial activities in an area, the more stressed the watershed.

In general, the State of Maryland is moderately stressed. However, based on the CBCP analysis, there are eight subwatersheds that are considered 'healthier subwatersheds.' They are located in the western panhandle of Maryland and include HUC 0207000303 (Fifteenmile Creek), HUC 0207000201 (Savage River), HUC 0207000205 (Wills Creek), HUC 0207000301 (Town Creek), HUC 0207000401 (Tonoloway Creek), HUC 0207000403 (Licking Creek), HUC 0207000308 (Long Hollow Run-Potomac River), and HUC 0207000203 (Georges Creek). The most heavily stressed subwatersheds are located on the Eastern Shore of Maryland, and within and surrounding Baltimore, Maryland and surrounding Washington, D.C.

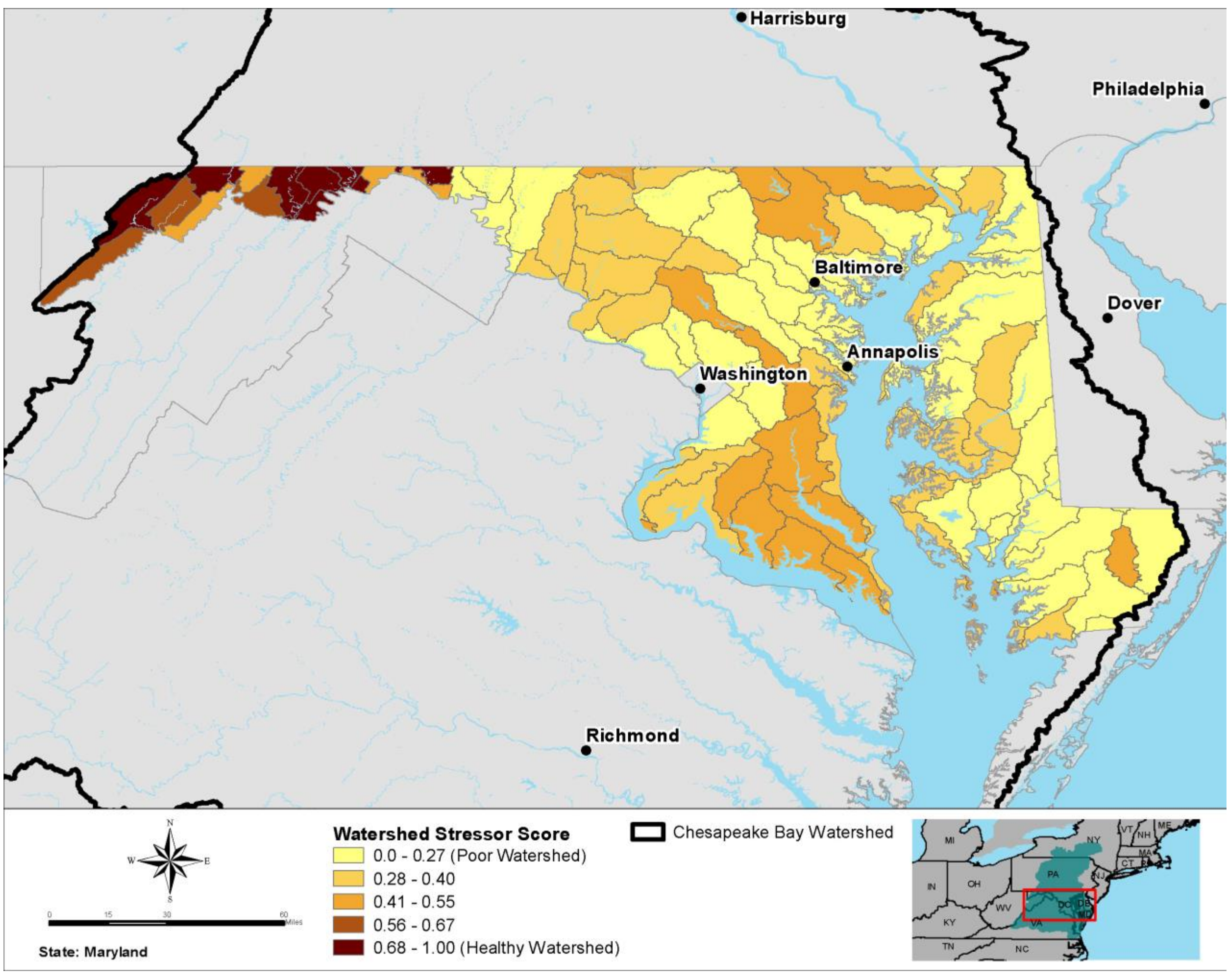

Figure 3. Watershed Stressor Analysis for subwatersheds in Maryland

SECTION 2

RESTORATION EFFORTS CONTRIBUTING TO WATERSHED WIDE PRIORITIES

2.1 Vital Habitats Goal

"Restore, enhance and protect a network of land and water habitats to support fish and wildlife and to afford other public benefits, including water quality, recreation uses and scenic value across the watershed."

2.1.1 Outcome: Black Duck

"By 2025, restore, enhance and preserve wetland habitat to support a wintering population of 100,000 black ducks. Refine population targets through 2025 based on best available science."

CBP Black Duck Focus Areas were overlaid on the CBCP wetland restoration and enhancement maps (described in Section 2.1.6) to identify subwatersheds that provide wetland restoration and enhancement opportunities with the potential to benefit black duck populations during the nonbreeding, over-wintering season.

The results of this analysis identified subwatersheds in which to focus wetland restoration and enhancement that have the potential to benefit black duck populations during the nonbreeding, over-wintering season lie within the tidally influenced wetland areas of the Chesapeake Bay mainstem and near the mouths of bay tributaries as these areas are the most important over-wintering habitats utilized by the black duck.

The subwatersheds identified as black duck areas are found in southern Maryland and on Maryland's Eastern Shore (Figures 13 and 14 below and Table A7). The Chester River subwatershed provides the greatest opportunity for nontidal wetland restoration (122,820 acres) with the potential to benefit the black duck population.

2.1.2 Outcome: Brook Trout

"*Restore and sustain naturally reproducing brook trout in the Chesapeake Bay's headwater steams, with an eight percent increase in occupied habitat by 2025.*"

Geospatial data and analyses regarding brook trout have been provided by the CBP and Trout Unlimited and are embedded in the fish passage, forest buffer, and stream restoration analyses below.

2.1.3 Outcome: Fish Passage

"Continually increase habitat to support sustainable migratory fish populations in the Chesapeake Bay watershed's freshwater rivers and streams. By 2025, restore historical fish migration routes by opening 1,000 additional stream miles to fish passage. Restoration success will be indicated by the consistent presence of alewife, blueback herring, American

> *shad, hickory shad, American eel and brook trout, to be monitored in accordance with available agency resources and collaboratively developed methods."*

Fish passage within the Chesapeake Bay Watershed is limited by a significant number of blockages that range from large hydroelectric power-generating dams to historical mill dams to road culverts and utility pipes that have been exposed by erosion. The intent of the CBCP's Fish Passage Blockages Opportunities Assessment was to build upon the work of the CBP's Fish Passage Workgroup to identify where high prioritized blockages are co-located with Opportunity subwatersheds identified for stream restoration. The following data were used in the Fish Passage Blockages Analysis (see the Planning Analysis Appendix for more details on the data used).

- *High prioritized fish passage blockages* (CBP Fish Passage Workgroup)
- *Stream Restoration Analysis results* (CBCP)

Results of the Fish Passage Blockages Opportunities Assessment for Maryland are shown in Figure 4 and in Table A3. High prioritized fish passage blockages (by the Chesapeake Bay Fish Passage Workgroup) are concentrated in the Chester-Sassafras subwatersheds on Maryland's Eastern Shore. Fish passage blockages on the Eastern Shore are typically in subwatersheds determined to be stressed by the Watershed Stressor Analysis. The highest concentration of high prioritized fish passage blockages to benefit anadromous fish are in the Chester and Elk River subwatersheds in the upper Eastern Shore of Maryland and the upper Patuxent River. Low connectivity (based on number of blockages) also exists throughout the Eastern Shore and just south of Washington DC.

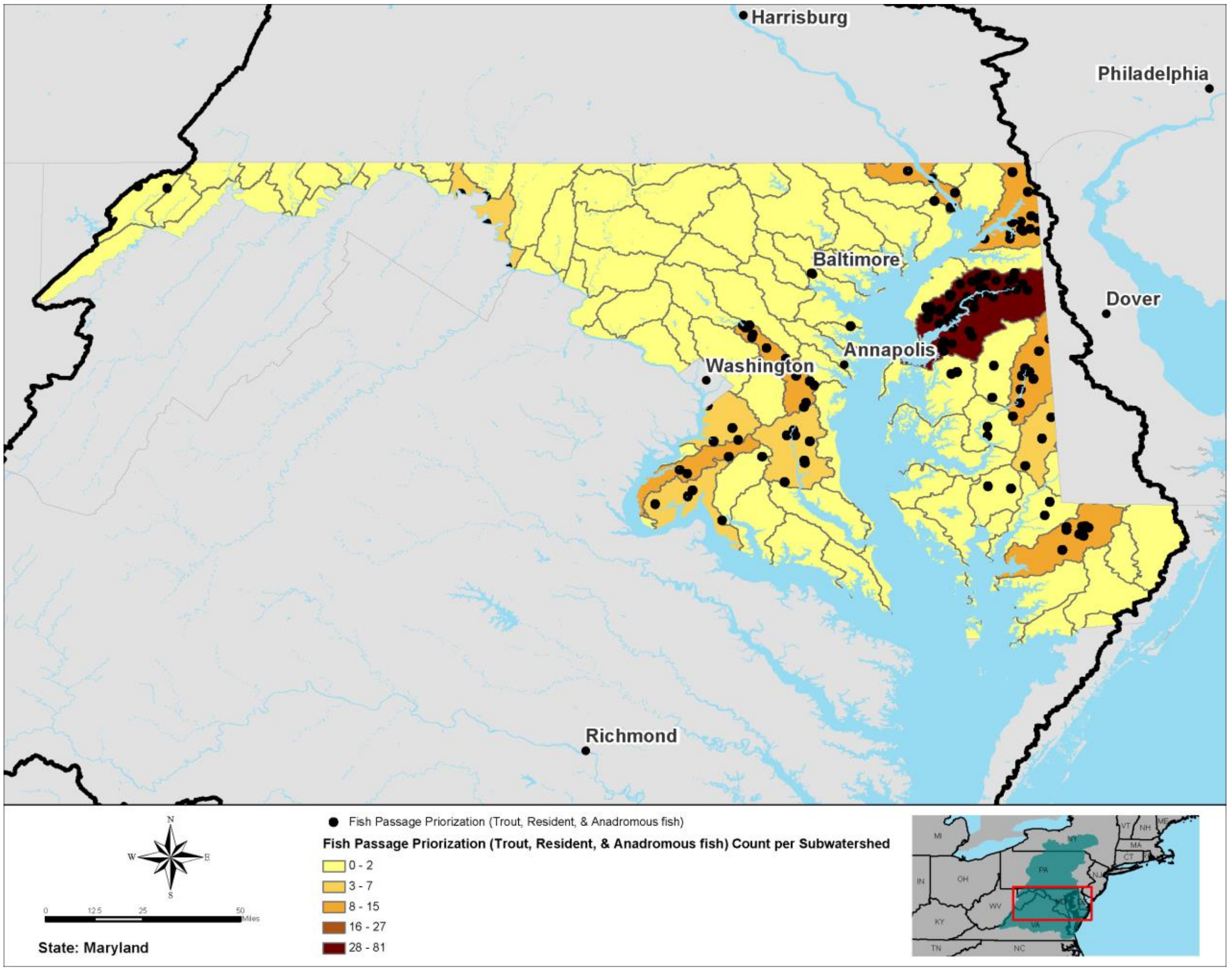

Figure 4. Prioritized fish passage blockages in Maryland

2.1.4 Outcome: Riparian Forest Buffers

> "Continually increase the capacity of forest buffers to provide water quality and habitat benefits throughout the Chesapeake Bay watershed. Restore 900 miles of riparian forest buffers per year and conserve existing buffers until at least 70 percent of riparian areas in the watershed are forested."

The purpose of the Riparian Forest Buffer Opportunities Assessment was to identify subwatersheds to focus riparian buffer restoration. Riparian buffer restoration can provide numerous benefits while targeting various impairments. This analysis identified subwatersheds where riparian buffer restoration opportunities exist to:

- Address watershed stressors (high-yielding nitrogen and phosphorous subwatersheds)
- Improve e brook trout habitat
- Support improving stream habitat for resident fish and migratory species

The following data layers were used in the Riparian Forest Buffer Opportunities Assessment (see the Planning Analysis Appendix for more details on the data used):

- *Area of existing riparian buffers* (acres) (forested and non-forested) (CBP from Chesapeake Conservancy 2016)
- *Nitrogen and phosphorous yields* (as predicted by Spatially Referenced Regressions on Watershed (SPARROW) modeling)
- *Brook Trout Watersheds* (U.S. Geological Survey (USGS) National Hydrography Dataset plus catchments identified as potentially supporting brook trout based on the Eastern Brook Trout Joint Venture Salmonid Catchment Assessment and Habitat Patch Layers)
- *National Fish Habitat Assessment* (National Fish Habitat Partnership (NFHAP))
- *Eastern Brook Trout Conservation Portfolio, Range-wide Habitat Integrity and Future Security Assessment, and* Focal Area Risk and Opportunity Analysis (Trout Unlimited, Fessenmeyer et al. 2017)

Results of the Riparian Forest Buffers Opportunities Assessment for Maryland are shown on Figure 5 and in Table A4. In general, there are broad riparian forest buffer *Opportunities* throughout the Chesapeake Bay watershed. Concentrated areas are in western Maryland and Maryland's Eastern Shore. These subwatersheds include HUC 0206000204 (Chester River), HUC 0205030617 (Susquehanna River), HUC 0207000408 (Conococheague Creek), HUC 0207000410 (Antietam Creek), and HUC 0206000502 (Upper Choptank River).

Riparian forest buffer restoration *Opportunities* to improve brook trout habitat are primarily located in the North and South Fork subwatersheds of the Potomac River in western Maryland (HUC 0207000408 Conococheague Creek and HUC 0207000410 Antietam Creek). Riparian forest buffer restoration *Opportunities* to improve resident fish habitat are concentrated in the Savage River and Stony River-North Branch Potomac River. Riparian forest buffer restoration *Opportunities* to reduce nitrogen and phosphorus loads are located across Maryland's Eastern Shore, the Patapsco River (HUC 0206000312 Patapsco River-Chesapeake Bay), the Anacostia River (HUC 0207001002), and in subwatersheds along the Pennsylvania/Maryland border.

When the riparian forest buffer restoration *Opportunities* for all three targeted objectives are compiled into one map, there are *Opportunities* to undertake riparian forest buffer restoration to benefit brook trout and resident fish in the upper Potomac in Maryland. *Opportunities* to manage nitrogen and phosphorus loadings are isolated from *Opportunities* to improve fish habitat with riparian forest buffer restoration.

Project development will require an additional finer scale step to identify spatially-explicit projects. At that stage, consideration will also be needed to determine if forested buffers are suitable for restoration, or if grass buffers are the appropriate approach given local conditions.

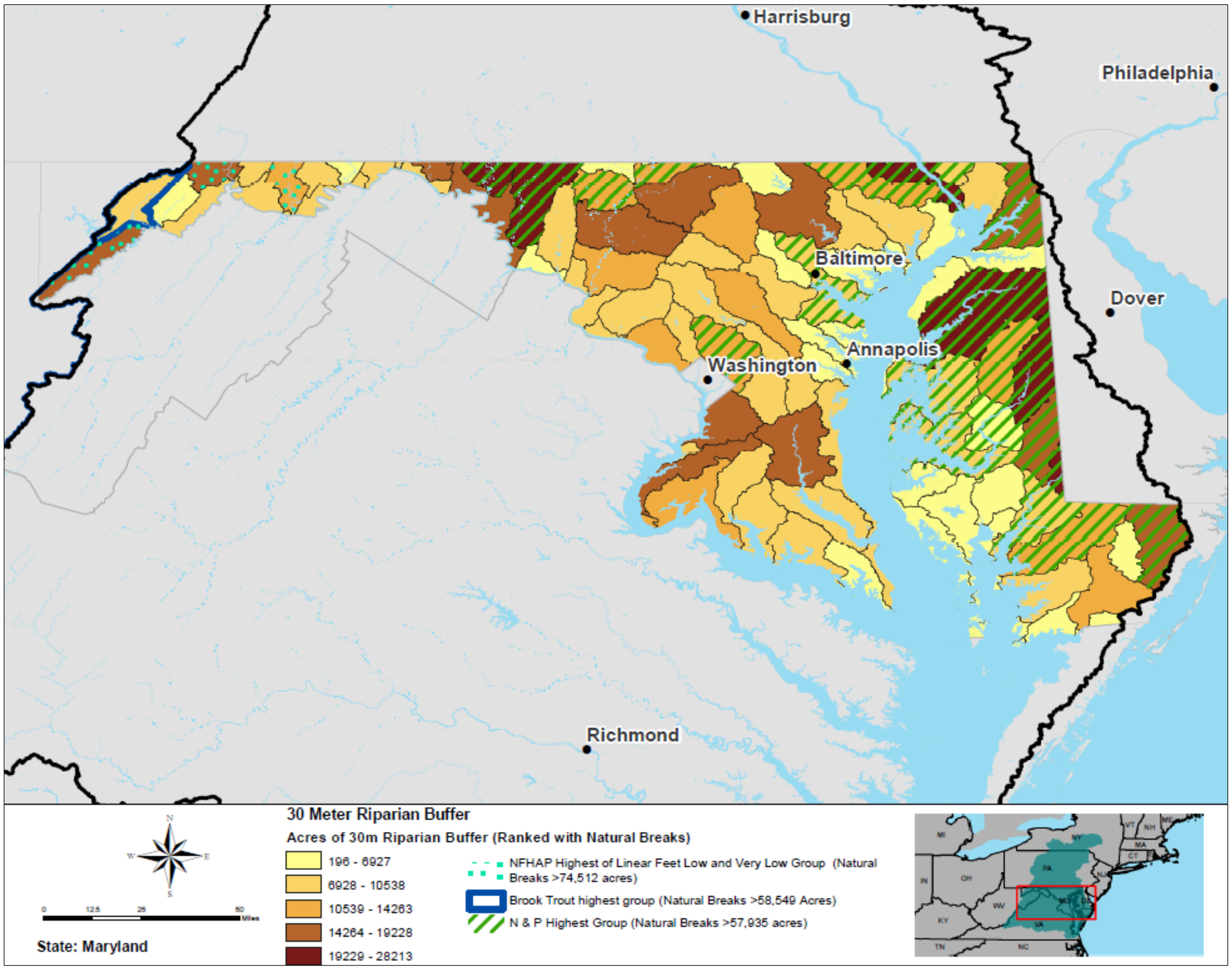

Figure 5. Riparian forest buffer Opportunities Assessment for Maryland

2.1.5 Outcome: Stream Health

> "Continually improve stream health and function throughout the Chesapeake Bay watershed. Improve the health and function of ten percent of stream miles above the 2008 baseline."

The purpose of this analysis was to identify subwatersheds to focus stream restoration efforts to benefit resident fish, brook trout, and anadromous fish species. The following layers were analyzed to develop the stream restoration analysis:

- Watershed Stressor Analysis (CBCP)
- National Fish Habitat Assessment (NFHAP)
- Brook Trout Watersheds (USGS)
- Extent of anadromous fish habitat (CBP)
- Conservation Strategies for Brook Trout (Trout Unlimited)

Results of the Stream Restoration Opportunities Assessment for Maryland are shown in Figure 6 and in Table A5. The subwatersheds with high watershed stressor analysis scores (healthier watersheds) are located in the western portion of Maryland. There are opportunities to benefit resident fish in Licking Creek (HUC 0207000403) and brook trout in Savage River (HUC 0207000201). Stream restoration in these relatively unstressed areas could provide habitat improvements. Zekiah Swamp Run (HUC 0207001104) is a moderately stressed subwatershed with the opportunity to undertake stream restoration to benefit resident fish once watershed stressors are further evaluated and addressed if needed. Numerous stressed subwatersheds line the mainstem of the bay in Maryland, particularly on the Eastern Shore. There are opportunities to implement stream restoration to benefit anadromous fish and resident fish in these subwatersheds once stressors are evaluated and addressed.

There are Trout Unlimited eastern brook trout conservation strategies identified for catchments within focus subwatersheds for eastern brook trout in western Maryland (see Figure 7). This information has the potential for siting projects on a smaller scale by follow-up investigations (see Planning Analyses Appendix).

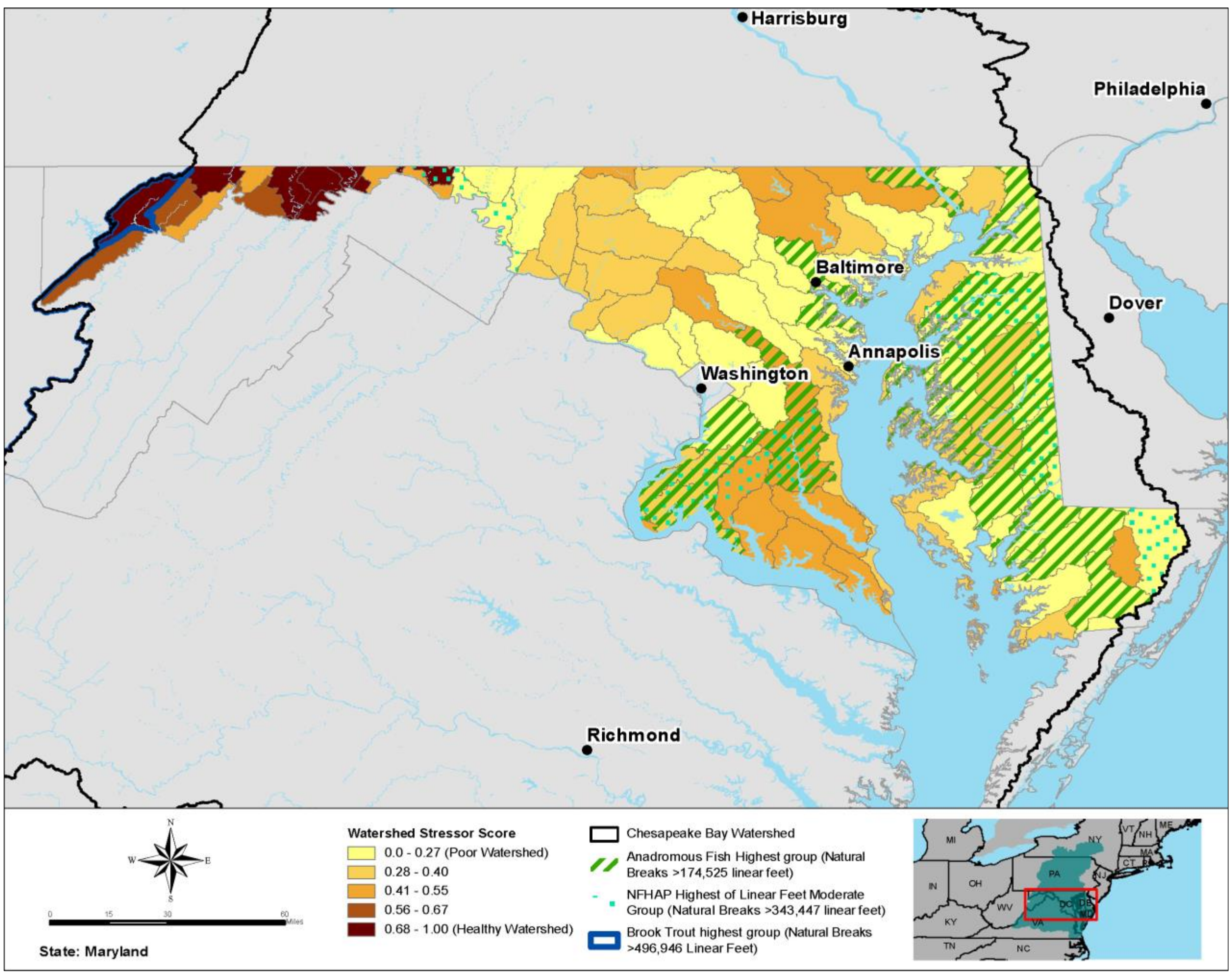

Figure 6. Stream restoration Opportunity Assessment for Maryland

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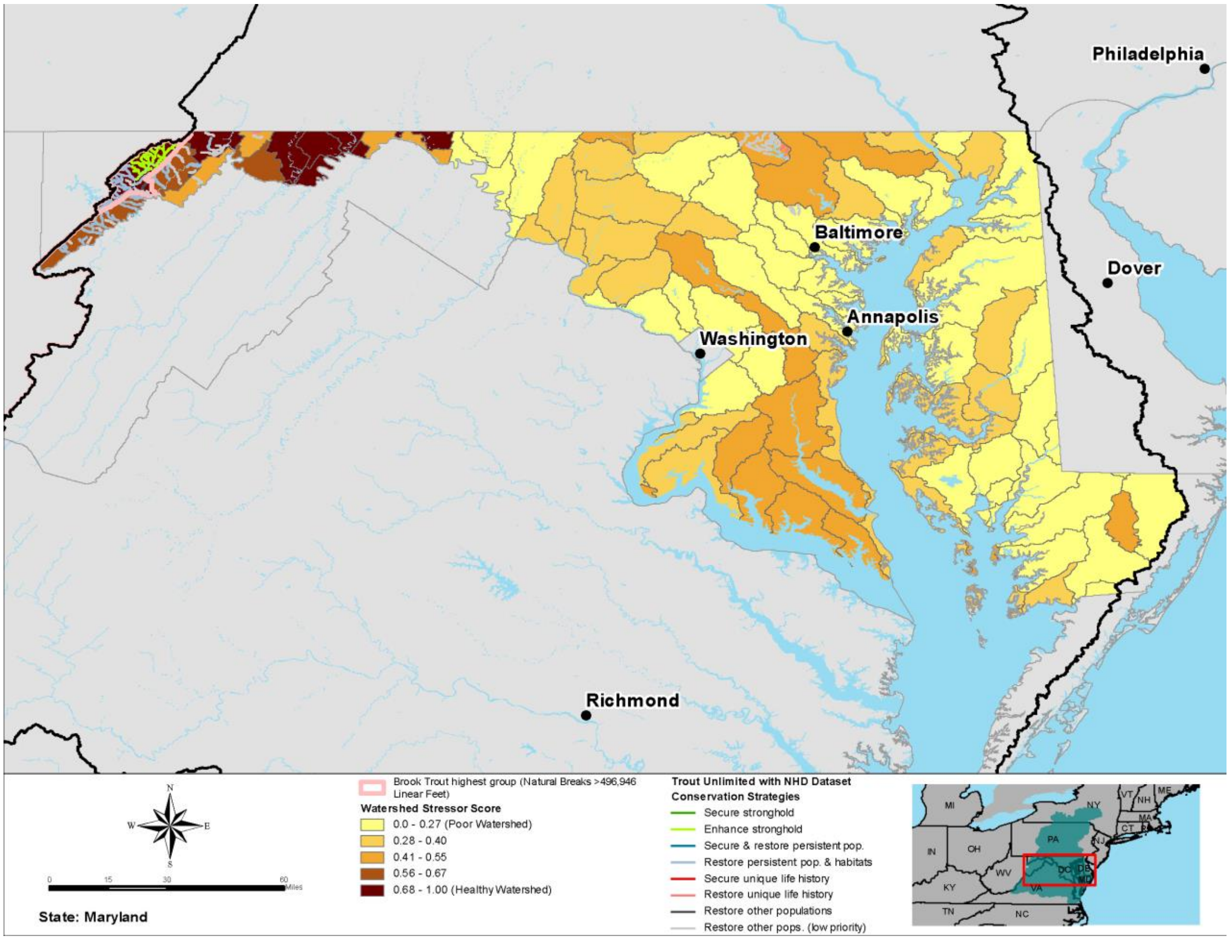

Figure 7. Potential areas for stream restoration to benefit brook trout based on Trout Unlimited conservation strategies and watershed stress in Maryland

2.1.6 Outcome: Wetlands

> "*Continually increase the capacity of wetlands to provide water quality and habitat benefits throughout the Chesapeake Bay watershed. Create or reestablish 85,000 acres of tidal and nontidal wetlands and enhance the function of an additional 150,000 acres of degraded wetlands by 2025. These activities may occur in any land use (including urban), but should primarily occur in agricultural or natural landscapes.*"

2.1.6.1 Identify Wetland Enhancement Opportunities

The Wetlands Enhancement Opportunities Assessment for Maryland identified areas where wetlands exist and may provide enhancement opportunities to increase their ecological value. The following data was used (see the Planning Analysis Appendix for more details on the data used):

- *High Resolution Land Cover Data* (Chesapeake Bay Conservancy 2016)

Results of the Wetlands Enhancement Opportunities Assessment for Maryland are shown in Figure 8 and in Tables A6 and A7 display the acreage of existing tidal and nontidal wetlands in each subwatershed in Maryland. Nontidal wetlands are concentrated on the Eastern Shore, followed by the southern portion of Maryland below Washington, D.C. Tidal wetlands are concentrated in the lower Eastern Shore in the Blackwater River and the subwatersheds lining Tangier Sound.

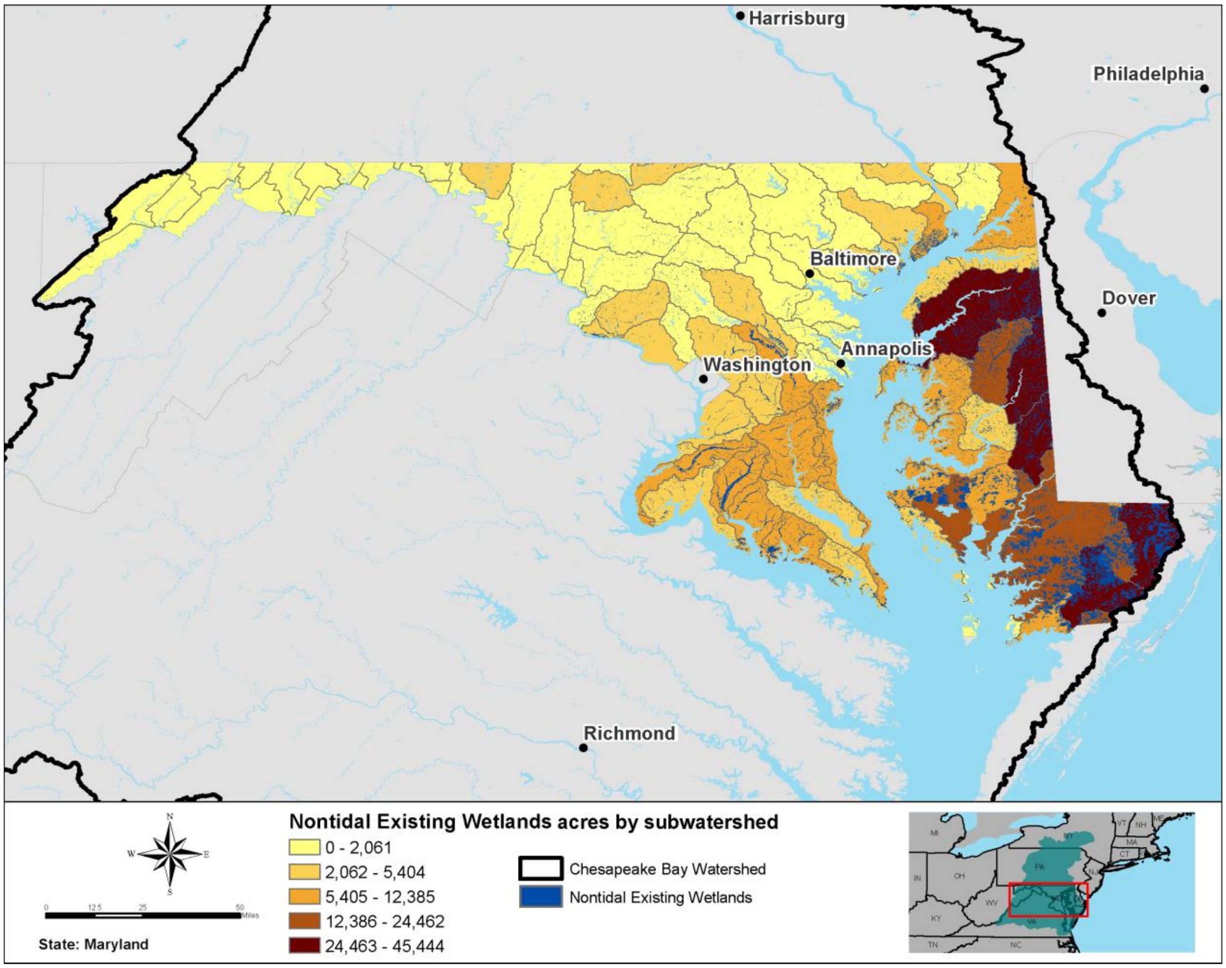

Figure 8. Nontidal wetlands enhancement Opportunity Assessment in Maryland

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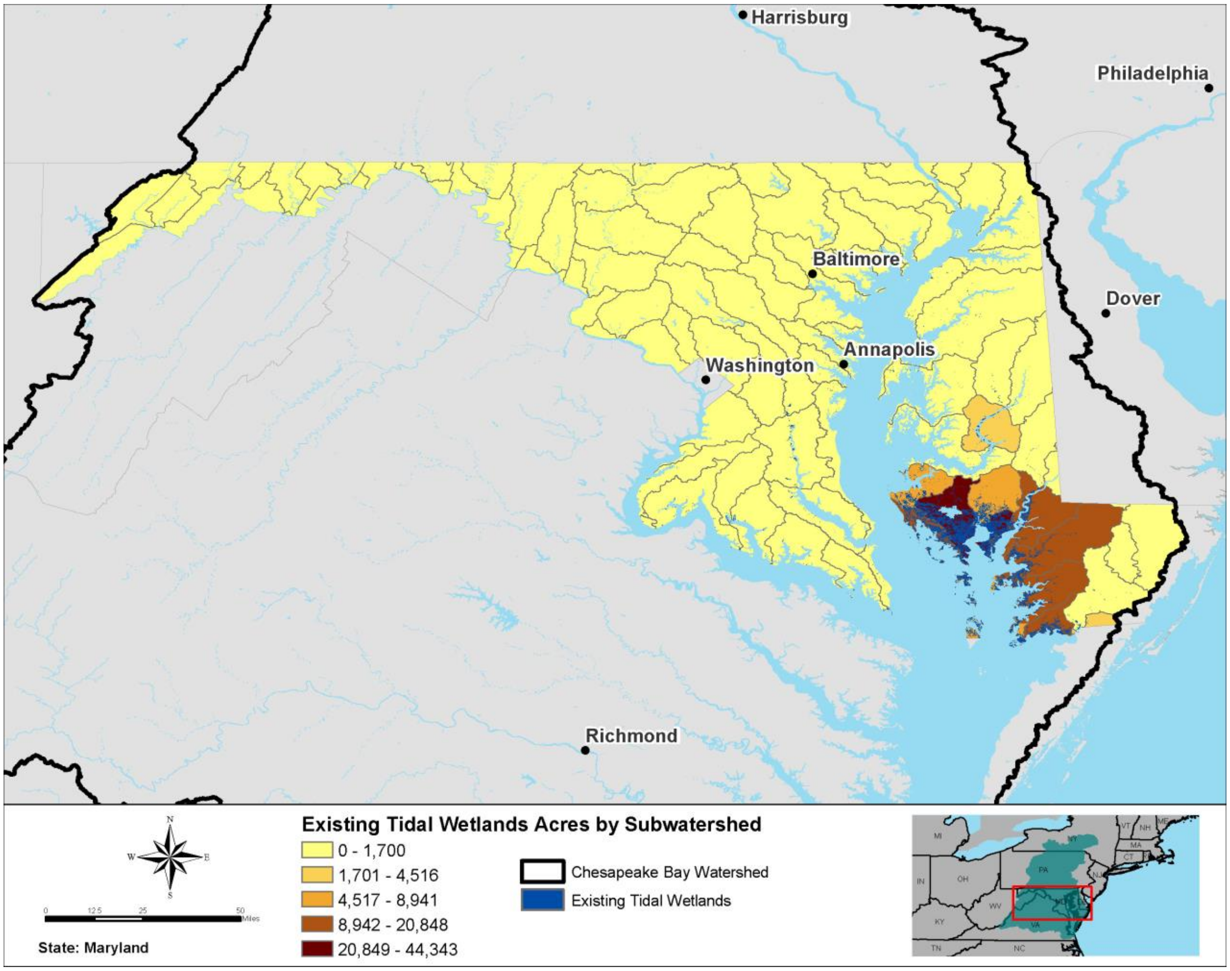

Figure 9. Tidal wetlands enhancement Opportunity Assessment in Maryland

2.1.6.2 Identify Wetland Restoration Opportunities

The Wetlands Restoration Opportunities Assessment for Maryland identified areas where the potential exists for wetland restoration. The following data was used (see the Planning Analysis Appendix for more details on the data used):

- *High Resolution Land Cover Data* (Chesapeake Bay Conservancy 2016)
- USGS Digital Elevation Model (nontidal assessment)
- *Hydric Soils Dataset* (CBP) (tidal assessment)

Results of the Wetland Restoration Opportunities Assessment for nontidal and tidal wetlands are shown in Figures 9 and 10, respectively, and in Table A7. The Wetland Restoration Opportunities Assessment for Maryland displays areas where the potential exists for wetland restoration. *Opportunities* for nontidal restoration areas were identified using CBP's hydric soils dataset. Within the extent of hydric soils, areas with certain land cover classes (pasture, tree canopy over turf grass, turf grass, mixed open, and cropland) were identified as areas for potential wetland restoration. This may over-inflate potential acreages for restoration due to the economic viability of the current land use. Cropland and pastureland may not be the best areas to convert to wetlands. Even so, the analysis aims to identify areas where work could be done to restore areas where wetlands may have existed in the past but are no longer present.

Subwatersheds in the lower Susquehanna River, Chester River, Upper Choptank River, and a portion of the Potomac River drainage in western Maryland fall in the category of having the most nontidal wetland restoration *Opportunities*. The subwatersheds with the highest acres of nontidal wetlands are Chester River (HUC 0206000204), Upper Choptank River (HUC 0206000502), Marshyhope Creek (HUC 0208010903), Antietam Creek, and Conococheague Creek (0207000408). There are several watersheds within the Elk River, Pocomoke, and Wicomico River drainages that are ranked in the second highest group with respect to number of acres available for nontidal wetland restoration.

The Choptank subwatershed and the lower Eastern Shore have the most existing tidal wetlands and tidal wetland restoration *Opportunities*. The Blackwater River (HUC 0208011002) has the highest number of acres of existing tidal wetlands (44,343 acres). The subwatersheds with the most potential restoration *Opportunities* for tidal wetlands include Blackwater River (HUC 0208011002), Transquaking River (HUC 0208011001), Honga River-Chesapeake Bay (HUC 0206000506), and the Little Choptank River (HUC 0206000504).

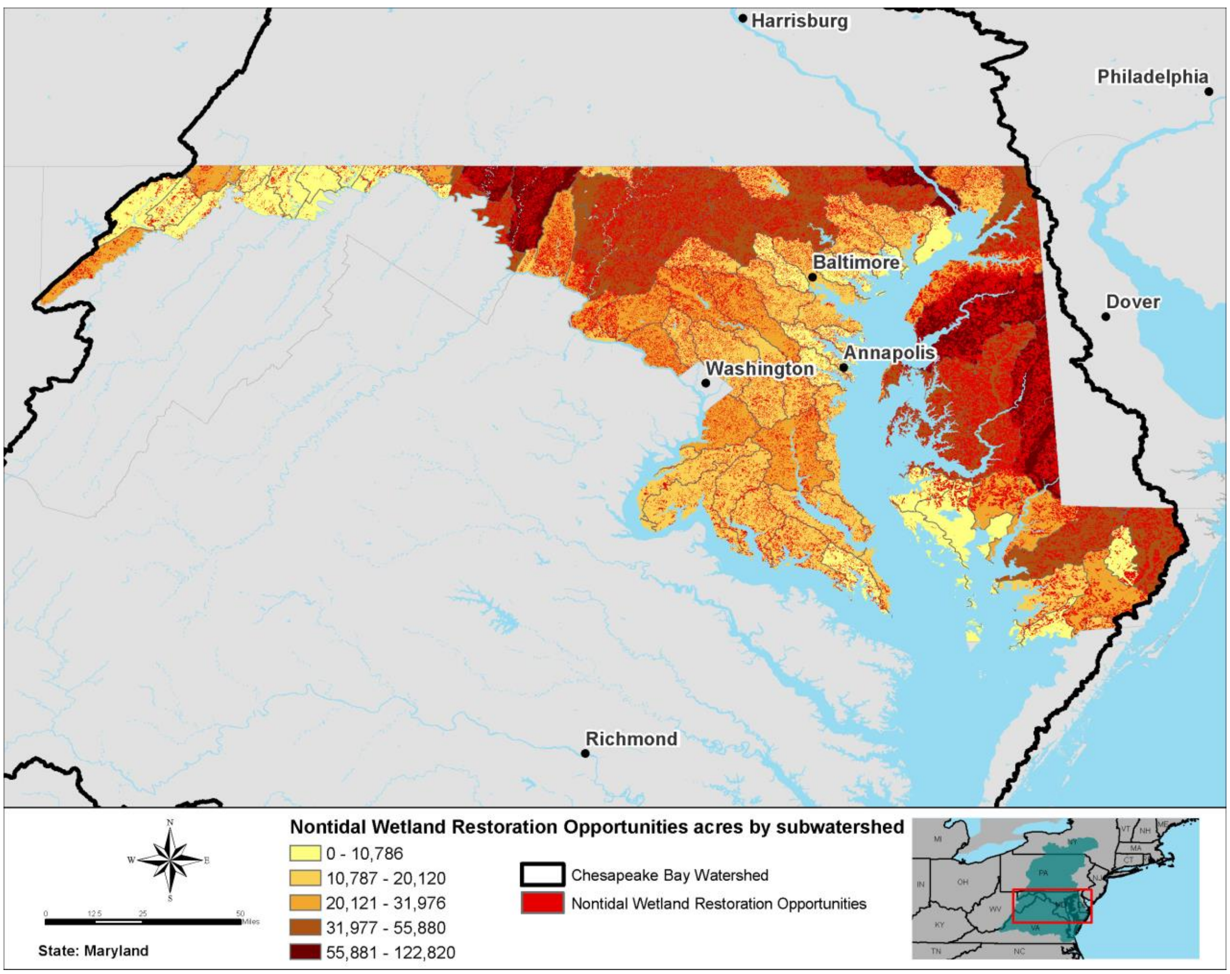

Figure 10. Nontidal wetland restoration Opportunity Assessment in Maryland

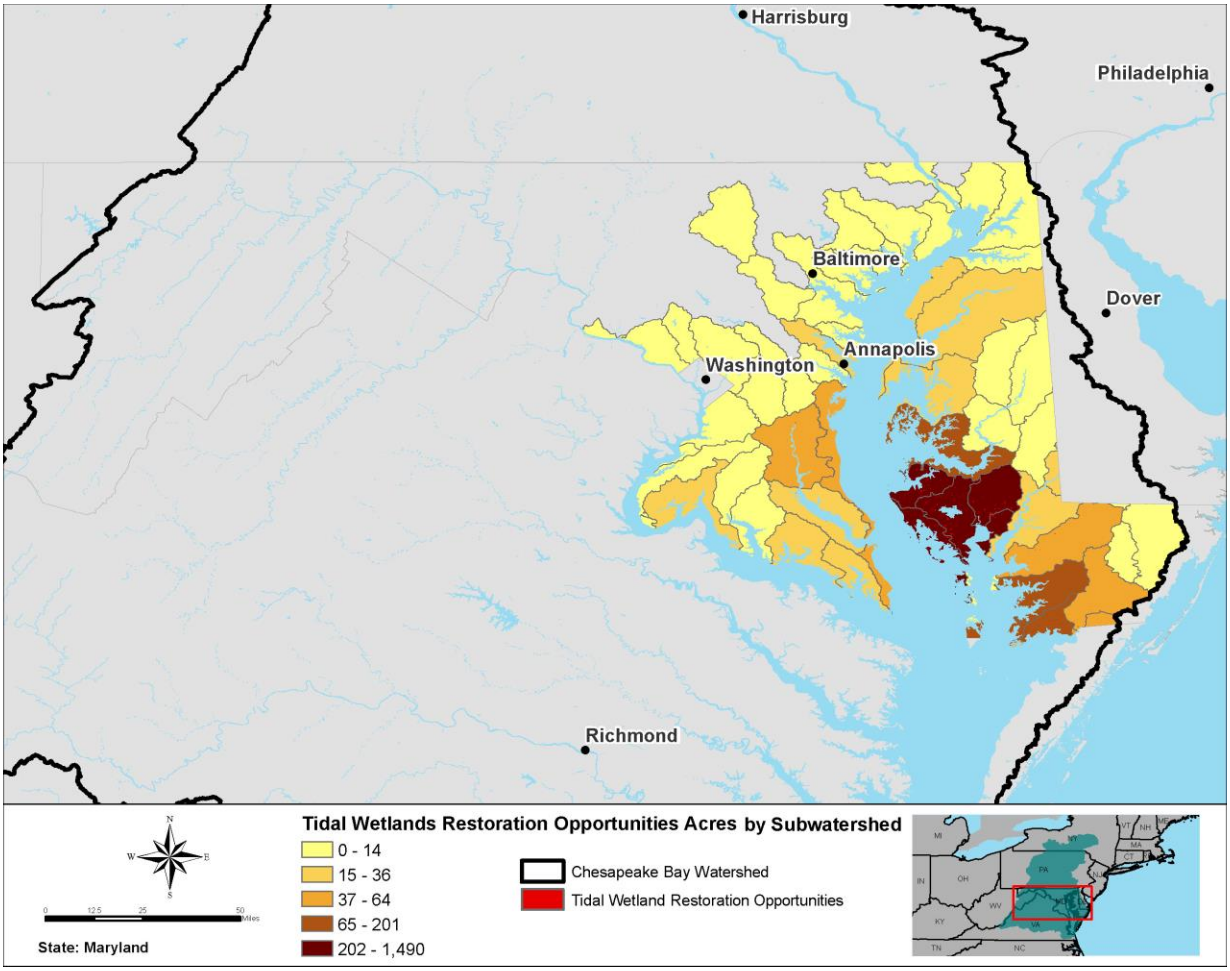

Figure 11. Tidal wetland restoration Opportunity Assessment in Maryland

2.1.6.3 Identify Wetland Restoration Opportunities that can Benefit Avian Wildlife

The purpose of this analysis is to identify wetland restoration *Opportunities* that have the potential to benefit avian wildlife by determining where restoration *Opportunities* overlap with Audubon Important Bird Areas. The following data was used in this analysis (see the Planning Analysis Appendix for more details on the data used):

- *Wetlands Restoration Opportunities Assessment Results* (CBCP)
- *Nesting locations for wading birds and waterbirds* (Center for Conservation Biology)
- *Black Duck Focus Areas* (CBP)
- *Audubon Important Bird Areas*

A unique analysis was completed for nontidal and tidal wetland *Opportunities*. Results of this analysis for Maryland are shown in Figures 12 and 13, and in Table A7. The Chester River (HUC 0206000204) provides the most overlap of nontidal wetland restoration *Opportunities* with all three compiled avian habitat resources: Audubon important bird areas, black duck focus area, and nesting habitat for wading and waterbird, followed by the Wicomico River (HUC

0208011003) subwatershed on the Eastern Shore. There are nontidal wetland restoration *Opportunities* in subwatershed that contain only Audubon important bird areas in the Rocky Marsh Run-Potomac River (HUC 0207000411), broadly along the Pennsylvania/Maryland border, in the Susquehanna River (HUC 0205030617), and the Marshyhope Creek (HUC 0208010903) on the Maryland/Delaware border.

In considering tidal wetland restoration *Opportunities*, the Blackwater River (HUC 0206000204), Transquaking River (HUC 0208011001), and Honga River-Chesapeake Bay (HUC 0206000506) subwatersheds provide the most overlap of tidal wetland restoration acreage with all three compiled avian habitat resources followed by the Manokin River (HUC 0208011004) subwatershed.

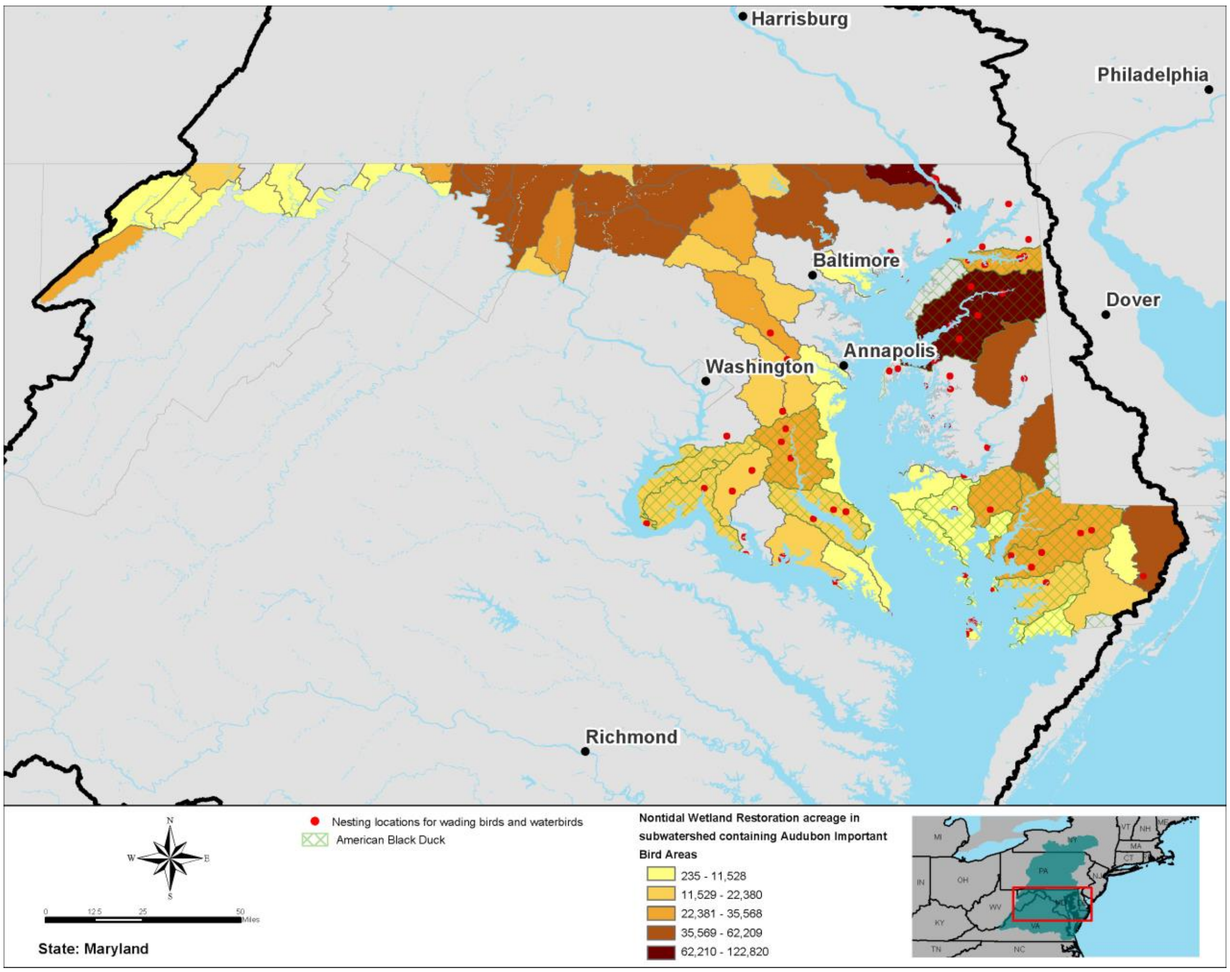

Figure 12. Nontidal wetland restoration Opportunities with avian benefits in Maryland

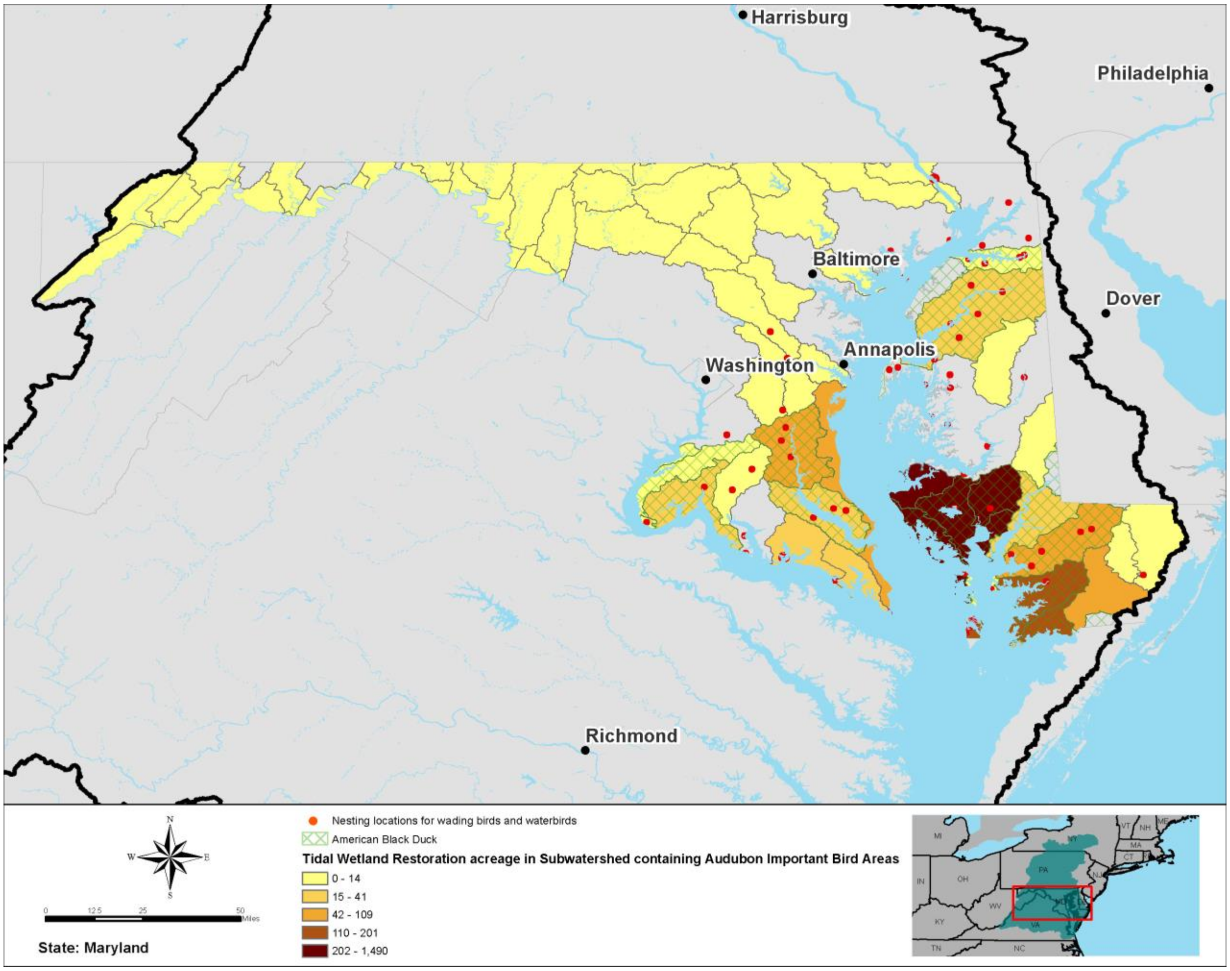

Figure 13. Tidal wetland restoration Opportunities with avian benefits in Maryland

2.1.6.4 Identify Wetland Restoration Opportunities that are Important Habitats for Imperiled Species (Rare, Threatened, and Endangered)

The purpose of this analysis was to identify wetland restoration Opportunities that are important habitats for rare, threatened and endangered (RTE) species. The following data was used in this analysis (see the Planning Analysis Appendix for more details on the data used):

- *Wetlands Restoration Opportunities Assessment Results* (CBCP)
- *Nature's Network Imperiled Species Dataset* (identifies important, moderately important, and less important habitat for imperiled species)

The greatest concentration of nontidal wetland restoration *Opportunities* containing core habitats for imperiled species is on Maryland's Eastern Shore in the following subwatersheds: Chester River (HUC 0206000204), Marshyhope Creek (HUC 0208010903), Dividing Creek-Pocomoke River (HUC 0208011103), Bald Cypress Branch- Pocomoke River (HUC 0208011102), Tuckahoe Creek (HUC 0206000501) and Wicomico River (HUC 0208011003). There are also nontidal wetland restoration *Opportunities* in the Patuxent and lower Potomac River drainages that overlap with imperiled species habitat.

Opportunities for tidal wetland restoration containing core habitats for imperiled species include the Little Choptank River (HUC 0206000504), Blackwater River (HUC 0208011002), Honga River-Chesapeake Bay (HUC 0206000506), Transquaking River, Wicomico River (HUC 0208011003), Manokin River (HUC 0208011004), and Marumsco Creek-Pocomoke River (HUC 0208011105) subwatersheds.

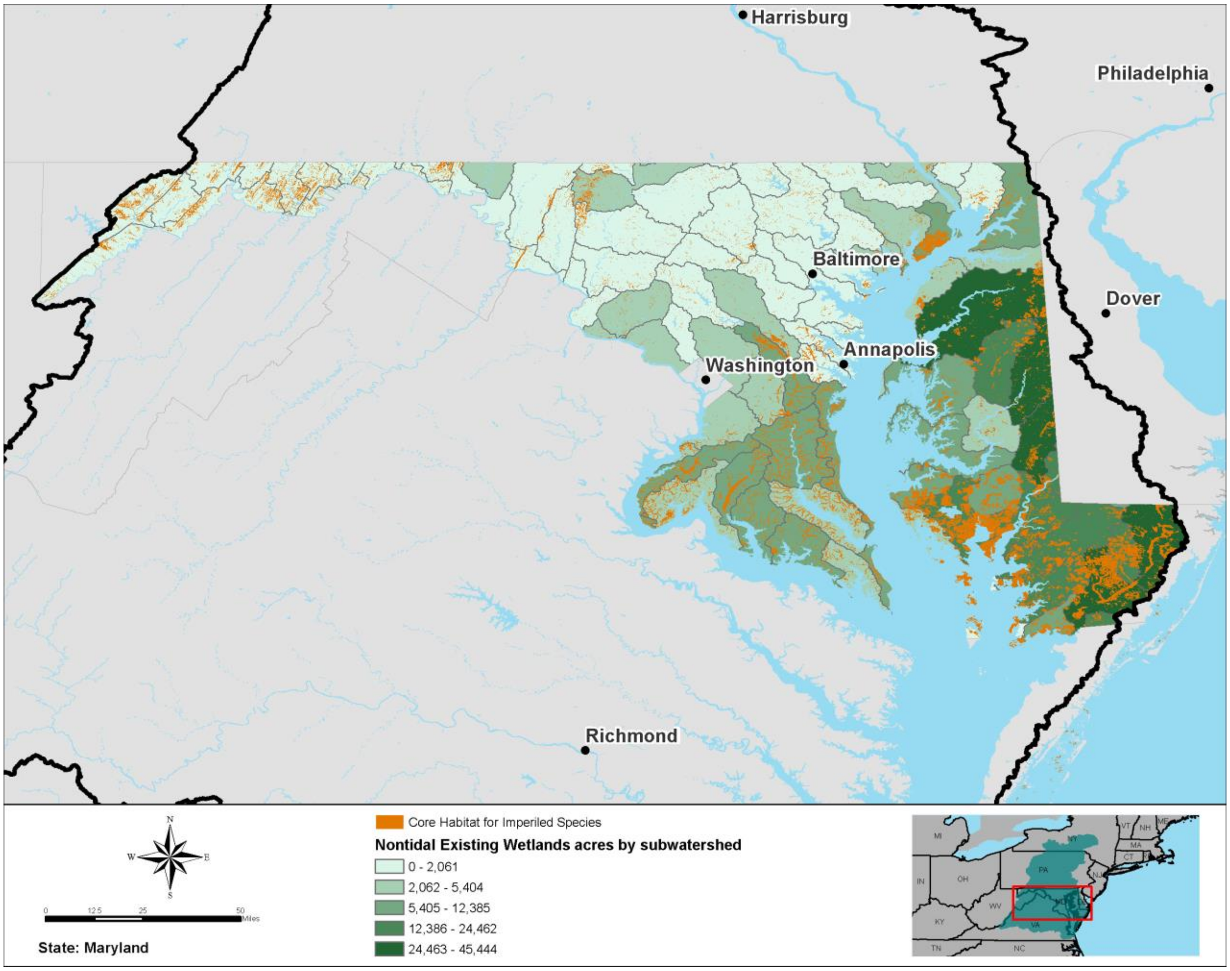

Figure 14. Core habitat for imperiled species in relation to nontidal wetland enhancement *Opportunities* in Maryland

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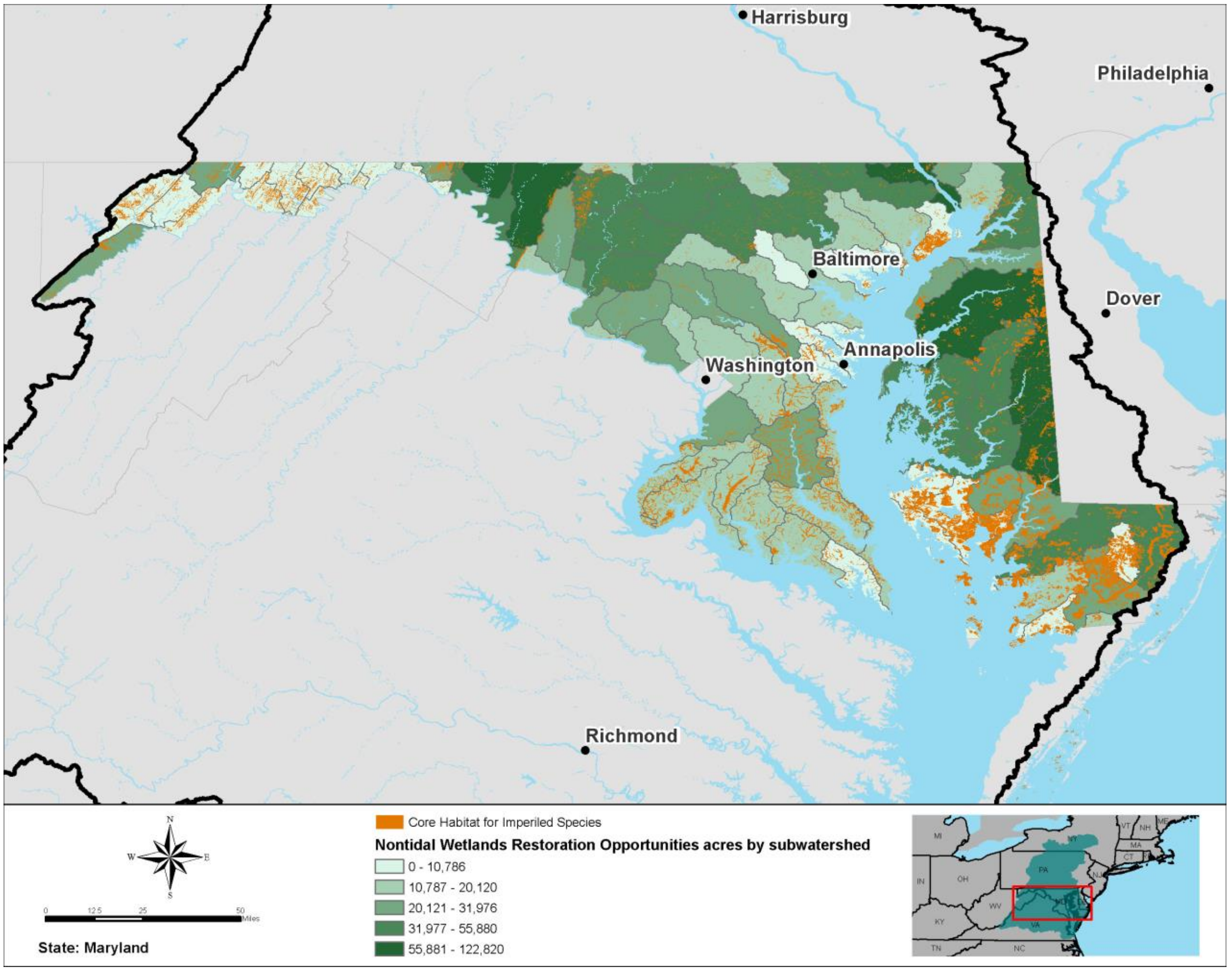

Figure 15. Core habitat for imperiled species in relation to nontidal wetland restoration *Opportunities* in Maryland

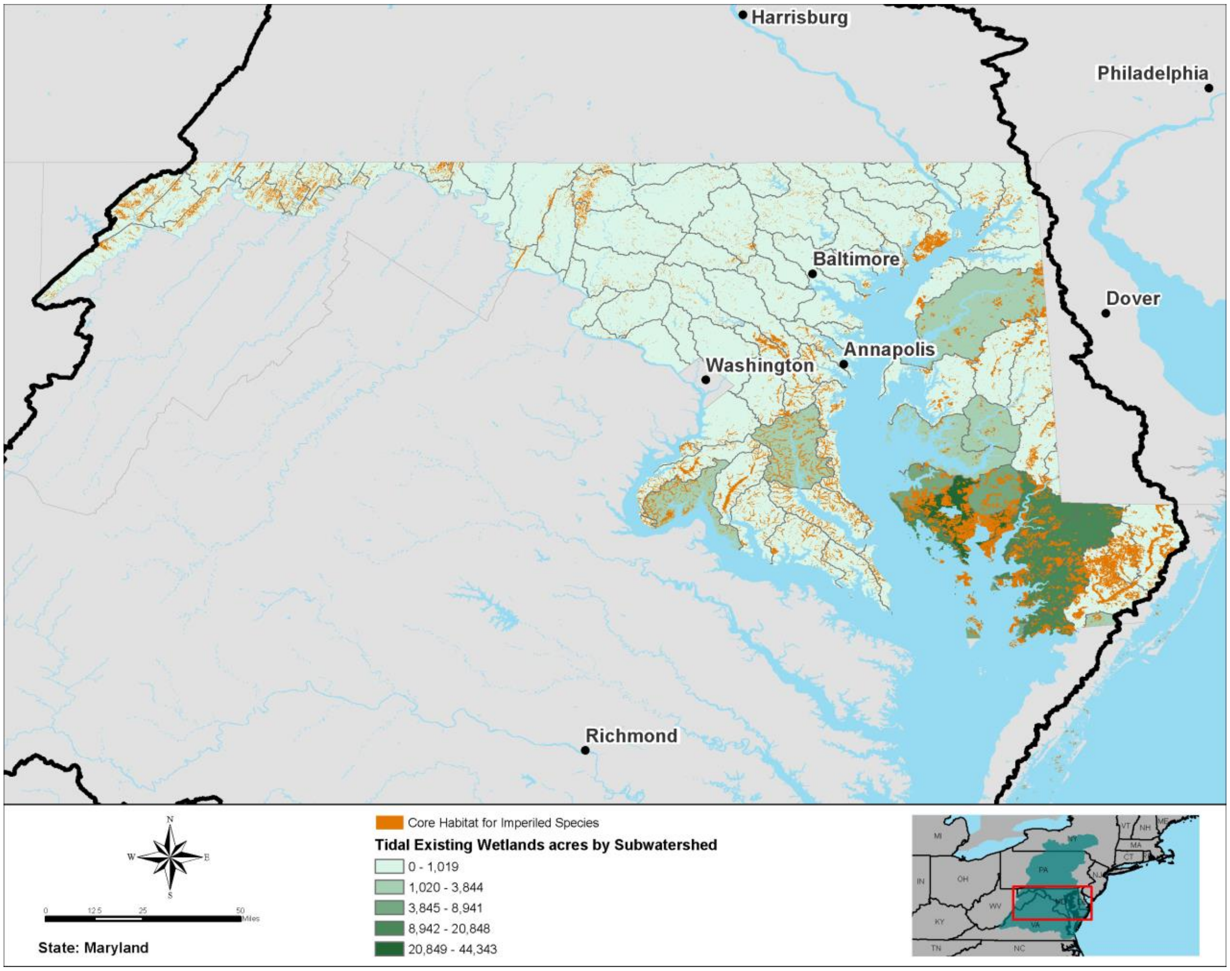

Figure 16. Core habitat for imperiled species in relation to tidal wetlands enhancement *Opportunities* in Maryland

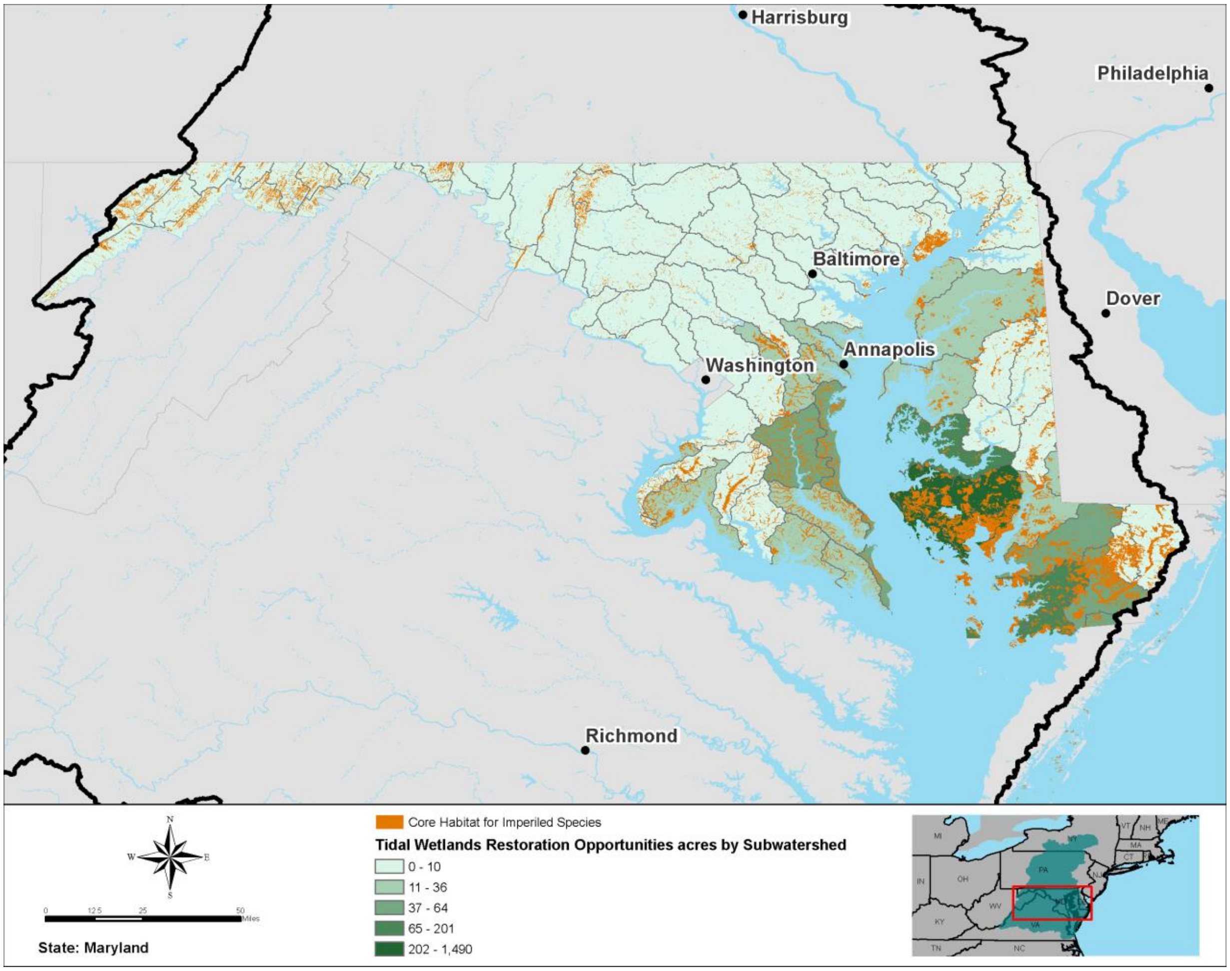

Figure 17. Core habitat for imperiled species in relation to existing tidal wetland restoration *Opportunities* in Maryland

2.1.6.5 Identify where potential wetland restoration projects exist that provide an opportunity for incorporating beneficial use

The purpose of this investigation was to evaluate where USACE navigation projects are located with respect to wetland restoration opportunities in order to identify wetland restoration and enhancement *Opportunities* that could utilize dredged material.

The following geospatial layers were overlaid to develop the wetland beneficial use of dredged material composite presented:

- *USACE navigation projects* (dredged channels)
- *Wetland restoration and enhancement Opportunities Assessment* (nontidal and tidal)

A unique analysis was completed for nontidal and tidal wetland opportunities (Figures 18 and 19, respectively and Table A8).

The Tangier Sound/Blackwater region on the lower Eastern Shore of Maryland and the Middle Eastern Shore are prime areas to incorporate dredged material into enhancement projects. These areas are dredged more frequently than channels along the Western Shore of Maryland. Channels dredged at the head of rivers provide significant opportunities to use dredged material to restore wetlands.

Subwatersheds with wetland restoration potential near navigation sites in Maryland include the Lower Choptank River (HUC 0206000505), Manokin River (HUC 0208011004), Little Choptank River (HUC 0206000504), the Blackwater River (HUC 0208011002), Honga River-Chesapeake Bay (HUC 0206000506), Marumsco Creek-Pocomoke River (HUC 0208011105), and Lower Tangier Sound (HUC 0208011006).

Additionally, the Maryland Department of Natural Resources (MD DNR) has identified the following state-maintained channels as priority channels to maintain for shallow water draft navigation. This prioritization makes it likely that additional sediments could be available from these areas should living shorelines or wetlands enhancement and restoration opportunities be located in the vicinity.

Table 1. Maryland Department of Natural Resources prioritized channels to maintain for shallow water draft navigation

Channel Name	County	Year Dredged by DNR	Current Dredged Material Placement Site
Kent Narrows - Chester River	Queen Anne's	2007, 2013	Ferry Point Beach (County)
Rock Hall	Kent	1980, 1982, 2006, 2015	Brambles DMP (Private), 7 miles
Rockhold Creek, Herring Bay	Anne Arundel	1980, 2008, 2016	South County DMP (County), 3 miles
Fishing Creek, Chesapeake Beach	Calvert	1989, 1997	Town DMP (Town), 0.5 miles
St. Jerome Creek	St. Mary's	1971, 1981, 1992, 2006, 2010, 2014	Buzz's Marina (Private), 2 miles
Knapps Narrows, Tilghman Island	Talbot		New Site under const. (County)
Bladensburg, Anacostia River	Prince George's		MNCPPC Site, west side of river
Nanticoke Harbor, Nanticoke River	Wicomico	1989	
Tar Bay, Honga River	Dorchester		
Chesapeake City Basin, C&D Canal	Cecil		USACE Site, 1 mile

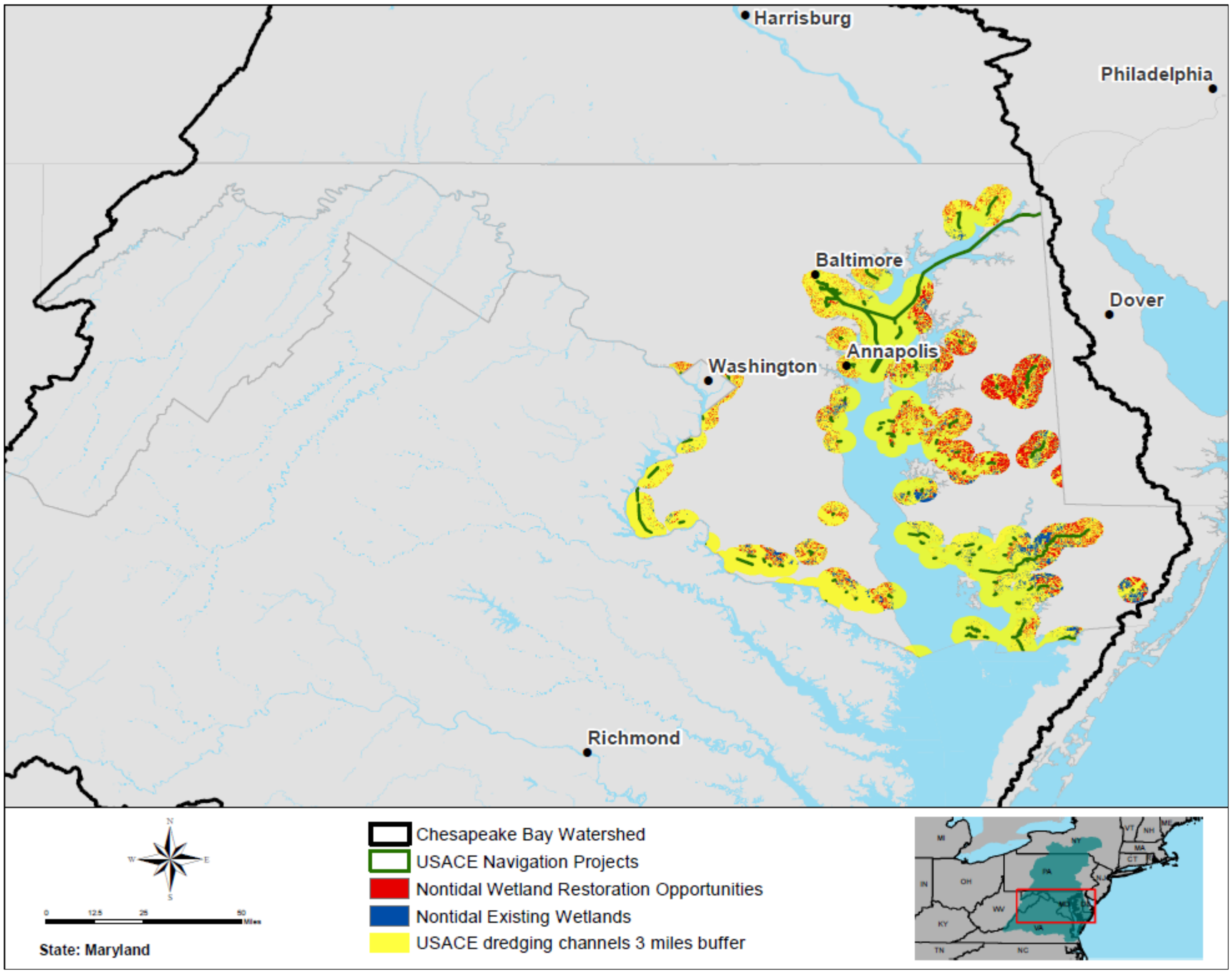

Figure 18. Potential sites for the incorporation of beneficial use of dredged material into nontidal wetlands restoration and enhancement opportunities in Maryland

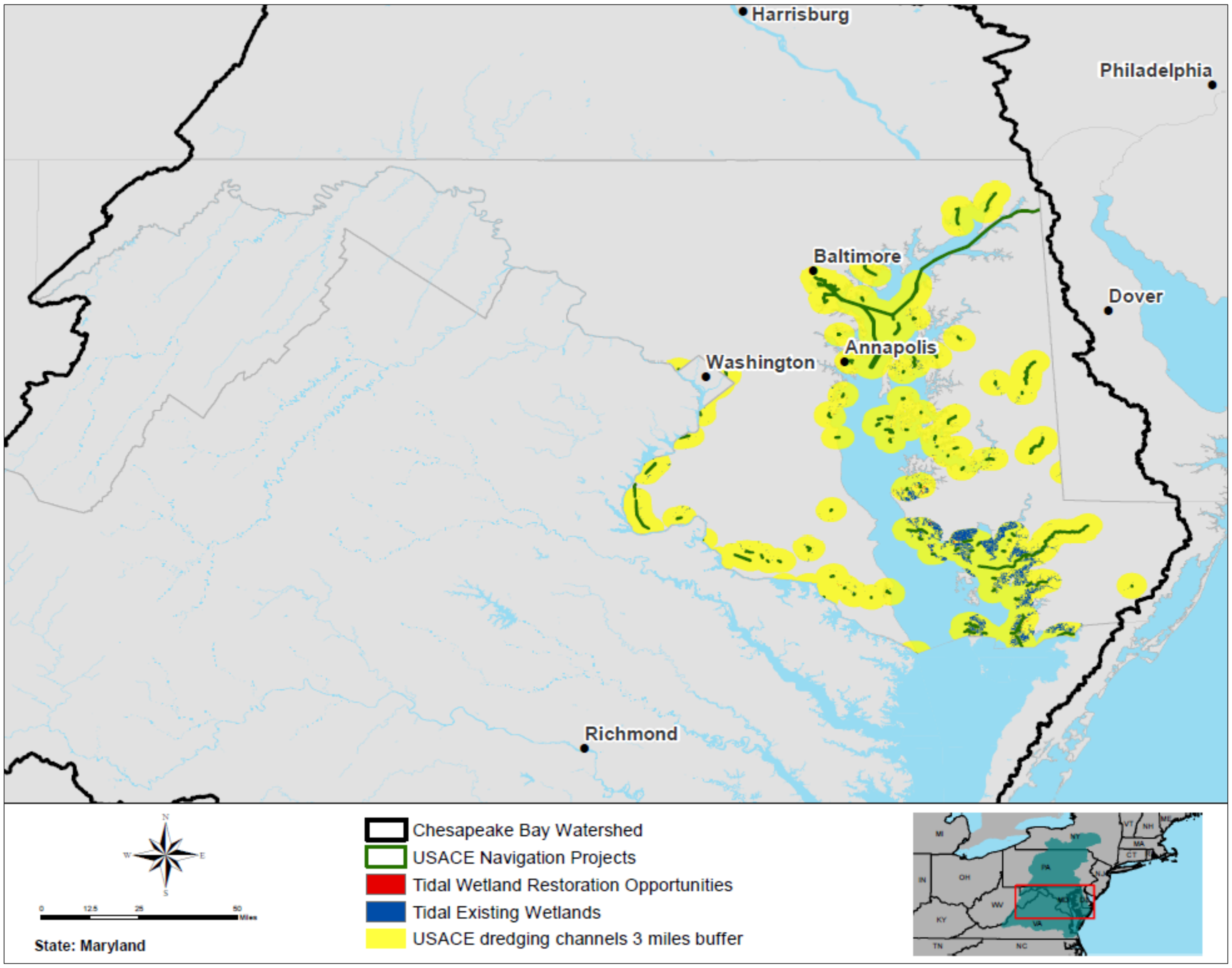

Figure 19. Potential sites for the incorporation of beneficial use of dredged material into tidal wetlands restoration and enhancement opportunities in Maryland

2.1.6.6 Wetlands Threats Opportunities Assessment

This Wetlands Threats Opportunities Assessment investigated whether wetland restoration *Opportunities* are at risk to climate change, anticipated increases in flooding and coastal storms, and projected development in the Chesapeake Bay Watershed. This analysis incorporated the results of the Threats Analysis with the Wetland Restoration Opportunities Assessment and the Wetlands Enhancement Opportunities Assessment to understand habitats that may be lost or impaired by future threats.

A unique analysis was completed to evaluate nontidal and tidal threats to existing wetlands (Figure 20 and 21) and nontidal and tidal threats to wetland restoration opportunities (Figure 22 and 23, respectively and Table A9).

Wetlands enhancement *Opportunities* at risk to future nontidal threats are in the Little Patuxent River (HUC 0200600602), Seneca Creek (HUC 020700808), Rock Creek (HUC 0207000901), and Upper Monocacy River (HUC 0207000905) subwatersheds.

Wetland restoration *Opportunities* at risk to nontidal threats are generally concentrated in the central-western part of the state and are located in the following subwatersheds: Middle Monocacy River (HUC 0207000906), Little Patuxent River (HUC 0200600602), Lower Monocacy River (HUC 0207000907), Double Pipe Creek (HUC 0207000904), Tuscarora Creek-Potomac River (HUC 0207000804), Antietam Creek (HUC 0207000410), and Conococheague Creek (HUC 0207000408).

Wetlands enhancement *Opportunities* exposed to future tidal threats are located on the lower Eastern Shore: Blackwater River (HUC 0208011002), Honga River-Chesapeake Bay (HUC 0206000506), Manokin River (HUC 0208011004), Marumsco Creek-Pocomoke Sounds (HUC 0208011105), Wicomico River (HUC 0208011003), and Lower Tangier Sound (HUC 0208011006).

Wetland restoration *Opportunities* impacted by tidal threats are centered in the Blackwater region of the Eastern Shore. These subwatersheds hold the largest acreage of tidal wetland restoration opportunities at risk to tidal threats: Honga River-Chesapeake Bay (HUC 0206000506), Little Choptank River (HUC 0206000504), Blackwater River (HUC 0208011002), and Transquaking River (HUC 0208011001).

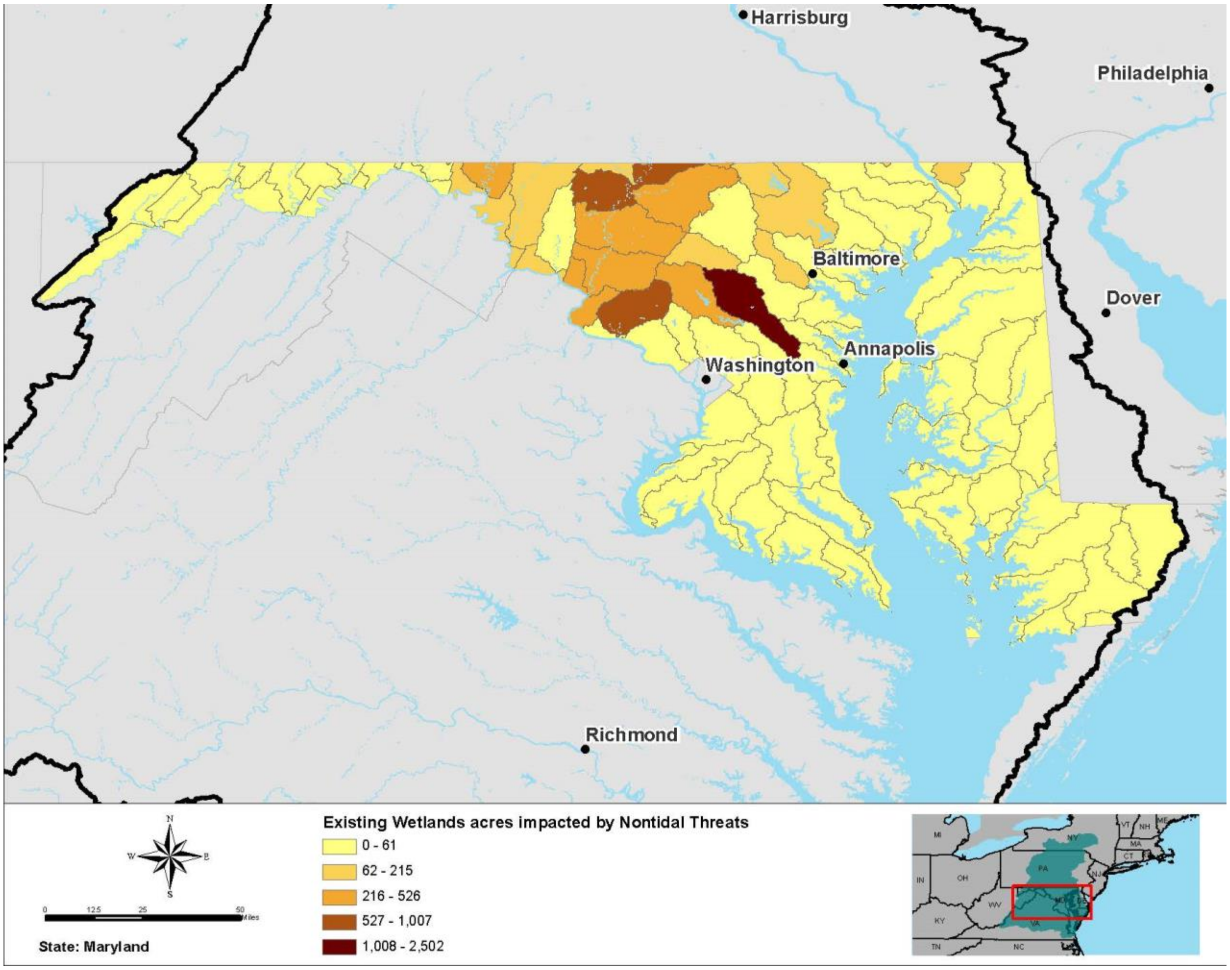

Figure 20. Wetland enhancement *Opportunities* at risk to nontidal threats in Maryland

US Army Corps of Engineers

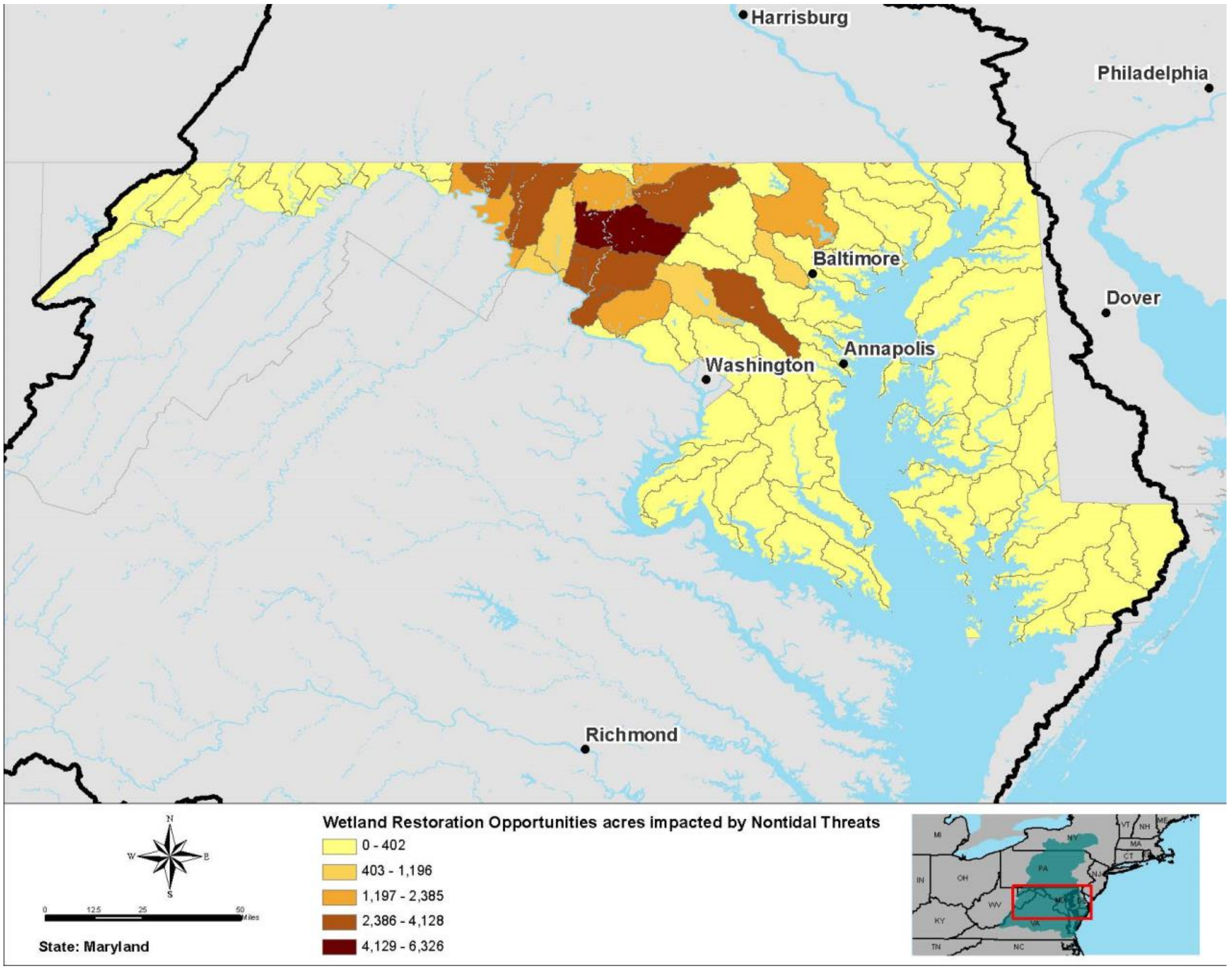

Figure 21. Wetland restoration *Opportunities* at risk to nontidal threats in Maryland

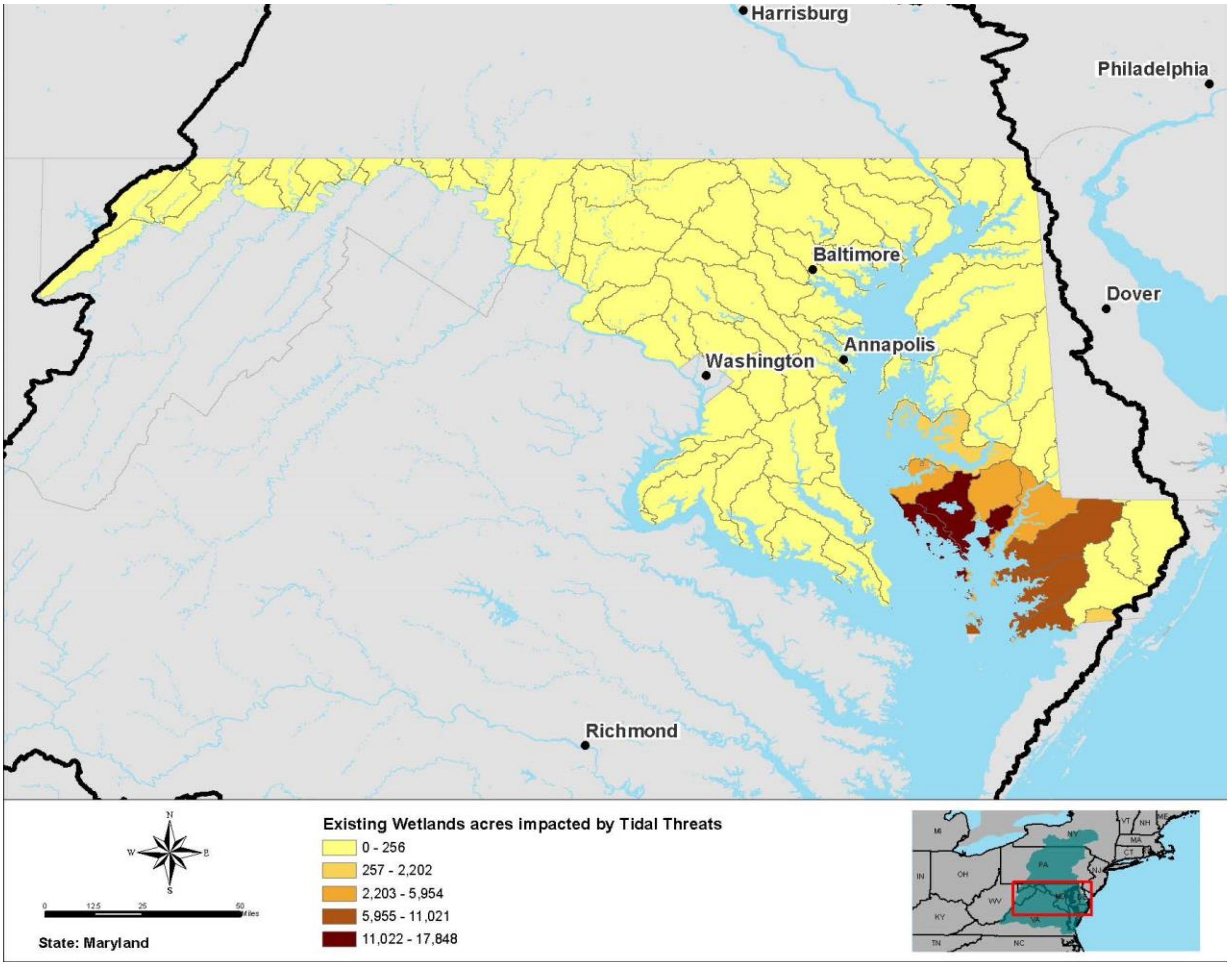

Figure 22. Wetland enhancement *Opportunities* at risk to tidal threats in Maryland

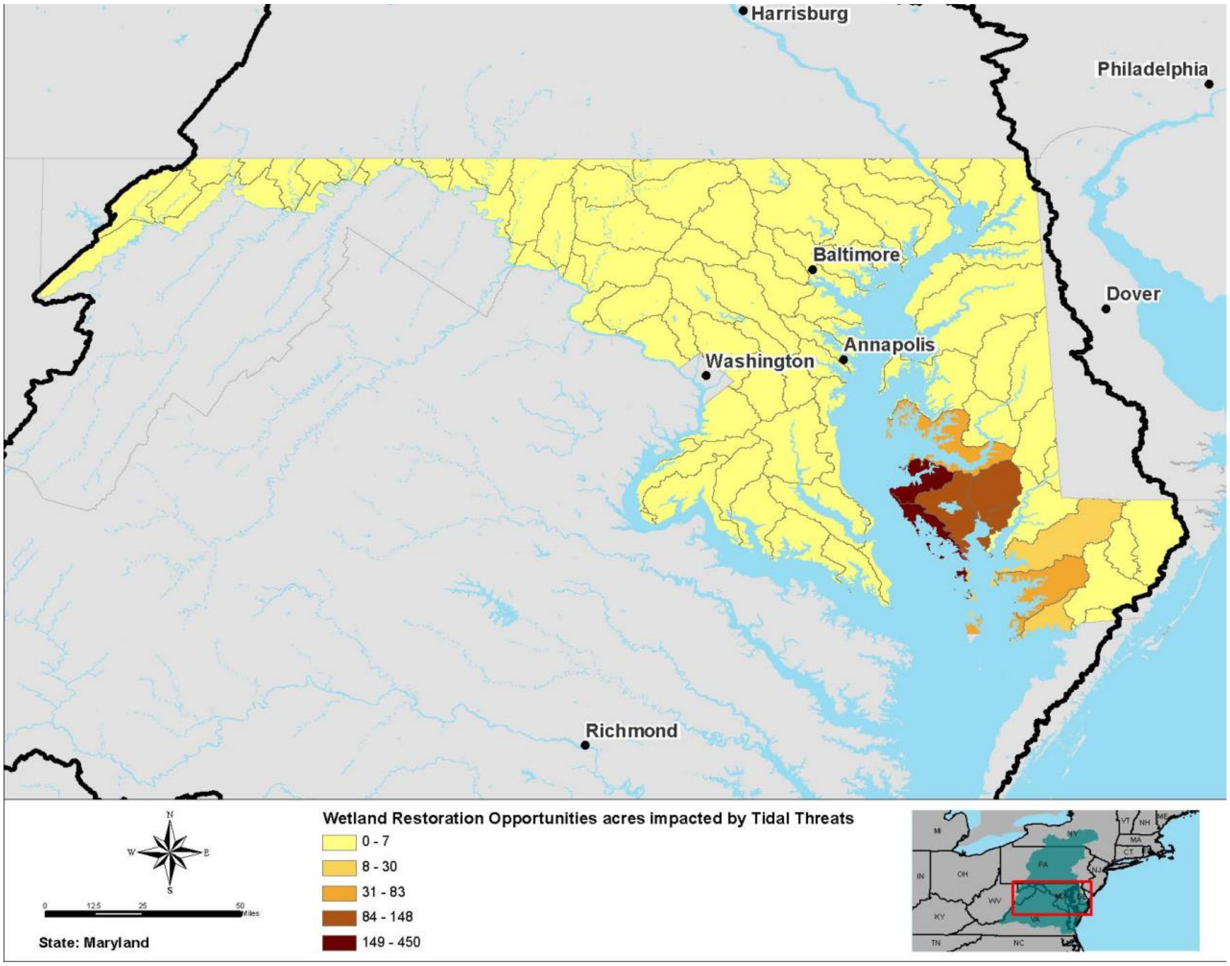

Figure 23. Wetland restoration *Opportunities* at risk to tidal threats in Maryland

2.1.7 Outcome: Submerged Aquatic Vegetation Restoration Analysis

"Sustain and increase the habitat benefits of SAV (underwater grasses) in the Chesapeake Bay. Achieve and sustain the ultimate outcome of 185,000 acres of SAV Bay-wide necessary for a restored Bay. Progress toward this ultimate outcome will be measured against a target of 90,000 acres by 2017 and 130,000 acres by 2025."

This analysis compares areas that have experienced significant historical submerged aquatic vegetation (SAV) loss and areas of SAV habitat based on 2015 surveys to identify potential areas in the Chesapeake Bay for SAV restoration. This analysis is focused on those subwatersheds with mainstem shoreline.

The following geospatial layers were overlaid to develop the SAV restoration analysis:

- *Virginia Institute of Marine Science (VIMS) SAV Survey Data (1971–2015)* (Compiled layer that represents all locations where SAV have been detected from 1971 through 2015)
- *VIMS SAV Survey Data (2015)* (Identifies current location of SAV habitat)

Opportunities for SAV restoration are positioned on the Eastern Shore of Maryland and along the Potomac River. These include:

- Chester River (HUC 0206000204)
- Eastern Bay (HUC 0206000206)
- Upper Tangier Sound (HUC 0208011005)
- Honga River (HUC 0206000506)
- Little Choptank River (HUC 0206000504)
- Lower Choptank River (HUC 0206000505)
- Manokin River (HUC 0208011004)
- Upper Chesapeake Bay (HUC 0206000205)
- Lower Chesapeake Bay (HUC 0208010100)
- Deep Creek-Pocomoke Sounds (HUC 0208011107)
- Lower Tangier Sounds (HUC 0208011006)
- Occoquan River- Potomac River (HUC 0207001008)
- Quantico Creek- Potomac River (HUC 0207001101)

The largest of these areas with degraded SAV is along the middle of Maryland's Eastern Shore (Figure 24 and Table A11). In these subwatersheds, there has been significant loss of SAV acreage without subsequent natural recovery. Conditions in these subwatersheds could be investigated to determine if the lack of recovery is due to water quality or rather is associated with a deficient seed bank or if other factors are at play. If it is determined that water quality is the primary driver, efforts could be undertaken to address those impairments in the watershed.

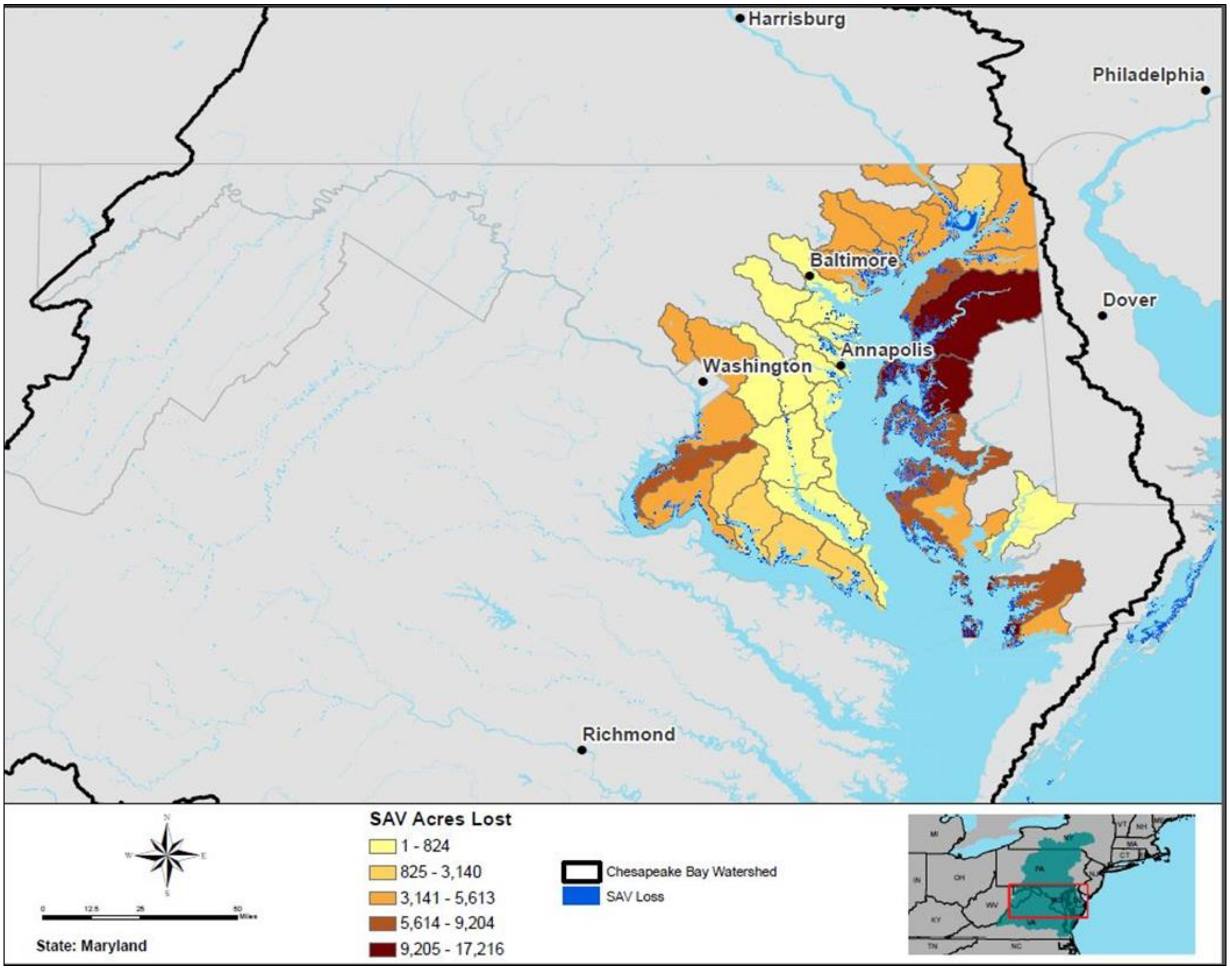

Figure 24. SAV restoration *Opportunities* in Maryland

2.2 Sustainable Fisheries Goal

"Protect, restore, and enhance finfish, shellfish and other living resources, their habitats and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Chesapeake Bay."

2.2.1 Outcome: Oysters

"Continually increase finfish and shellfish habitat and water quality benefits from restored oyster populations. Restore native oyster habitat and populations in 10 tributaries by 2025 and ensure their protection."

As there are extensive stakeholder efforts focused on identifying tributaries to undertake oyster restoration in the Chesapeake Bay, this analysis is focused on those subwatersheds that drain directly to priority oyster restoration tributaries slated or recommended for restoration by 2025. This strategy is aimed at restoring native oyster reefs in areas where they historically occurred and where there are the most suitable conditions for oyster restoration. The intent is to understand the relationship between the priority oyster restoration tributaries and watershed stressors in the Chesapeake Bay watershed.

The 2014 Bay Agreement is the guiding directive for restoration of the Chesapeake Bay and establishes a goal to restore and protect native oyster populations and their habitats in 10 tributaries by 2025. Executive Order 13508, Chesapeake Bay Protection and Restoration, signed in 2009, is the complementary federal directive to the 2014 Bay Agreement to protect and restore native oyster populations and habitats in Chesapeake Bay.

The *Chesapeake Bay Oyster Recovery: Native Oyster Restoration Master Plan* was completed in September 2012 by USACE in partnership with the State of Maryland and the Commonwealth of Virginia. State, federal, and local governmental agencies; nongovernmental organizations; and scientific experts contributed to the development of the plan, which described priority tributaries for oyster restoration in Maryland and Virginia based on an extensive geospatial analysis of locations of historic reefs and scientific parameters driving restoration success. Key parameters affecting oyster reef success (surface and bottom salinity, dissolved oxygen, and water depth) were assessed to determine the relative suitability of potential sites for oyster restoration in Maryland and Virginia.

The following geospatial layers were overlaid to develop the oyster restoration analysis (Figure 26 and Table A10):

- *Oyster restoration data layer* (compilation of Virginia and Maryland restoration sites)
- *Watershed Stressors Analysis*

Tributaries that have been selected or proposed for large-scale tributary restoration efforts in Maryland exhibit stressed conditions as determined by the Watershed Stressors Analysis. Most restoration opportunities are on Maryland's lower Eastern Shore, specifically in Dorchester County. There are opportunities to address watershed impairments in the subwatersheds that drain to the oyster restoration tributaries, which include the Little Choptank River (HUC 0206000505) and the Lower Choptank River (HUC 0206000505).

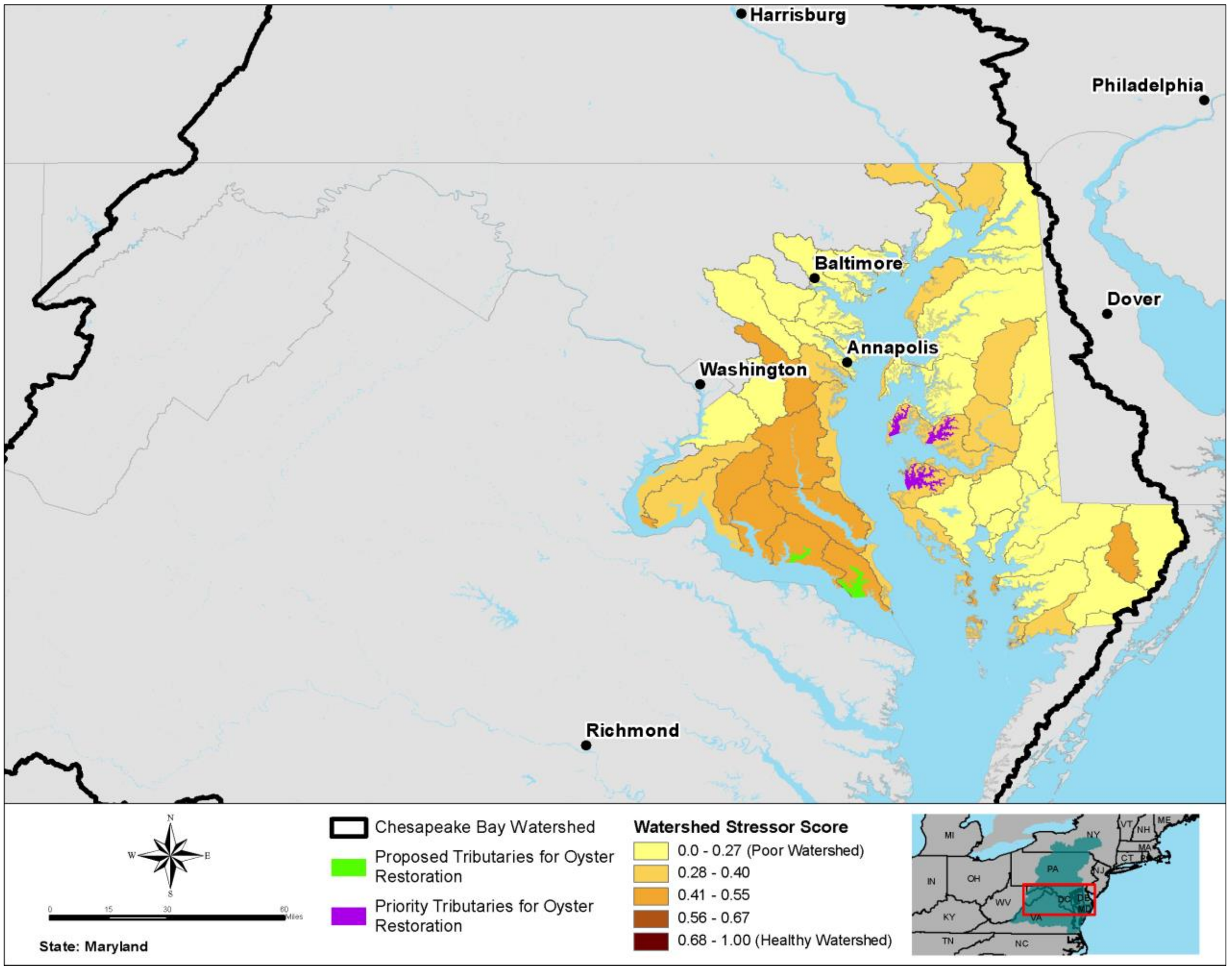

Figure 25. Subwatersheds that drain to oyster restoration tributaries and watershed stressors in Maryland

2.3 Toxic Contaminants Goal

"Ensure the Chesapeake Bay and its rivers are free of the effects of toxic contaminants on living resources and human health."

2.3.1 Outcome: Toxic Contaminants Research

"Continually increase our understanding of the impacts and mitigation of toxic contaminants. Develop a research agenda and further characterize the occurrence, concentrations, sources and effects of mercury, polychlorinated biphenyls (PCBs) and other contaminants of emerging and widespread concern. In addition, identify which best management practices might provide the multiple benefits of reducing nutrient and sediment pollution as well as toxic contaminants in waterways."

2.3.2 Outcome: Toxic Contaminants Policy and Prevention

> *"Continually improve practices and controls that prevent or reduce the effects of toxic contaminants on aquatic systems and humans. Build on existing programs to reduce the amount and effects of polychlorinated biphenyls (PCBs) in the Chesapeake Bay watershed. Use research findings to evaluate the implementation of additional policies, programs and practices for other contaminants that need to be further reduced or eliminated."*

The following data was available for the Toxic Contaminants Opportunities Assessment (see the Planning Analysis Appendix for more details on the data used):

- *National Priorities List (NPL) Sites (Superfund Sites) (*downloaded from https://toxmap-classic.nlm.nih.gov/toxmap/superfund/identifyAll.do and cross referenced with EPA for accuracy)
- *Abandoned Mines and Abandoned Mine Land Problem Areas*

Results of the Toxic Contaminants Opportunities Assessment for are shown on Figure 26 and in Table A12. There are 40 Superfund sites within the State of Maryland. The toxic contamination points are distributed throughout the Chesapeake Bay watershed but are minimal on the Delmarva Peninsula. Most of the final (completed) Superfund sites are located along the I-95 corridor and tidal plain between Baltimore, Maryland, and Washington, D.C. Final status is defined as:

> "[a] site determined to pose a real or potential threat to human health and the environment after completion of [Hazard Ranking System] HRS screening and public solicitation of comments about the proposed site" (U.S. Department of Health & Human Services 2017).

Most of the toxic sites are located within wetland restoration Opportunity areas. A number of subwatersheds contain one Superfund site, but there are multiple subwatersheds that contain several Superfund sites including:

- Quantico Creek-Potomac River (HUC 0207001101)
- Elk River (HUC 0206000202)
- Susquehanna River (HUC 0205030617)
- Anacostia River (HUC 0207001002)
- Rock Creek (HUC 0207000901)
- Rock Creek-Potomac River (HUC 0207001001)
- Back River-Chesapeake Bay (HUC 0206000307)

Data was not available to characterize the abandoned mines and mine land problem areas in Maryland.

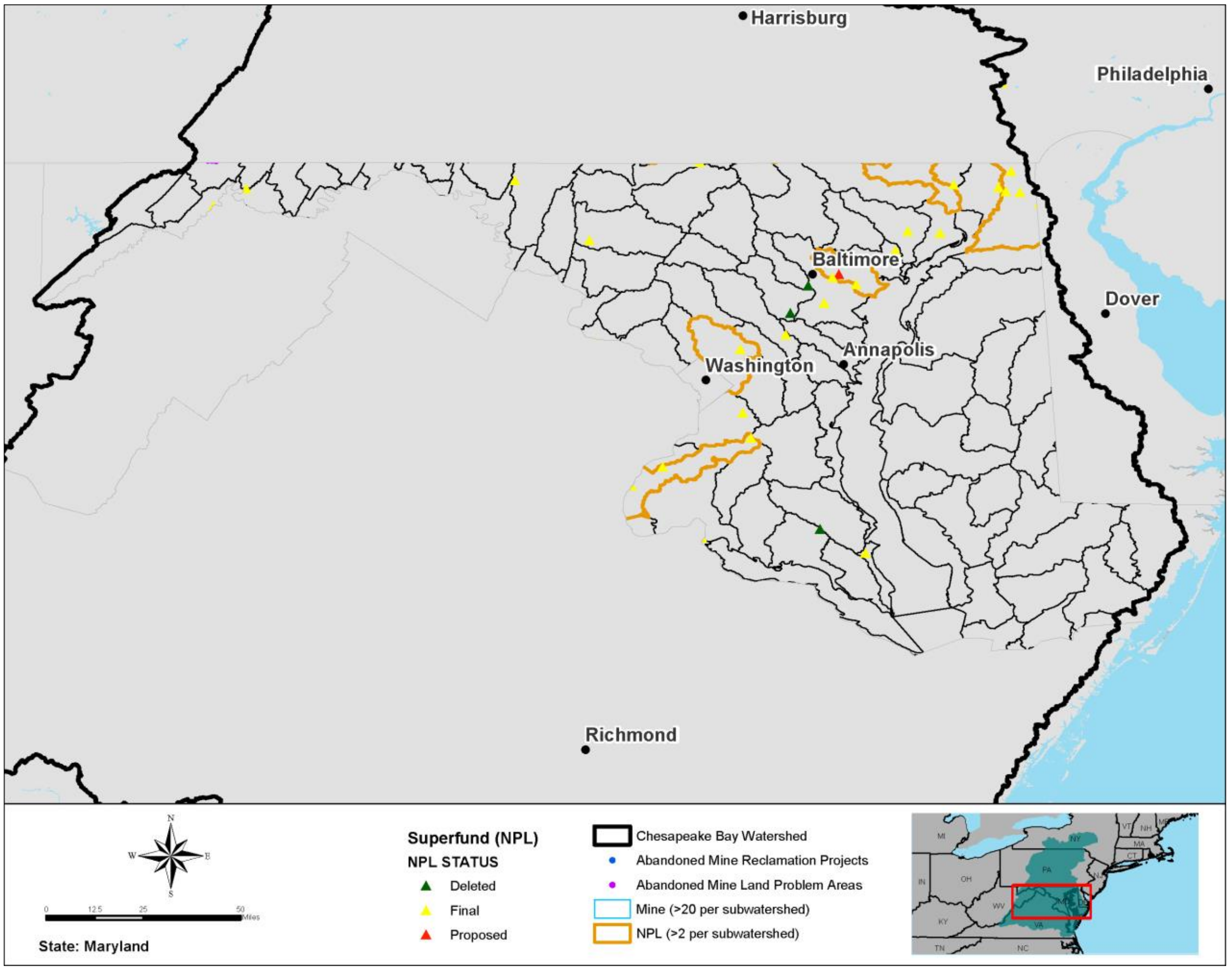

Figure 26. National Priorities List Superfund sites in Maryland

2.4 Healthy Watersheds Goal

"Sustain state-identified healthy waters and watersheds, recognized for their high quality and/or high ecological value."

2.4.1 Outcome: Healthy Watersheds

"Ensure 100 percent of state-identified currently healthy waters and watersheds remain healthy."

The Healthy/High Value Habitats Opportunities Assessment identifies areas in the Chesapeake Bay Watershed that have the healthiest habitats. The following data was used in the Healthy/High Value Habitats Opportunities Assessment (see the Planning Analysis Appendix for more details on the data used):

- *State-identified Healthy Watersheds* (based on state-derived definitions and classifications of healthy waters and watersheds)
- *Subwatersheds identified as brook trout catchments (*National Hydrography Dataset plus catchments identified as potentially supporting brook trout based on the Eastern Brook Trout Joint Venture Salmonid Catchment Assessment)
- *Black Duck Focus Areas* (CBP)
- *Audubon Important Bird Areas*
- *Index of Ecological Integrity (IEI)*
- *Nature's Network Core and Connector Habitat*

Results of the Healthy/High Value Habitats Opportunities Assessment for Maryland are shown in Figure 27 and in Table A13. No Maryland subwatersheds were identified as an *Opportunity* in this assessment in the baywide evaluation (top 2 categories in Figure 27). The healthy/high value habitats present in Maryland occur mainly in western and southern Maryland, with the exception of the Middle Gunpowder Falls subwatershed north of Baltimore. The Potomac River below Washington D.C. is listed as a high value/healthy habitat for the Quantico Creek-Potomac River (HUC 0207001101) and Nanjemoy Creek-Potomac River (HUC 0207001103) subwatersheds. On the Eastern Shore of Maryland, the highest valued subwatershed is the Blackwater River subwatershed (HUC 0208011002). This subwatershed has thousands of acres that have been identified as having healthy ecosystems and habitats, which increase the ecological value of the area.

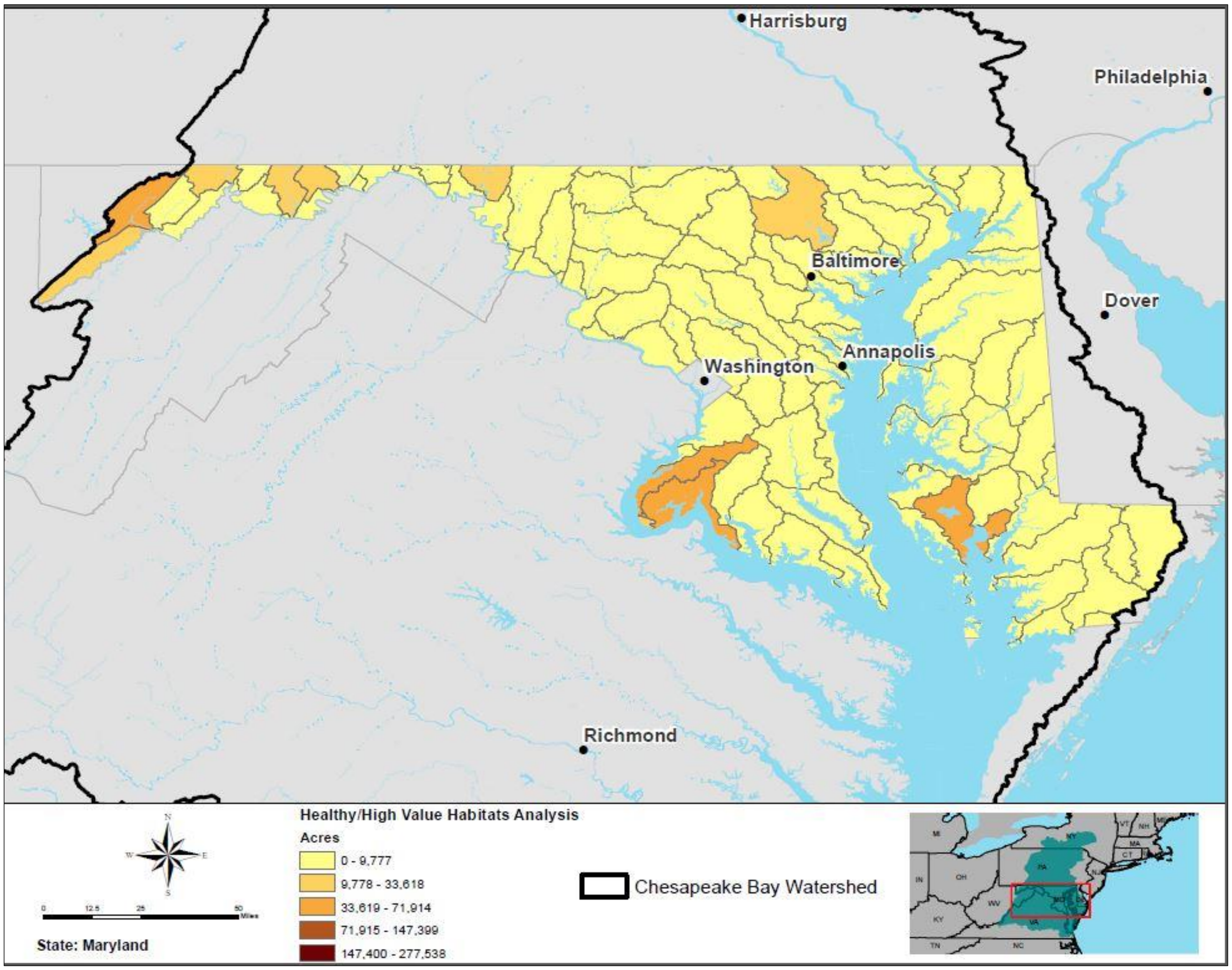

Figure 27. Locations of healthy/high value habitats in Maryland

Land Conservation Goal

2.5 Land Conservation Goal

> "*Conserve landscapes treasured by citizens in order to maintain water quality and habitat; sustain working forests, farms and maritime communities; and conserve lands of cultural, indigenous and community value."*

2.5.1 Outcome: Protected Lands

> *"By 2025, protect an additional two million acres of lands throughout the watershed – currently identified as high-conservation priorities at the federal, state or local level – including 225,000 acres of wetlands and 695,000 acres of forestland of highest value for maintaining water quality."*

The purpose of the Conservation Opportunities Assessment was to identify habitats in need of potential conservation. Areas in potential need of conservation consist of healthy/high value habitats that are currently not conserved and potential habitat enhancement and restoration areas that align with conservation initiatives.

The following data were used in the Conservation Opportunities Assessment (see the Planning Analysis Appendix for more details on the data used):

- *Healthy/High Value Habitats Opportunities Assessment Results* (CBCP)
- *Protected Lands Dataset* (CBP)

Results of the Conservation Opportunities Assessment for Maryland are depicted on Figure 28 and in Table A14.

Conservation *Opportunities* of healthy/high value habitats are in the Nanjemoy Creek-Potomac River (HUC 0207000308), Savage River (HUC 0207000201), Stony River-North Branch Potomac River (HUC 0207000202), and Potomac Creek-Potomac River (HUC 0207001102) subwatersheds.

The Healthy/High Value Habitats Opportunities Assessment was then overlaid with the following layers to identify those prime habitat enhancement and restoration opportunities that align with conservation initiatives:

- *Habitat Restoration Compilation including the Stream Restoration Riparian Buffer Restoration Opportunities Assessment Results* (CBCP)
- *Wetlands Restoration and Enhancement Compiled Opportunities Assessment Results* (CBCP)

Results of this assessment for Maryland are shown in Figures 29 through 32 and in Table A14. Unique analyses were completed to evaluate opportunities to conserve nontidal wetland enhancement and restoration opportunities, respectively (Figures 29 and 30) as well as tidal wetland enhancement and restoration opportunities, respectively (Figures 31 and 32).

All subwatersheds identified with high overlap of conservation and wetland restoration *Opportunities* (nontidal and tidal) also have been identified as habitat restoration focus subwatersheds. All subwatersheds identified with high overlap of conservation and wetland enhancement (existing wetlands) (nontidal and tidal) *Opportunities* also have been identified as habitat restoration focus subwatersheds.

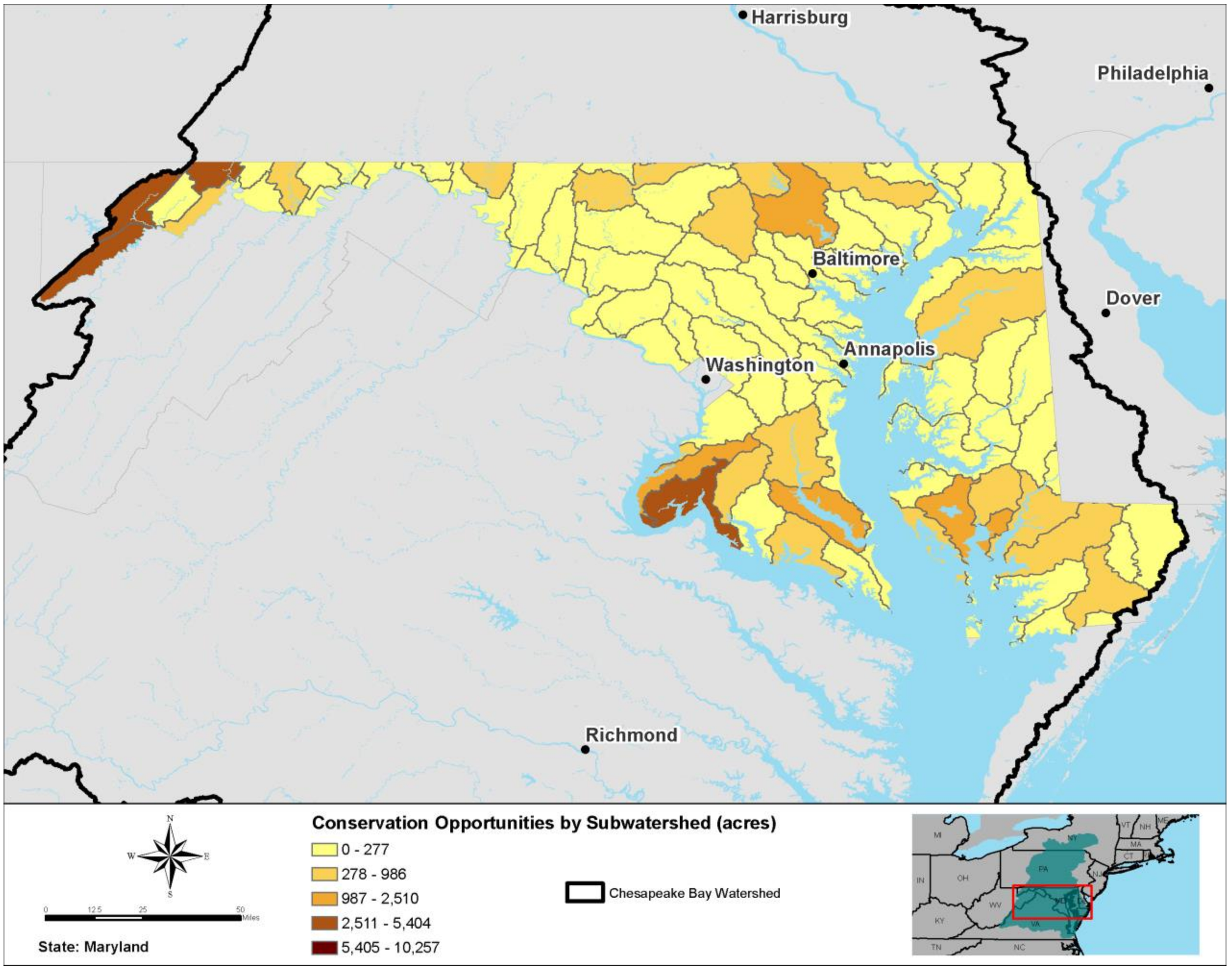

Figure 28. Conservation *Opportunities* Assessment for Maryland

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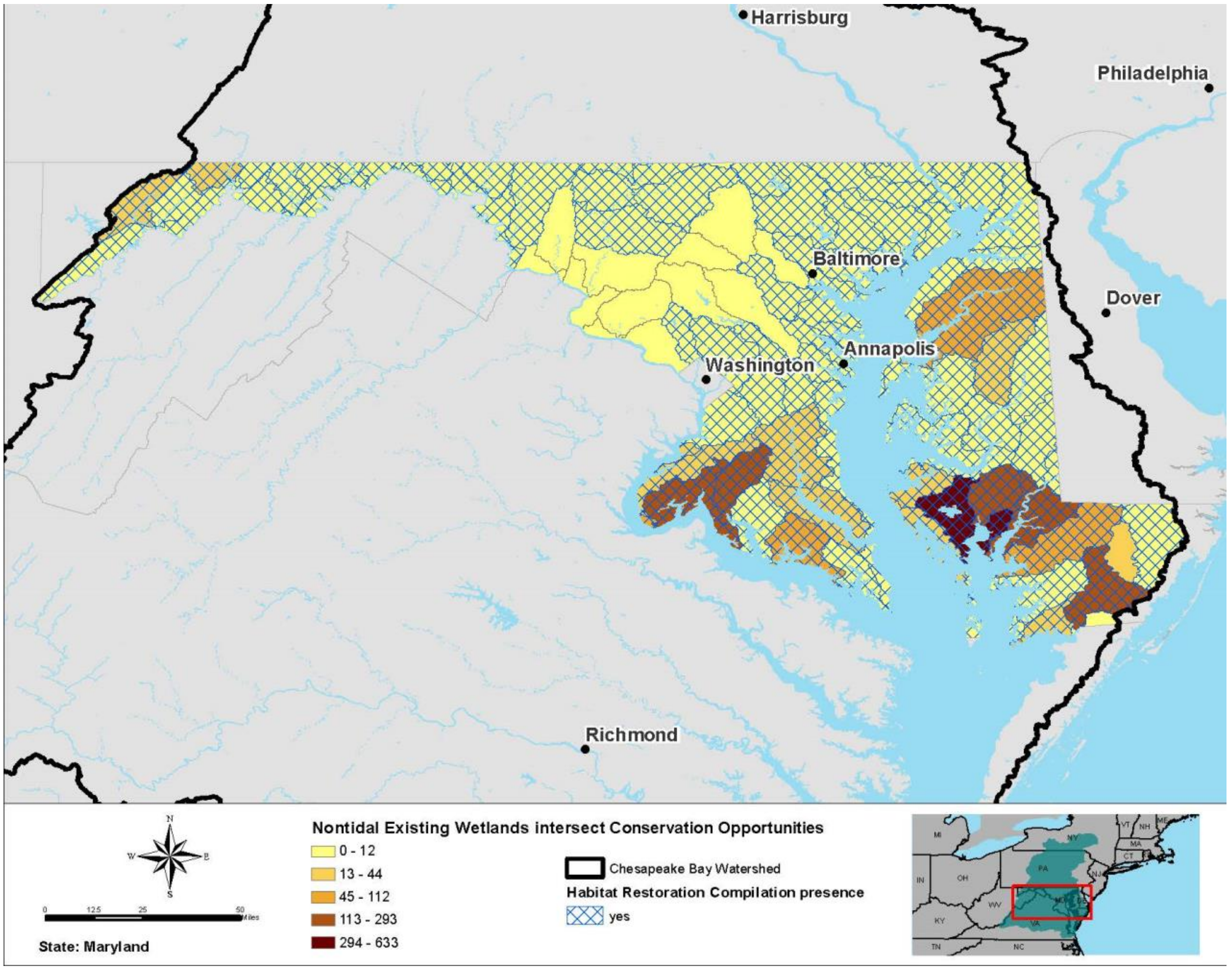

Figure 29. Conservation and nontidal wetland enhancement *Opportunities* compared to habitat restoration in Maryland

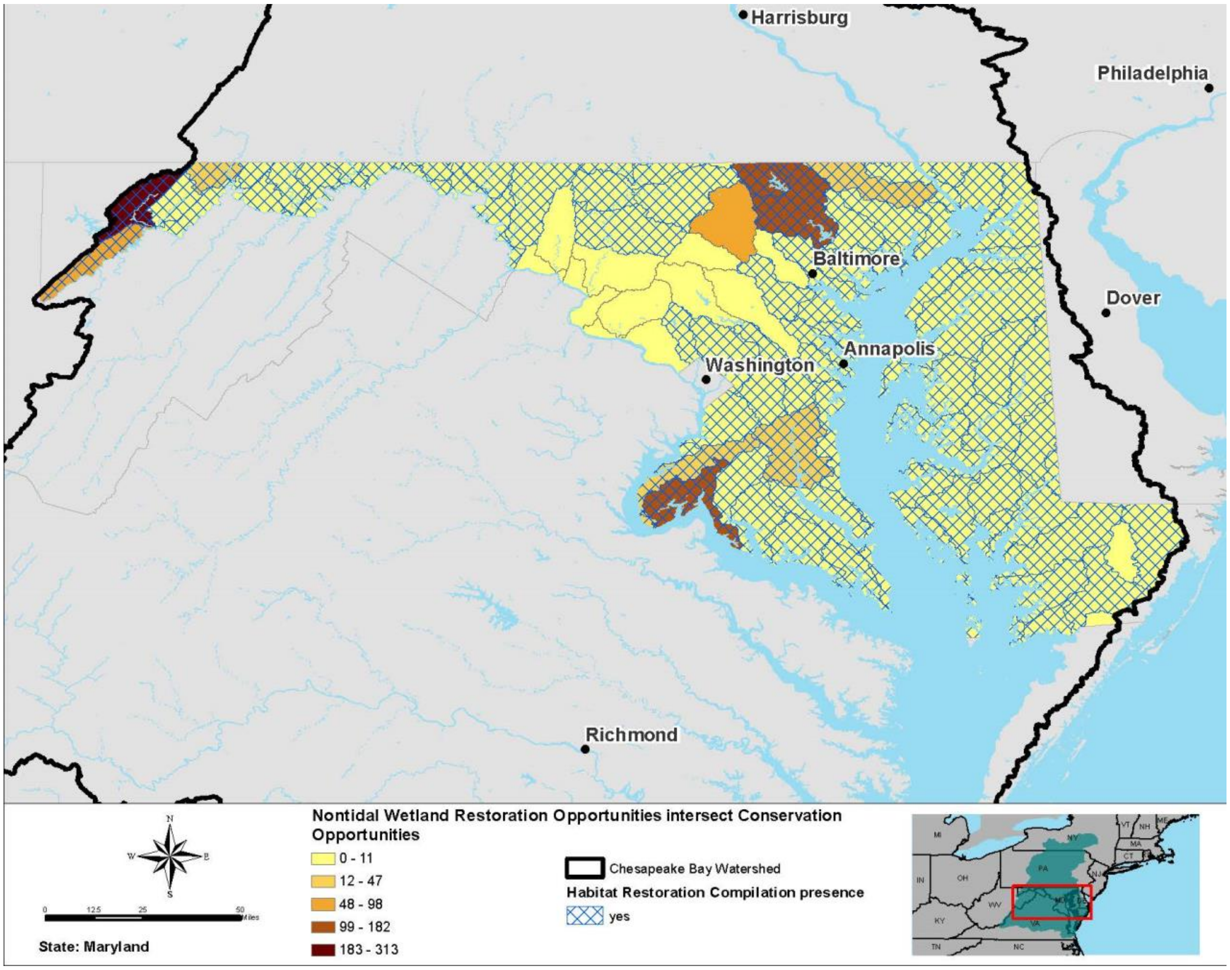

Figure 30. Conservation and nontidal wetland restoration *Opportunities* compared to habitat restoration in Maryland

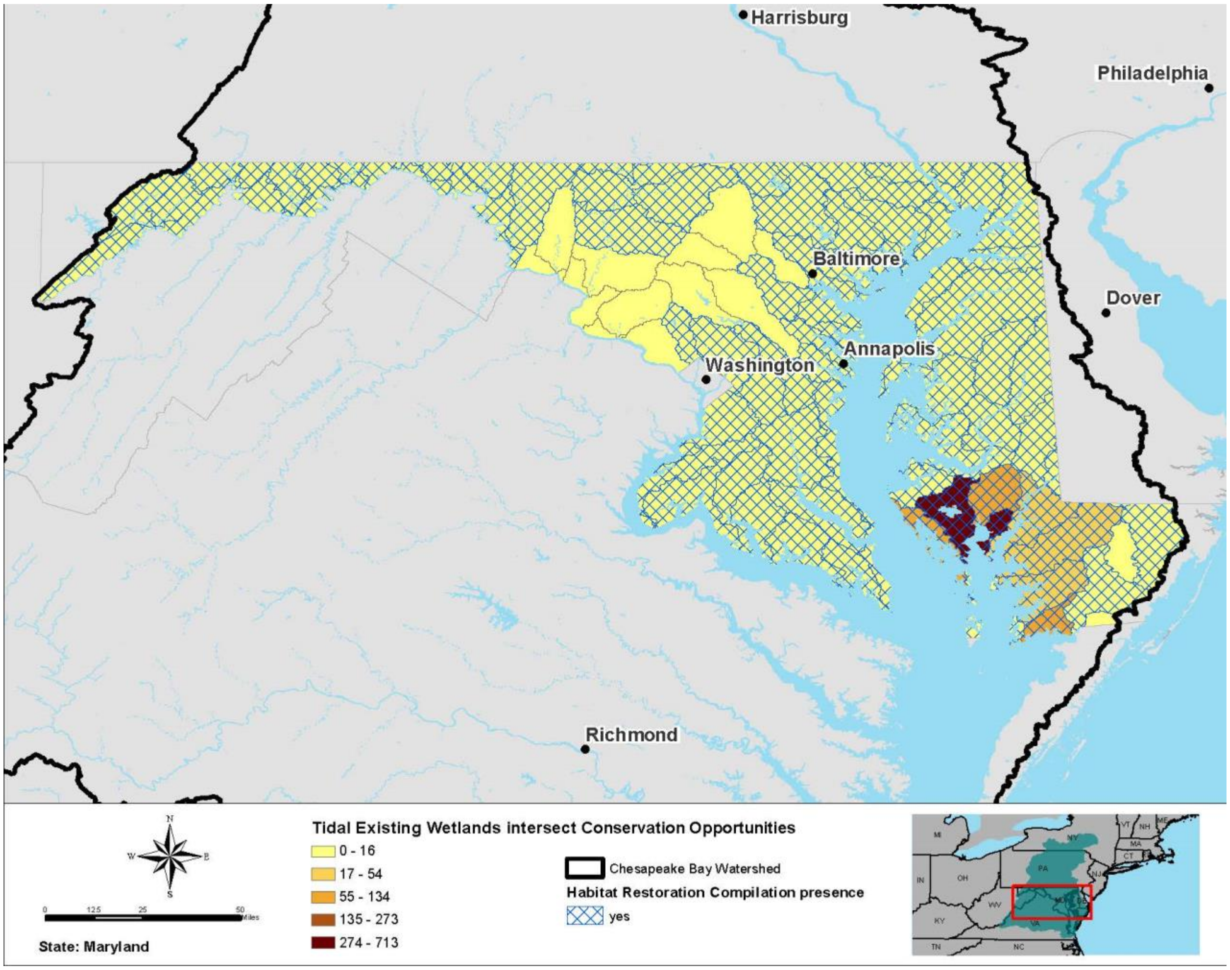

Figure 31. Conservation and tidal wetland enhancement *Opportunities* compared to habitat restoration in Maryland

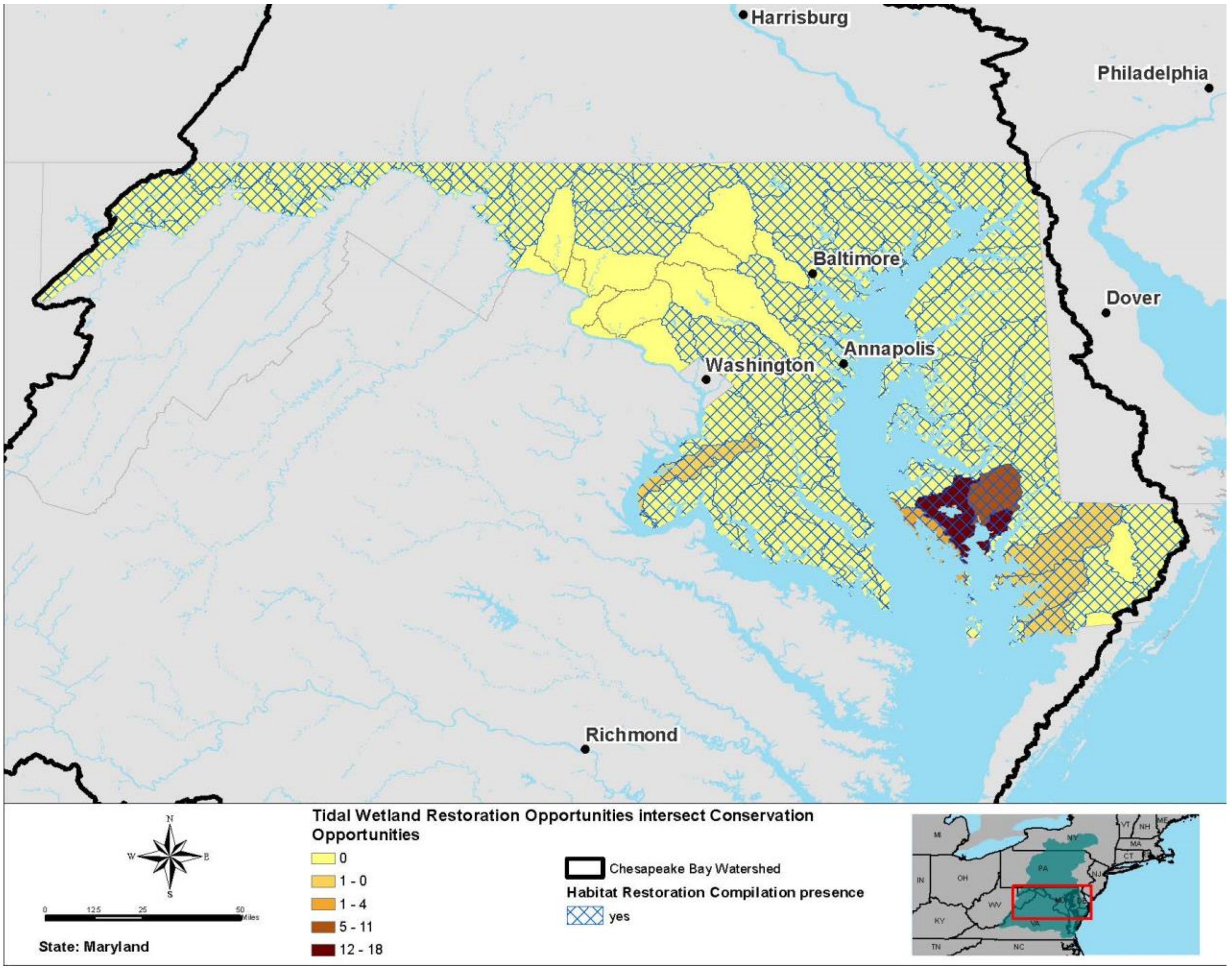

Figure 32. Conservation and tidal wetland restoration *Opportunities* compared to habitat restoration in Maryland

2.6 Public Access Goal

> "*Expand public access to the Chesapeake Bay and its tributaries through existing and new local, state, and federal parks, refuges, reserves, trails and partner sites.*"

2.6.1 Outcome: Public Access Site Development

> *"By 2025, add 300 new public access sites to the Chesapeake Bay watershed, with a strong emphasis on providing opportunities for boating, swimming and fishing, where feasible."*

The Socioeconomic Analysis synthesizes information that reflects societal use of resources within the Chesapeake Bay Watershed. The compilation characterizes the locations in the watershed that are important for recreation and public access, water supply, and source water protection and those areas where underserved populations are located.

The following data were used in the Socioeconomic Analysis (see the Planning Analysis Appendix for more *details on the data used):*

- *Locations of national, state, and local parks*
- *Public access points* (Nationally designated trails, existing and proposed public access sites compiled by the CBP)
- *Underserved populations* (Minority and low-income populations provided by the CBP)
- *National Inventory of Dams* (Congressionally authorized database documenting dams in the U.S. and its territories; maintained and published by the USACE)
- *Locations of reservoirs* (Susquehanna River Basin Commission (SRBC))
- *Locations of water supply withdrawals in the Susquehanna River Basin (SRBC/Pennsylvania Boundary Dataset credited to USGS and the U.S. Department of Agriculture* (USDA) Natural Resources Conservation Services (NRCS))

Results of the Socioeconomic Analysis for Maryland are shown in Figure 33 and in Table A15.

In general, public access points are well distributed along major tributaries. There are few to no access points reported in Baltimore County, Maryland north of Baltimore City, Carroll County to the west of Baltimore County, and the westernmost subwatersheds in Maryland. Underserved (minority) populations are predominantly located on the Western Shore and inland areas of Maryland as well as the Delmarva Peninsula. The greatest concentration of park lands is located to the west of Baltimore, Maryland and Washington, D.C.

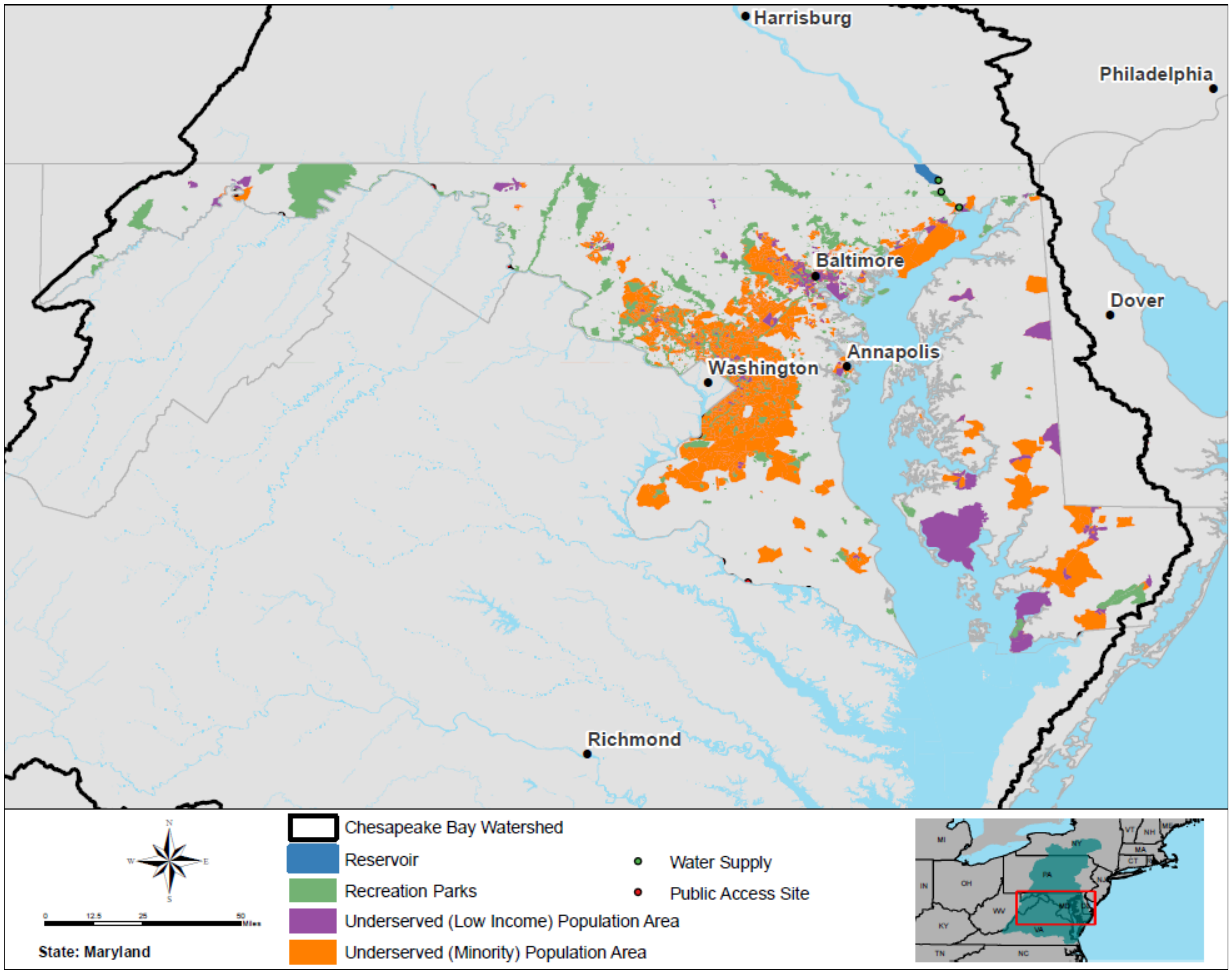

Figure 33. Socioeconomic analysis for Maryland

The following data were used to determine where conservation may provide societal benefits to the public:

- *Conservation Opportunities Assessment Results* (CBCP)
- *Socioeconomic Analysis Results* (CBCP)

The results of this analysis are shown in Figure 34 and Table A15. Subwatersheds that have the greatest overlap between conservation *Opportunities* (unprotected healthy habitats) and socioeconomic resources are primarily located in the Potomac River basin and Dorchester County, Maryland. Undertaking conservation in these areas has the potential to provide societal benefits. A second overlap is just east of Washington D.C., along the Patuxent River.

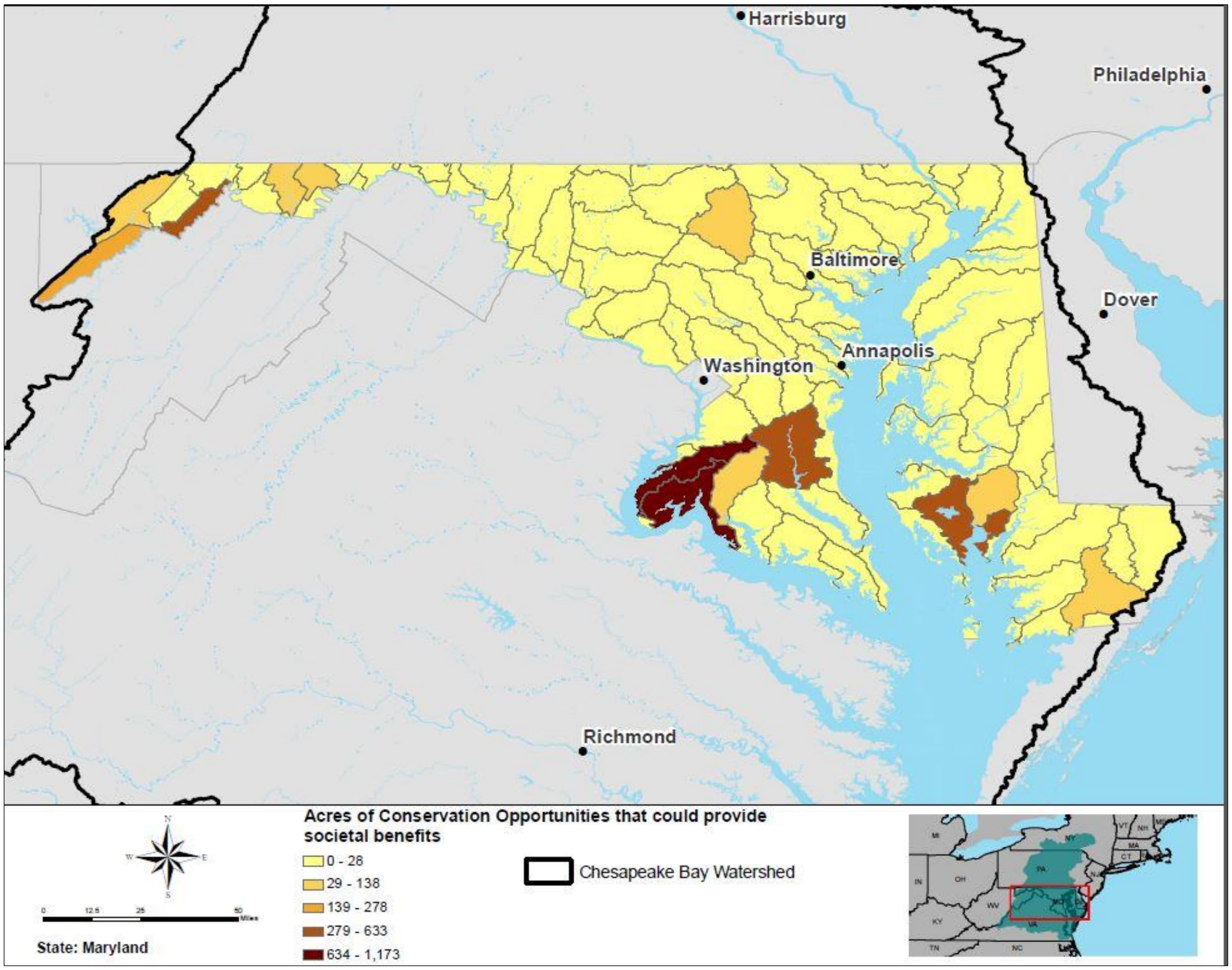

Figure 34. Conservation *Opportunities* that could provide societal benefits in Maryland

US Army Corps of Engineers

2.7 Climate Resiliency Goal

"Increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure and communities, to withstand the adverse impacts from changing environmental and climate conditions."

2.7.1 Outcome: Climate Adaptation

"Continually pursue, design and construct restoration and protection projects to enhance the resiliency of the Chesapeake Bay and its aquatic ecosystems against the impacts of coastal storm erosion, coastal flooding, more intense and more frequent storms, and sea level rise."

This compilation identifies the areas within the watershed threated by urbanization and climate change, as well as which areas are prone to increased/persistent flooding in the future. Nontidal threats are evaluated separately from tidal threats.

The following data was used in the Nontidal Watershed Threats Analysis (see the Planning Analysis Appendix for more details on the data used):

- *Nontidal flooding* (USGS)
- *Future projected development* (USACE North Atlantic Coast Comprehensive Study (NACCS))
- *National Fish Habitat Assessment* (NFHAP)

Results of the Nontidal Watershed Threats Analysis for Maryland are shown in Figure 35 and in Table A16. The threats analysis incorporates factors, including nontidal flooding, future projected development, and the National Fish Habitat Assessment to determine areas that could be impacted by increased flooding in the future. In general terms, the northern and western portions of the subwatersheds are at minimal risk to future nontidal threats. The subwatersheds that have the largest acreage at risk to nontidal threats are subwatersheds west of Baltimore, Maryland and north and west of Washington, D.C.

The following data was used in the Tidal Watershed Threats Analysis (see the Planning Analysis Appendix for more details on the data used):

- *Areas projected to have more frequent "normal" flooding* (NACCS and USGS)
- *Future projected development* (NACCS)
- *Sea level rise curves* (USGS Sea Level Rise Calculator)
- *Resources at risk to coastal storms* (NACCS)
- *Coastal vulnerability index* (USGS)

Results of the Nontidal Watershed Threats Analysis for Maryland are shown in Figure 35 and in Table A16. The areas with the highest exposure of land to tidal threats are the Lower Choptank River (HUC 0206000505), Blackwater River (HUC 0208011002), and Manokin River (HUC 0208011004) subwatersheds. Tidal subwatersheds along the mainstem of Chesapeake Bay below

Annapolis also have large acreages exposed to tidal threats. This area includes those subwatersheds below the South River in Maryland on the Western Shore. The subwatersheds that line the mid-western shore in Maryland are at moderate risk.

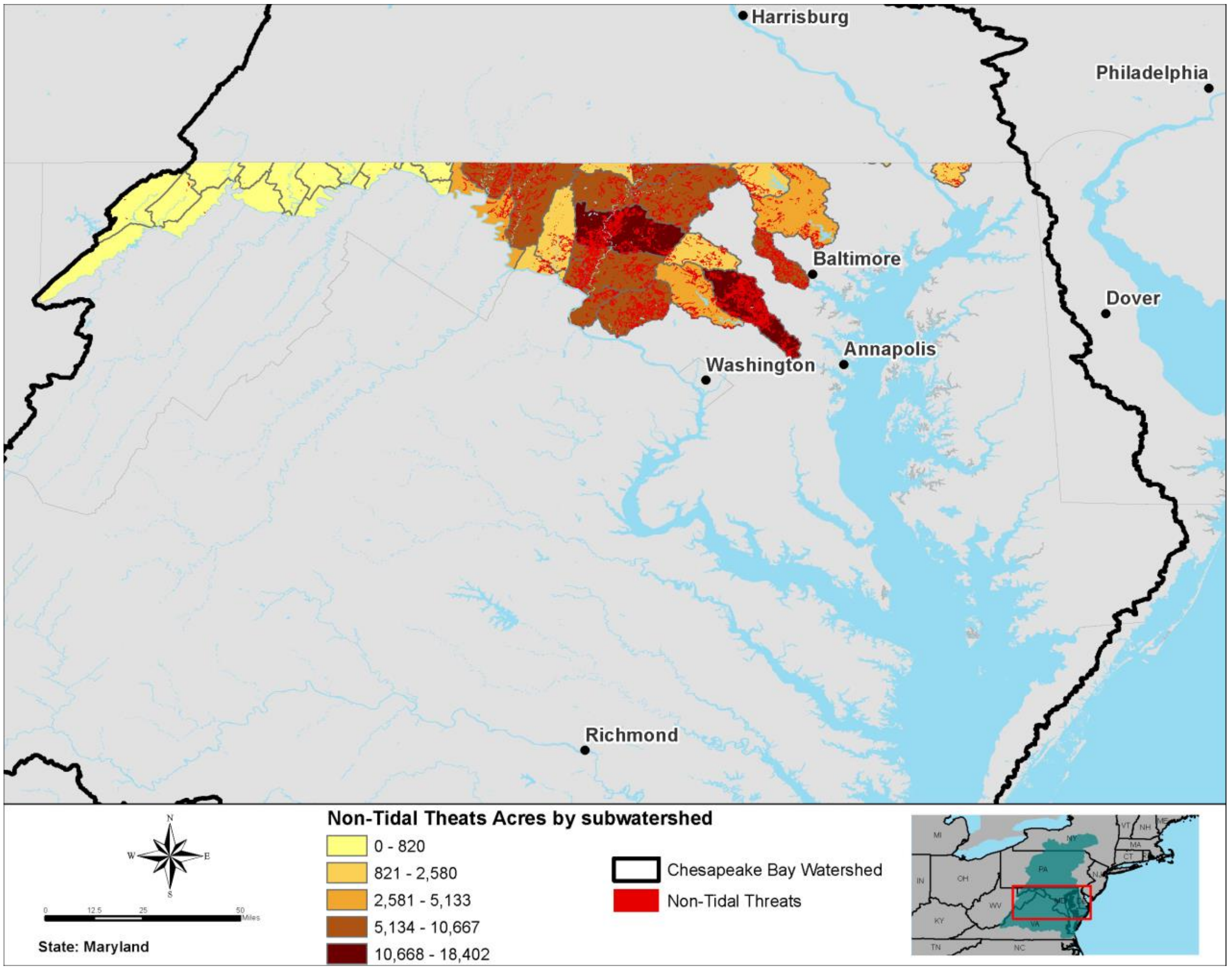

Figure 35. Nontidal watershed threats analysis for Maryland

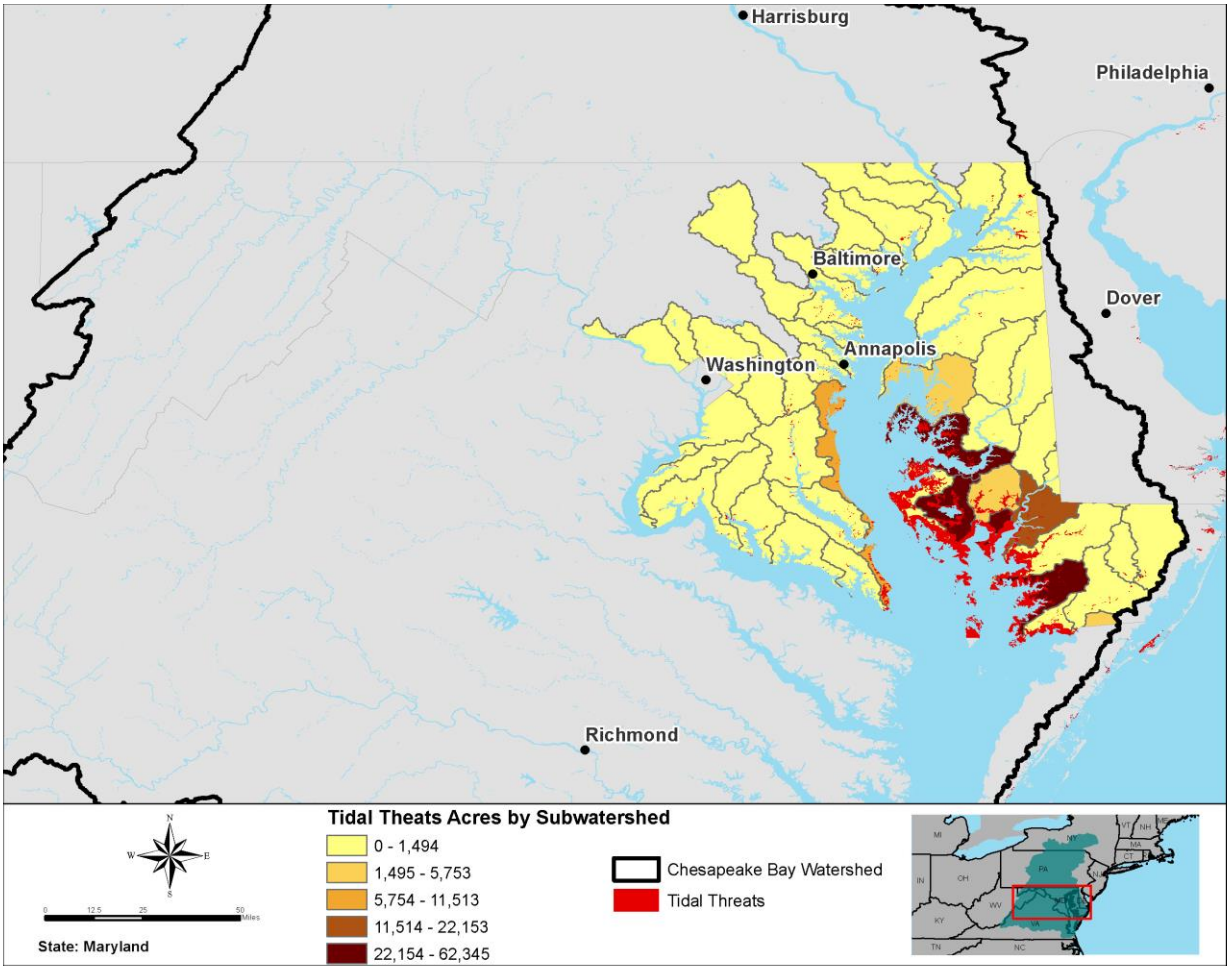

Figure 36. Tidal watershed threats analysis for Maryland

SECTION 3

WATERSHED PLANNING CONSIDERATIONS OUTSIDE THE 2014 BAY AGREEMENT

3.1 Rare, Threatened, and Endangered Species and USFWS Species of Concern

The following maps (Figures 37 through 40) display areas in Maryland that have federally listed rare, threatened, and endangered species as well as species identified as critical by the USFWS. The species have been placed into categories–aquatic, beach, stream, and wetland dependent. The following maps display the number of species per subwatershed that fall into the aquatic (Figure 37), beach (Figure 38), stream (Figure 39), or wetland (Figure 40) categories and whether they are federally listed, critical, or both.

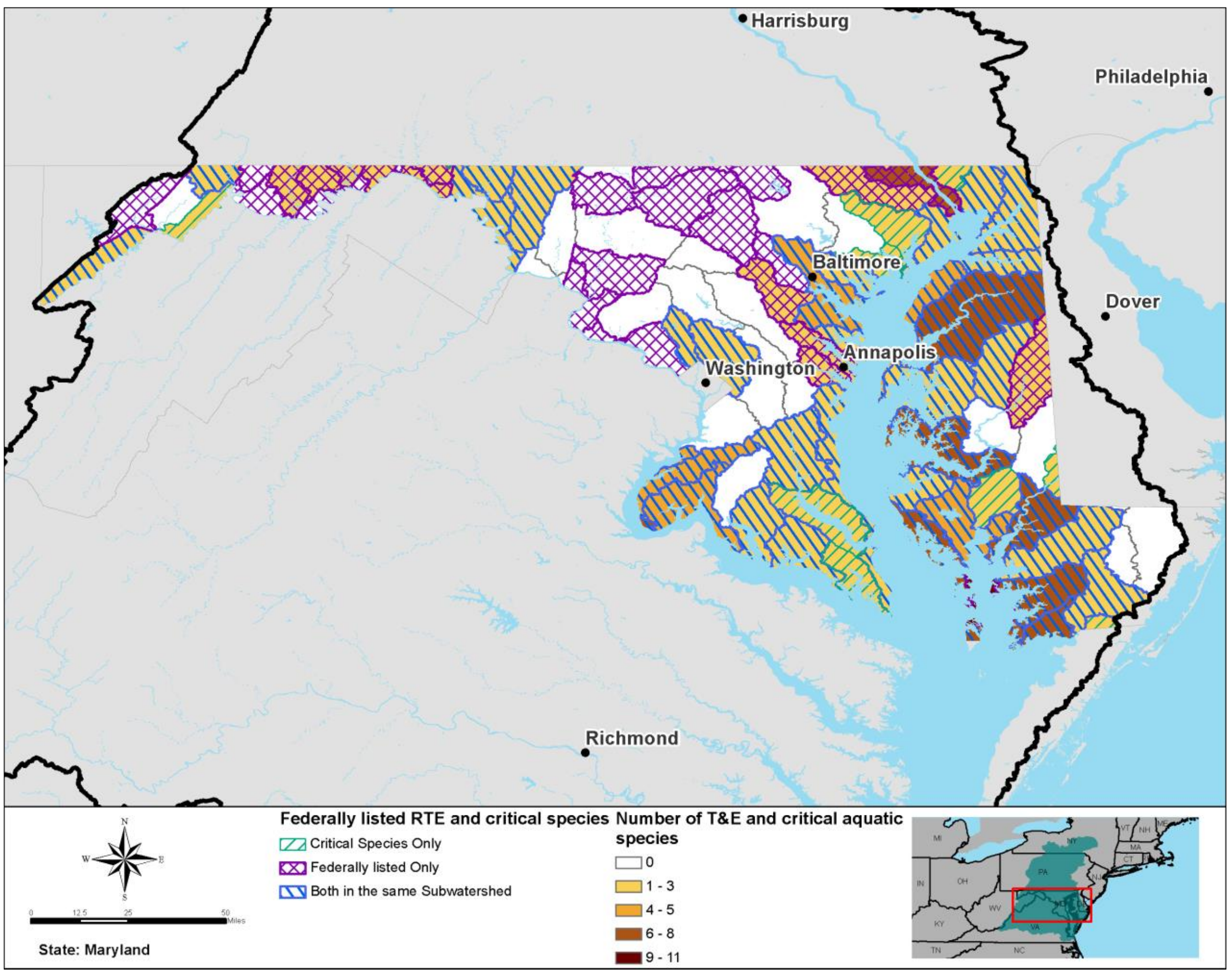

Figure 37. Occurrence of rate, threatened, and endangered, and U.S. Fish and Wildlife Service critical aquatic species in Maryland

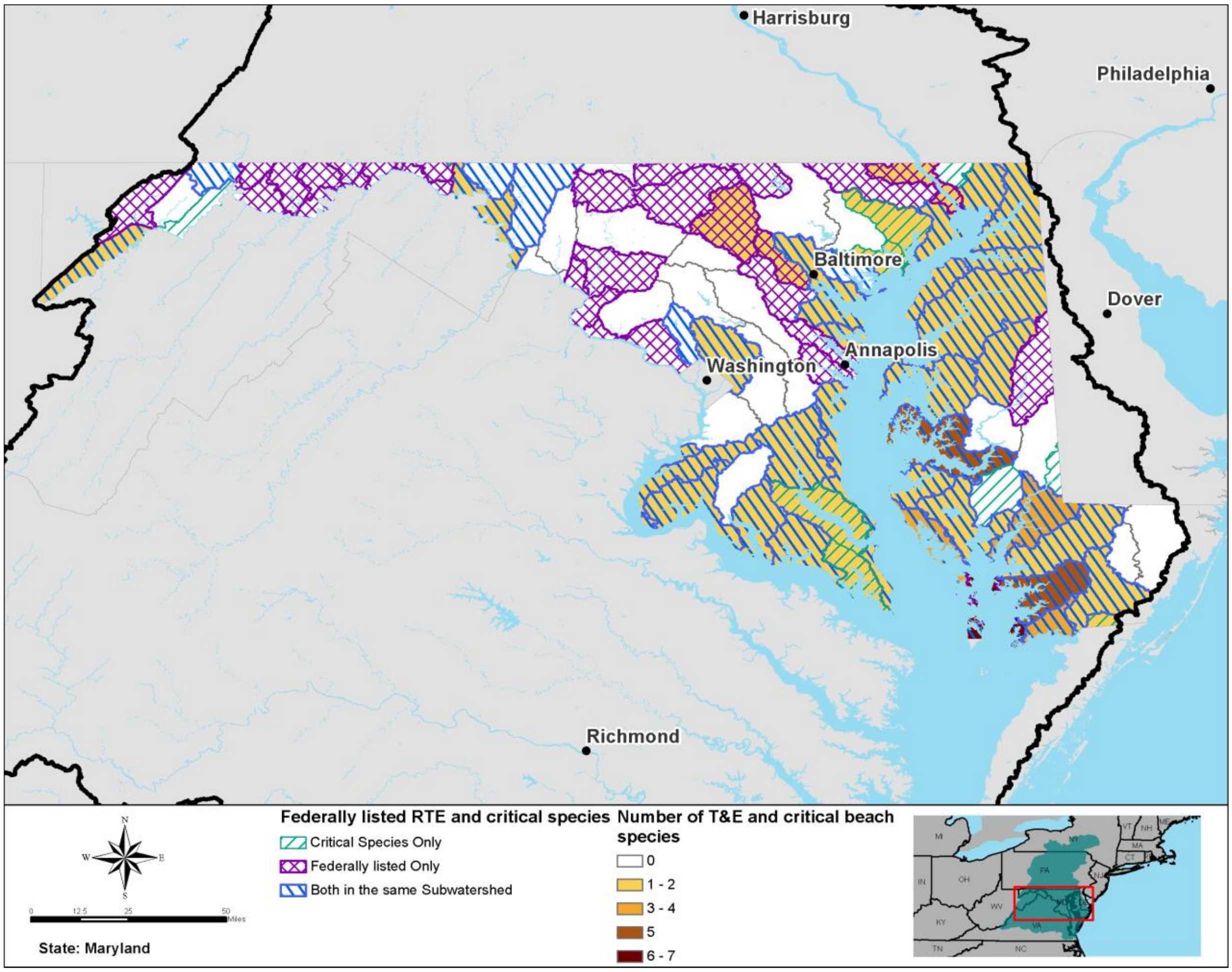

Figure 38. Occurrence of rare, threatened and endangered, and U.S. Fish and Wildlife Service critical beach species in Maryland

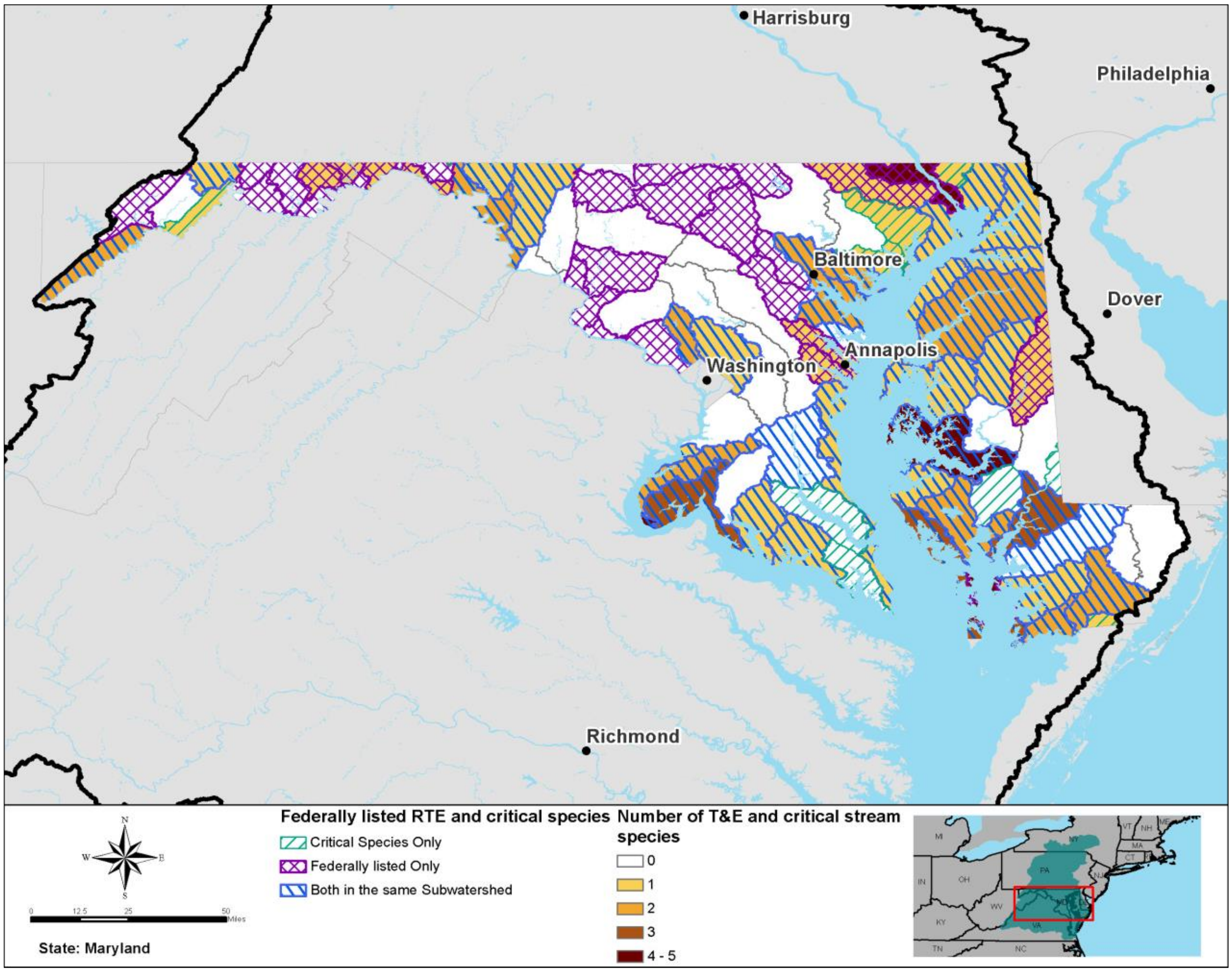

Figure 39. Occurrence of rare, threatened, and endangered, and U.S. Fish and Wildlife Service critical stream species in Maryland

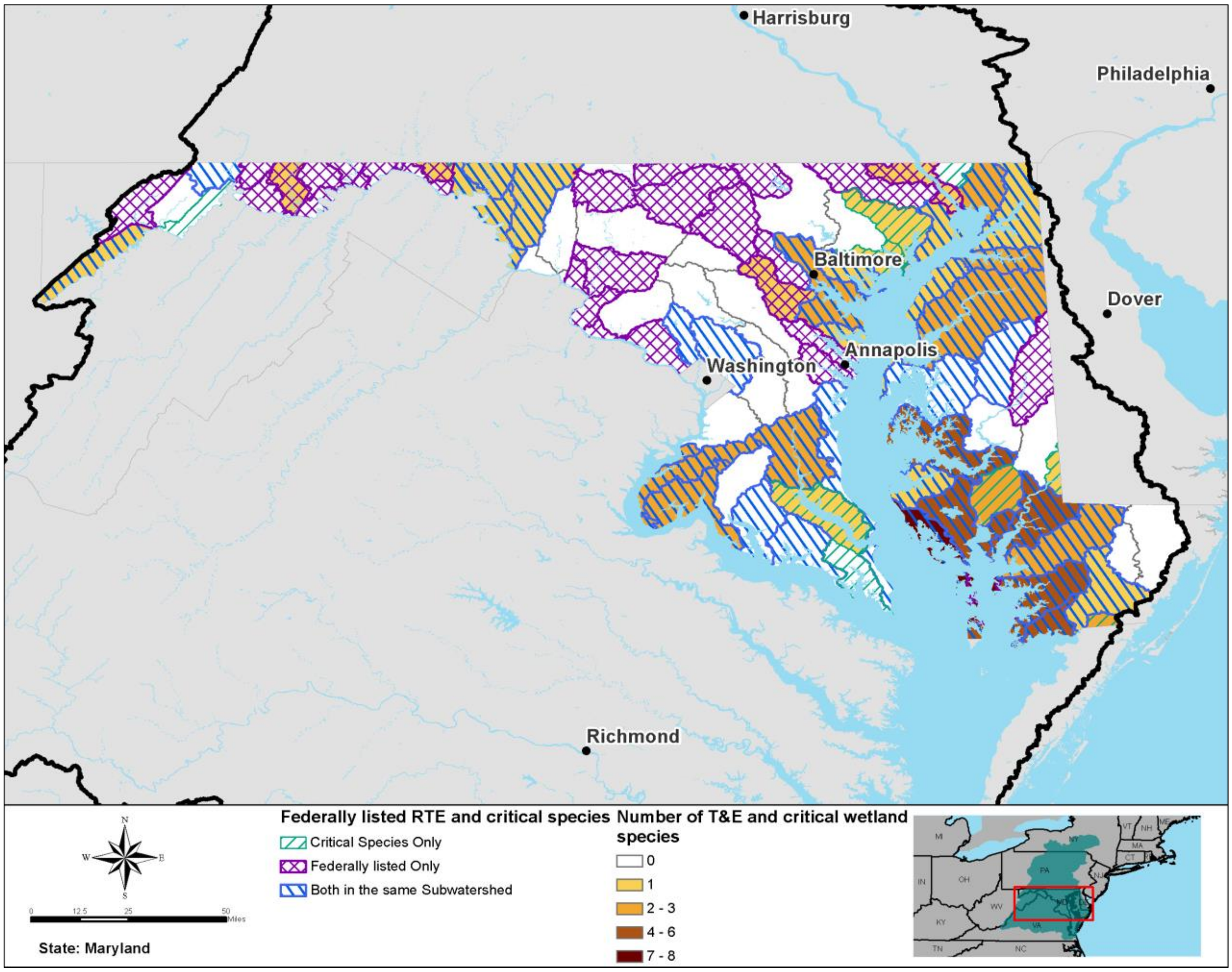

Figure 40. Occurrence of rare, threatened and endangered, and U.S. Fish and Wildlife Service critical wetland species in Maryland

3.2 Wetland Migration

As sea levels rise, the ability of a marsh (wetland) to migrate inland will be an important factor determining the future location of tidal wetlands. NOAA (2015) developed a model based on previous work by TNC that evaluates the potential for tidal wetlands to migrate inland. A cost distance approach was taken which considers elevation and land use adjacent to existing wetlands to estimate the inland migration potential. For this analysis the following geospatial data layers were used (see the Planning Analysis Appendix for definitions of each category):

- *Marsh migration* (NOAA 2015)
- *Tidal wetland enhancement Opportunity Assessment* (CBCP)
- *Tidal wetlands restoration Opportunity Assessment* (CBCP)

The results of NOAA's modeling were incorporated with CBCP analyses as described below. The intent was to identify where wetland restoration *Opportunities* should consider inland migration corridors.

The analysis investigated which subwatersheds have the highest potential for wetland migration by tallying the lowest migration cost acres greens and blues) in each subwatershed. The results are presented in Figure 41 and Table A17. The connectivity of migration corridors was evaluated by overlaying the existing wetlands layer with the migration analysis (Figure 42). Finally, the potential to utilize wetland restoration to restore migration corridors was evaluated by overlaying the migration data and the tidal wetland restoration Opportunities (Figure 43).

The upper/middle Eastern Shore of Maryland region is a focal location for low cost wetland migration: Chester River, Eastern Bay, Lower Choptank, and the Transquaking River. The Lower Patuxent, Middle Choptank, Nanticoke, Blackwater River, and the Little Choptank River subwatersheds are also areas where wetland migration may be possible on a meaningful scale. The wetlands in the Blackwater/Tangier Sound region have vast opportunities for wetlands restoration in that area, as well as potential for low cost wetland migration.

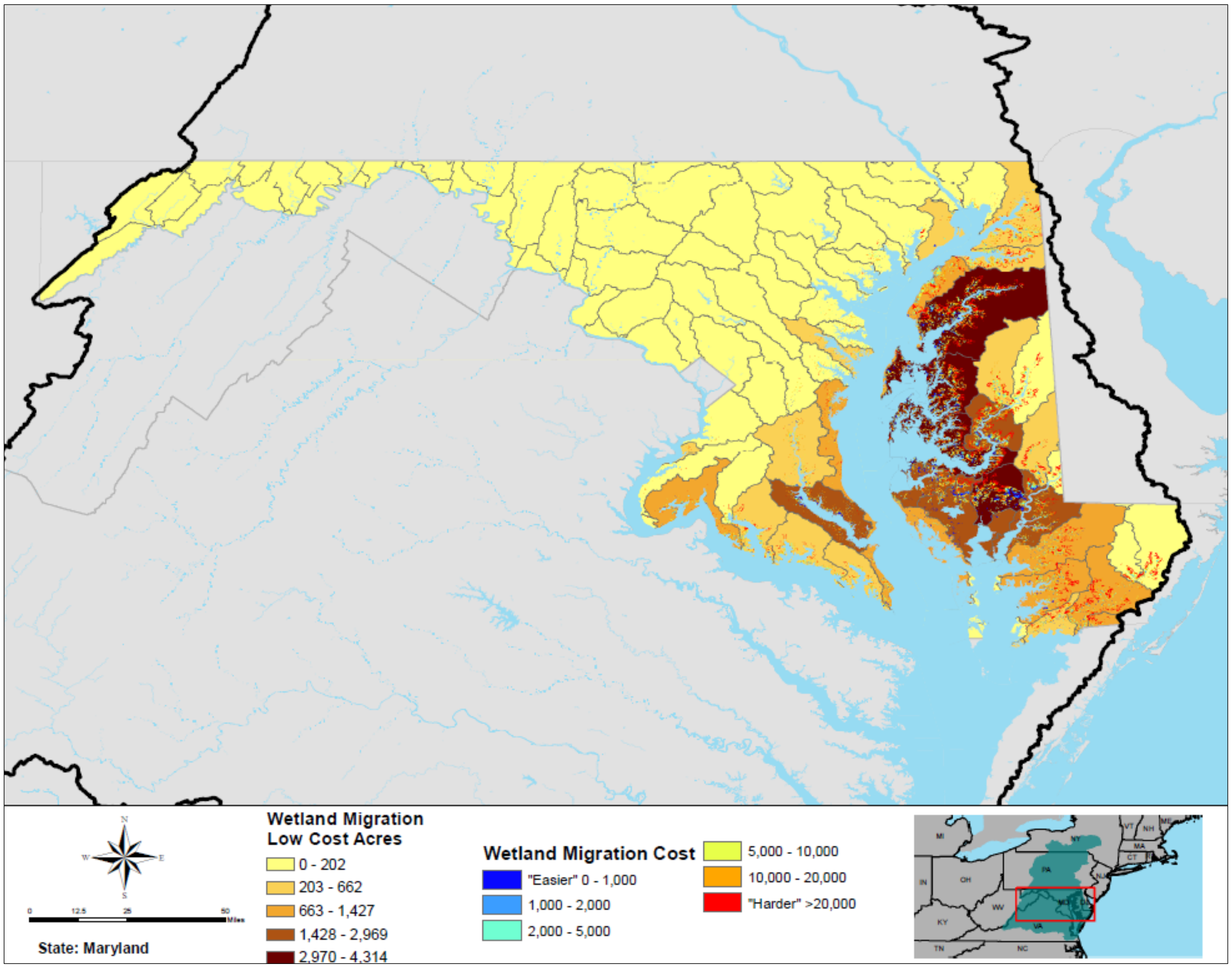

Figure 41. Wetland migration cost for Maryland

US Army Corps of Engineers

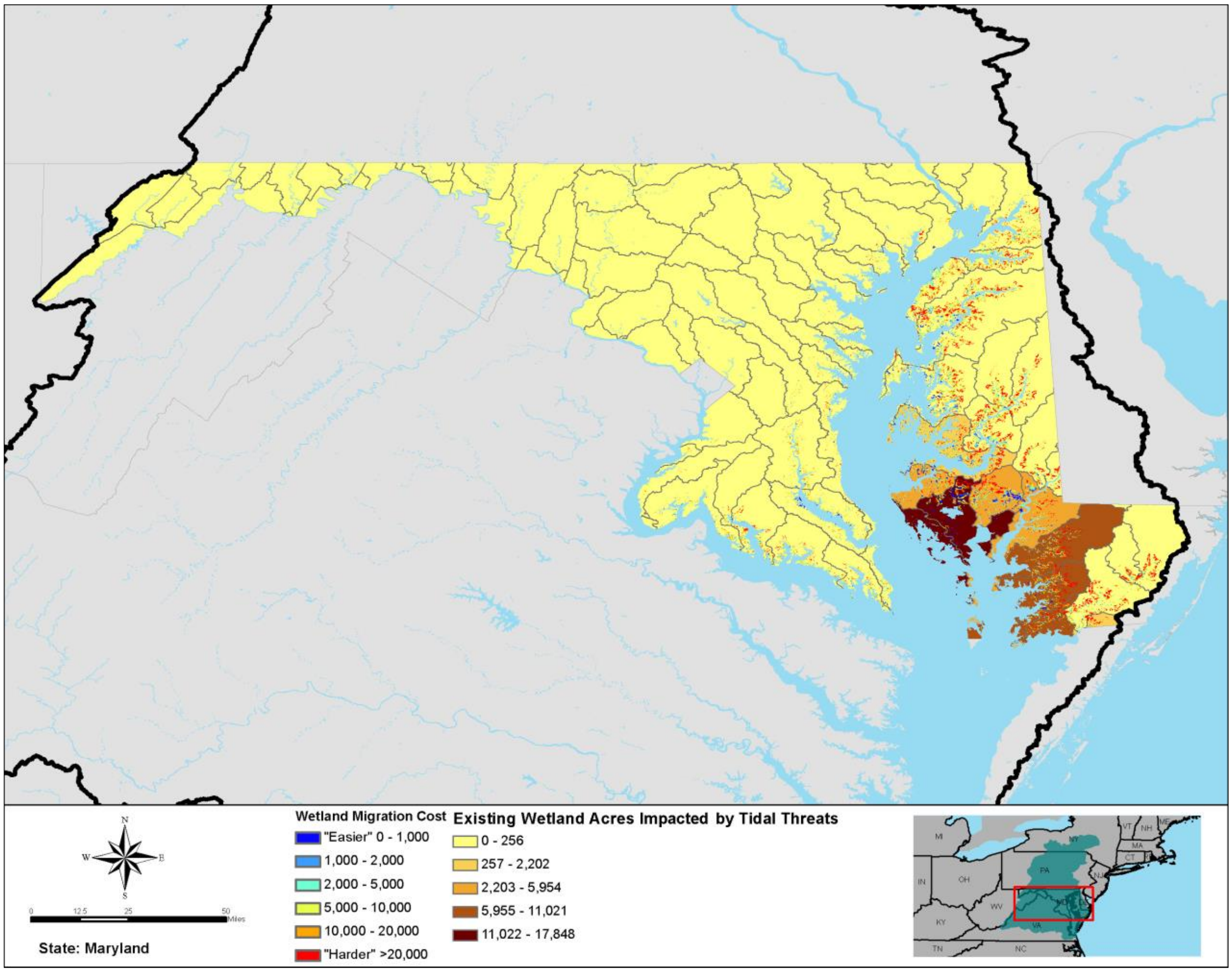

Figure 42. Wetland migration cost and existing wetlands in Maryland

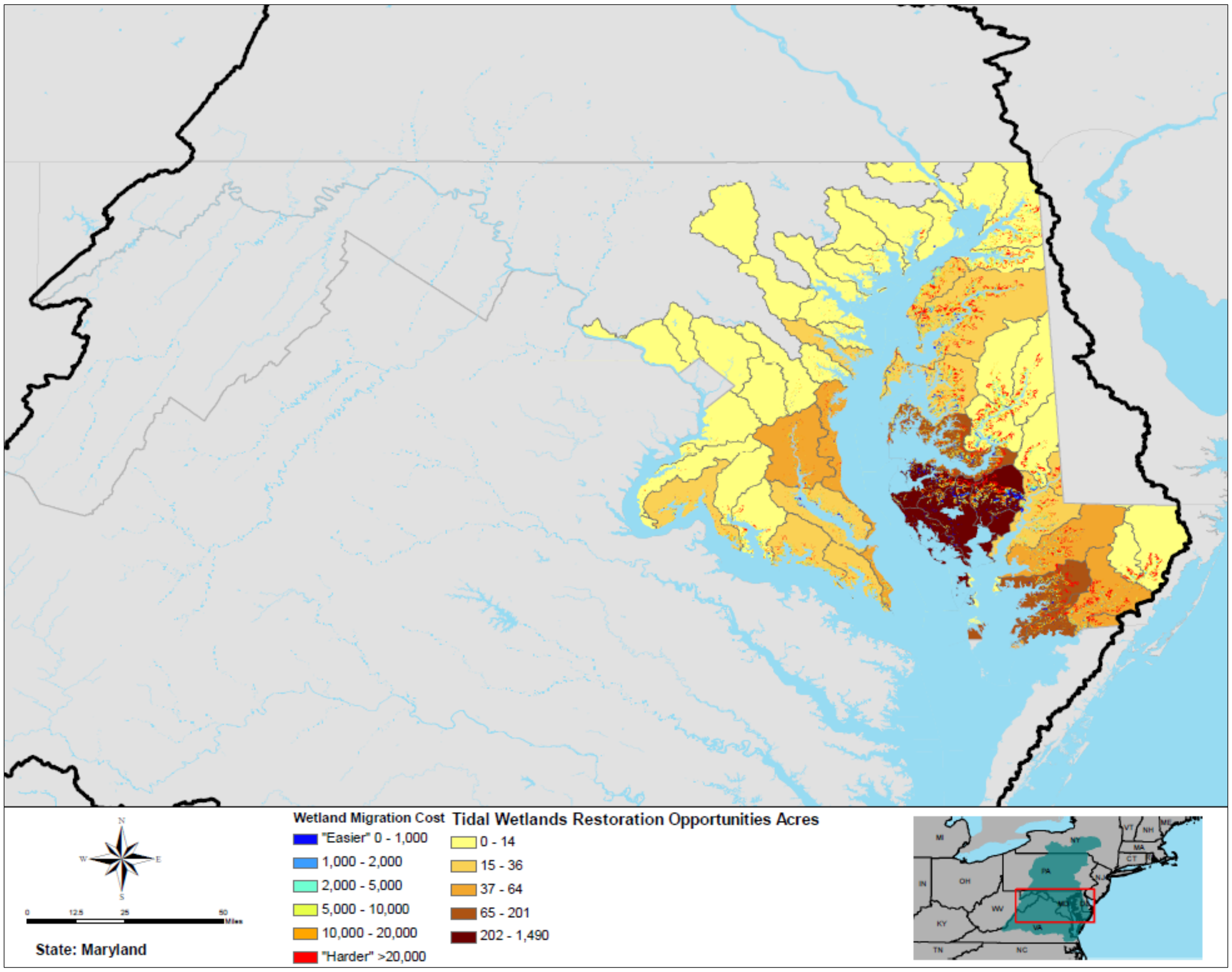

Figure 43. Wetland migration cost and wetland restoration Opportunities in Maryland

3.3 Regional Flow and Connectivity

Nature's Network developed data that characterizes the ability of flora and fauna to move across the landscape. This regional flow data characterizes areas within a range of constrained flow to high diffuse flow (see the Planning Analysis Appendix for definitions of each category). The purpose of this analysis is to discern where there are important areas of regional flow, as determined by TNC (2016), which could benefit from tidal and/or nontidal wetland restoration. By aligning areas for potential wetland restoration with regional flow, opportunities to improve connectivity and ease of passage are identified. To investigate this concept, the CBCP overlaid the combined wetland restoration Opportunities with this regional flow data (Figure 44 and Table A18). The acreage that is identified by Nature's Network as being a regional flow corridor of any degree was summed within each subwatershed. Those subwatersheds with the greatest overlap between wetland restoration Opportunity (acres) and regional flow data include: Stony River-North Branch Potomac River (HUC 0207000202), Wills Creek (HUC 0207000205), Licking Creek (HUC 0207000403), Bald Cypress Branch-Pocomoke River (HUC 0208011102), the Middle Patuxent (HUC 0206000605), Dividing Creek-Pocomoke River (HUC 0208011103), Susquehanna River (HUC 0205030617), and West Branch Conococheague Creek (HUC 0207000406).

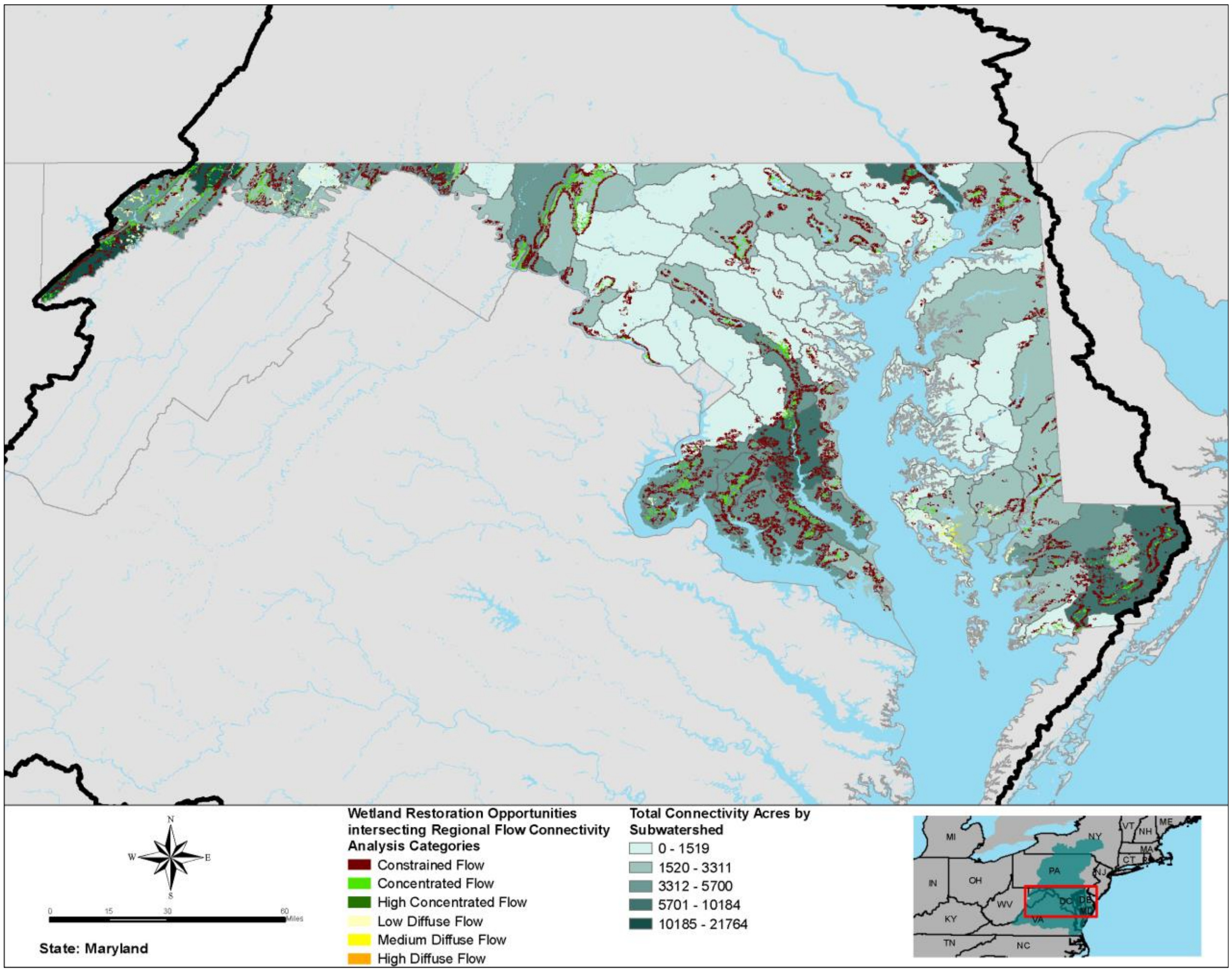

Figure 44. Wetland restoration Opportunities that could beneficially impact regional flow in Maryland

3.4 Road-Stream Crossings

A number of human activities can disrupt the continuity of river and stream ecosystems. The most familiar human-caused barriers are dams. Fish passage projects and dam removals have been a focus of the Chesapeake Bay Fish Passage Workgroup (FPWG) since 1989, and many dams and fish passage structures have been installed, opening thousands of miles of potential fish habitat. In recent years, there is growing concern about the role of road-stream crossings, especially culverts, in altering habitats, disrupting river and stream continuity, and blocking fish passage. Over 160,000 road-stream crossings exist in the Chesapeake Bay Watershed. In Maryland alone there are 23,490 road-stream crossings. However, few culverts in the Chesapeake Bay Watershed have been assessed for fish passage. Of those in Maryland, 2,319 culverts, approximately 10%, have been surveyed (Figure 45).

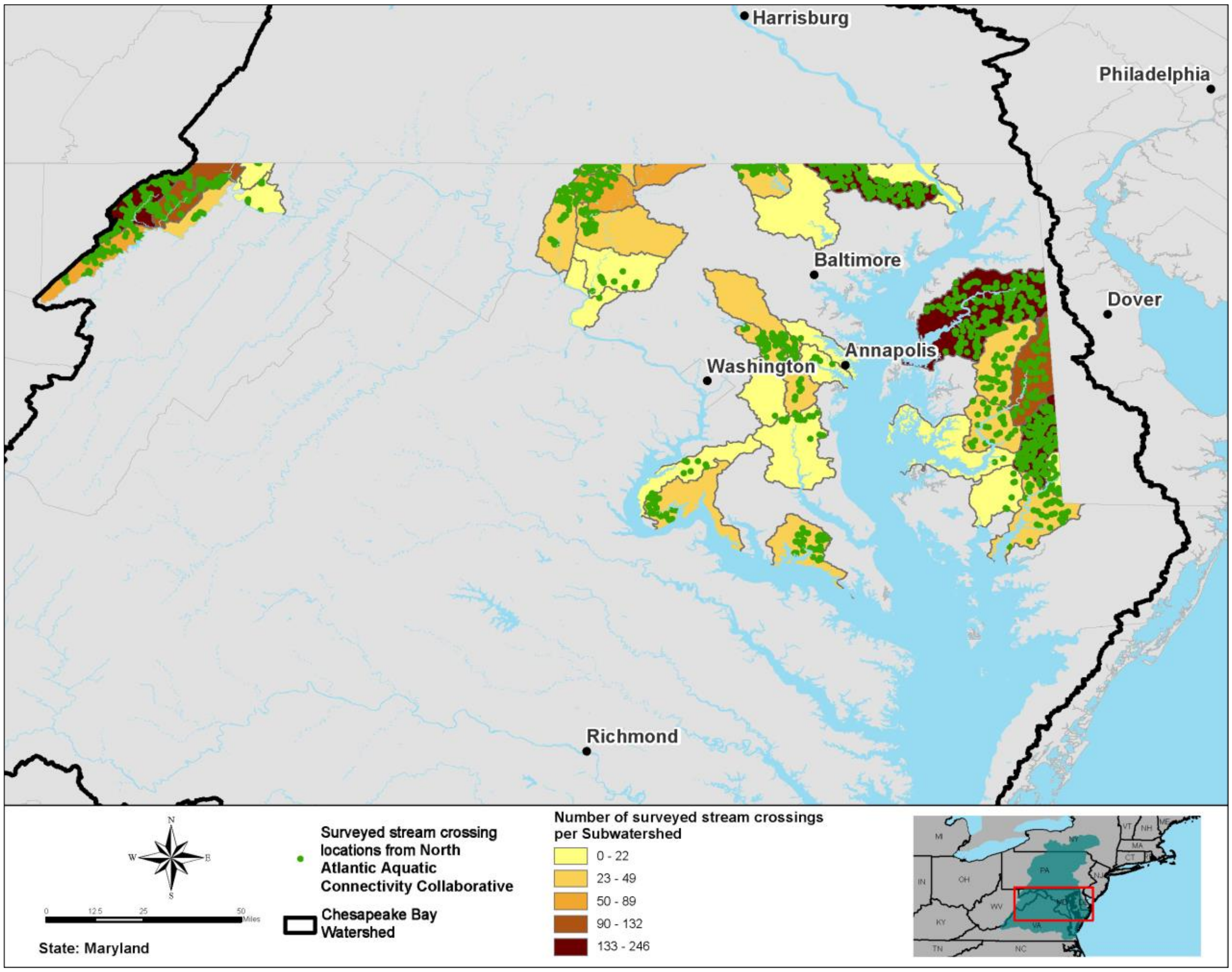

Figure 45. Surveyed stream crossings in Maryland

Given the sheer volume of potential fish blockages, funding and time constraints do not allow for assessment of all potential road crossings. In the past, culvert assessments have been focused near priority dam removal projects and in previously identified high priority watersheds, such as the Choptank River Habitat Focus Area. This was done as a cost savings measure and to conduct targeted restoration in watersheds that were previously designed for habitat restoration work.

More recently, road-stream crossings have been assessed using a regional assessment protocol developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC). The NAACC is a network of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving aquatic connectivity across a 13-state region, from Maine to West Virginia, and includes the Chesapeake Bay region. The goal of the collaborative is to assess stream crossings for flood resiliency and aquatic organism passage. Assessments using these methods in the Chesapeake Bay have focused on watersheds that are used by priority species including anadromous fish, brook trout, and endangered freshwater mussel species. While much progress has been made, additional road-stream crossing assessments are needed. Data are entered into the NAACC database and automatically assigned a passability score ranging from 0 (not passable) to 1 (fully passable). According to data collected in Maryland, over 50 percent of road-stream crossings pose some barrier to aquatic organism passage, but only about 27 percent of the crossings assessed are moderate, significant, or severe blockages (Figures 46 and 47).

Once assessments are complete, the FPWG pursues funding for design and implementation of removal or replacement for each of the priority blockages. Potential future projects for fish passage may include removal or retrofits to the existing roadways/culverts or implementation of more fish friendly designs such as bottomless culverts and bridges. These types of projects often have the added benefit of reduced flooding in the surrounding area. Damage to roadways during storm events is reduced, meaning less costly repairs and improved public safety. Identification of future projects is critical for meeting the fish passage outcome in the 2014 CBA, which includes opening 1,000 additional miles by 2025.

Although an individual stream crossing may appear to have a minor impact on the landscape, cumulatively the magnitude of the number of stream crossings within the Chesapeake Bay basin is significant to not only fish passage, but also to habitat connectivity and flooding. Going forward, stream crossings and their impact on the landscape should receive greater attention. When undertaking watershed restoration projects, stream crossings should be evaluated.

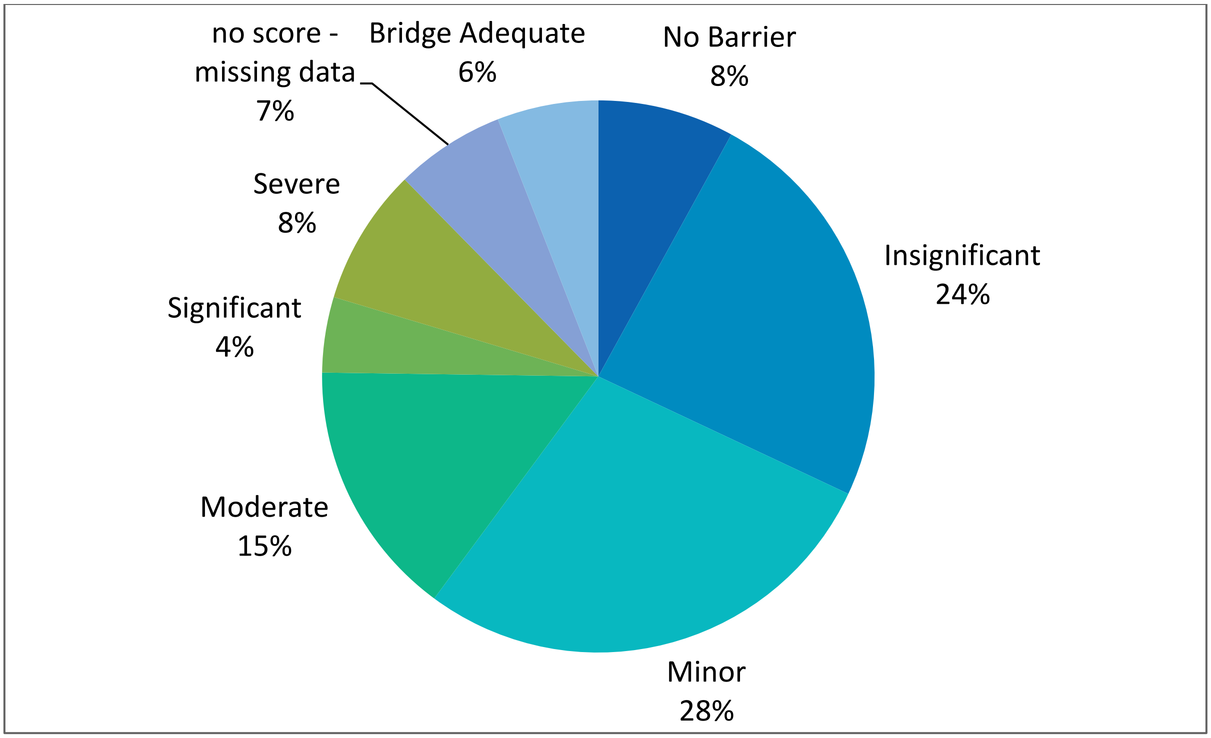

Figure 46. Fish passage blockage rating for stream crossings surveyed in Maryland

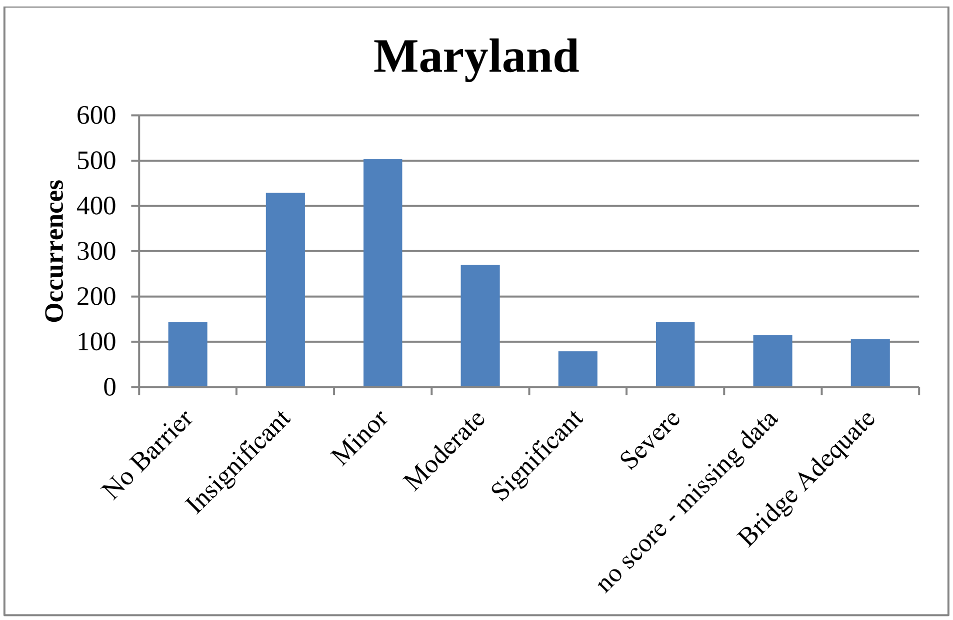

Figure 47. Occurrence of fish passage blockages surveyed in Maryland based on blockage rating

3.5 Shoreline Erosion

Shoreline erosion is a significant concern along the mainstem of the Chesapeake Bay in Maryland as sea levels rise and land continues to erode at a fast pace. The purpose of this analysis is to identify where wetland enhancement and restoration could be implemented to help address eroding shorelines. Alternatively, this evaluation will provide information to identify where potential projects are co-located in areas at risk to shoreline erosion.

The following data layers were included in the evaluation (Figures 48 and 49 and Table A19):

- *Eroding shoreline* (VIMS shoreline inventory)
- *Tidal wetlands enhancement Opportunity Assessment* (CBCP)
- *Tidal wetlands restoration Opportunity Assessment* (CBCP)

A separate analysis was performed to consider wetland restoration versus enhancement opportunities.

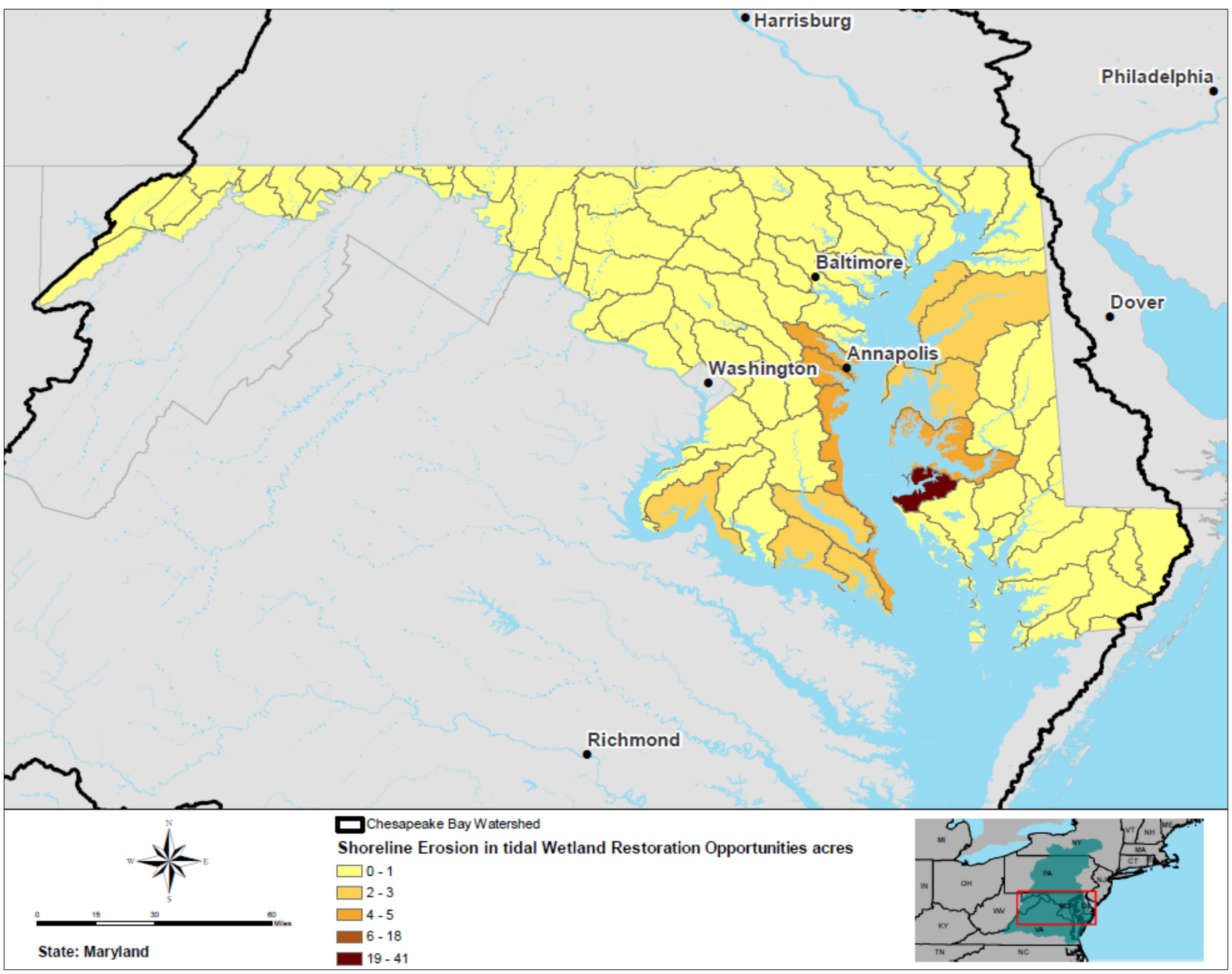

Figure 48. Shoreline erosion in tidal wetland restoration Opportunity subwatersheds in Maryland

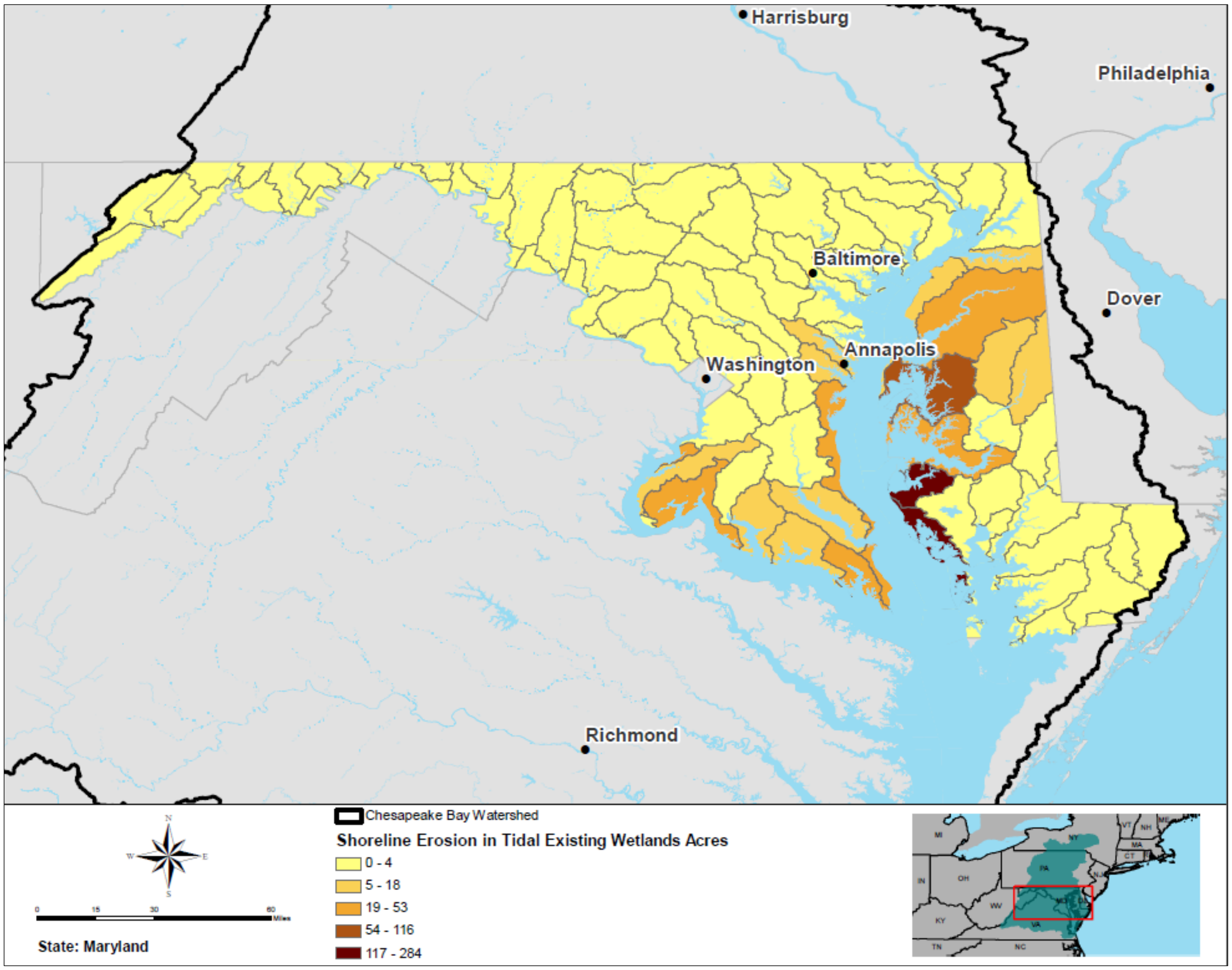

Figure 50. Shoreline erosion in tidal wetland enhancement Opportunity subwatersheds in Maryland

Opportunities to use wetland restoration to address shoreline erosion were identified in Eastern Bay (HUC 0206000206), Lower Choptank (HUC 0206000505), Severn River (HUC 0206000402), Chester River (HUC 0206000204), Little Choptank (HUC 0206000504), Herring Bay (HUC 0206000404), Lower Patuxent River (HUC 0206000606), and St. Clements Bay-Potomac River (HUC 0207001107) subwatersheds.

Opportunities to use wetland enhancement to address shoreline erosion exist in Eastern Bay (HUC 0206000206), Little Choptank (HUC 0206000504), and Honga River (HUC 0206000506) subwatersheds.

SECTION 4

INTEGRATION ANALYSIS

The *Opportunity* maps can guide various stakeholders and focus efforts. The purpose of the Integration Analysis was to evaluate the results of the individual Opportunity Assessments to identify where multiple 2014 Bay Agreement goals and outcomes or co-benefits that could be achieved. The resulting *Restoration Roadmap* is a compilation of the *Opportunity Assessments* which highlights co-benefits and the potential to address multiple problems with an integrated water resources management approach.

In Maryland, the following *Opportunity Assessments* identified subwatersheds with opportunities aligning with the 2014 Bay Agreement goals and outcomes:

- Nontidal and tidal wetlands restoration
- Tidal/nontidal wetlands restoration where dredged material may be used
- Wetlands restoration to benefit avian wildlife
- Connectivity-regional flow
- SAV restoration
- Oyster restoration
- Riparian forest buffers
- Stream restoration
- Future threats – tidal
- Eroding shorelines
- Wetland migration
- Toxic contaminants
- Watershed Stressors (water quality improvements)
- Healthy/High-Value Habitats at risk to nontidal Threats (Policy)

The analysis determined that the Lower Choptank River subwatershed had the highest number of *Opportunities* (11) for subwatersheds in Maryland. There is a need to comprehensively address conservation and restoration needs in the Lower Choptank River subwatershed to provide multiple benefits to the subwatershed and the Chesapeake Bay. The state-selected subwatershed for Maryland is the Choptank River subwatershed, and reaffirms the value of this subwatershed.

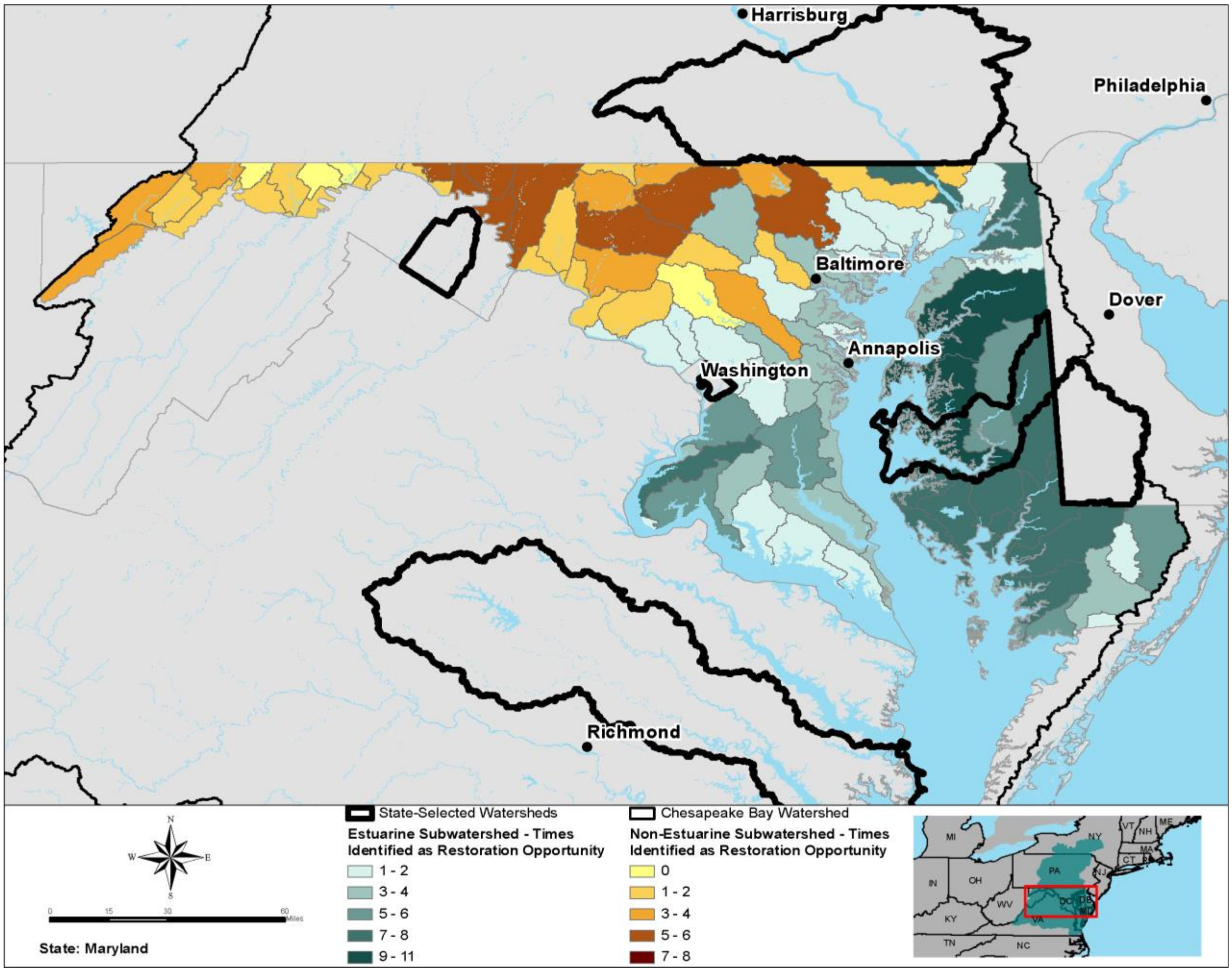

Figure 51. ***Restoration Roadmap*** **for Maryland**

Table 2. *Restoration Roadmap* for Maryland*:* Compilation of Opportunity Assessments (1 = yes; 0 = no) (non-estuarine subwatersheds)

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Nontidal Wetlands Restoration Opportunity	Wetlands Restoration Benefiting Avian Wildlife Opportunity	Connectivity - Regional Flow Opportunity	Riparian Forest Buffers Opportunity	Stream Restoration Opportunity	Future Threats – Nontidal Opportunity	Toxic Contaminants Opportunity
MD,WV	0207000204	New Creek-North Branch Potomac River	0	1	0	0	0	0	0
MD,WV	0207000106	Lower South Branch Potomac River	1	0	1	1	1	0	0
MD,PA	0207000901	Rock Creek	0	1	0	0	0	0	1
MD,PA	0207000903	Toms Creek	0	1	0	0	0	0	0
MD,WV	0207000411	Rocky Marsh Run-Potomac River	1	1	0	1	1	0	0
MD,WV	0207000202	Stony River-North Branch Potomac River	0	1	1	1	1	0	0
MD	0205030616	Deer Creek	1	1	0	0	0	0	0
MD	0206000303	Upper Gunpowder Falls	0	1	0	0	0	0	0
MD	0206000309	Gwynns Falls	0	0	0	0	0	1	0
MD	0206000310	South Branch Patapsco River	0	1	0	0	0	0	0
MD,PA	0205030601	South Branch Conewago Creek	0	1	0	0	0	0	0
MD,PA	0205030613	Muddy Creek	1	0	0	0	0	0	0
MD,PA	0207000205	Wills Creek	0	1	1	1	0	0	0
MD,PA	0207000206	Evitts Creek	0	0	0	0	0	0	0
MD,PA	0207000401	Tonoloway Creek	0	0	0	0	1	0	0
MD,PA	0207000403	Licking Creek	0	1	1	1	1	0	0
MD,PA	0207000408	Conococheague Creek	1	1	0	1	0	1	0
MD,PA	0207000410	Antietam Creek	1	1	0	1	0	1	0
MD,PA	0207000902	Marsh Creek	0	1	0	0	0	0	0
MD	0206000601	Headwaters Patuxent River	0	0	0	0	0	0	0
MD	0206000602	Little Patuxent River	0	1	0	0	0	1	0
MD	0207000201	Savage River	0	1	0	0	1	0	0
MD	0207000203	Georges Creek	0	1	0	0	0	0	0
MD	0207000801	Catoctin Creek-MD	0	1	0	0	0	0	0

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Nontidal Wetlands Restoration Opportunity	Wetlands Restoration Benefiting Avian Wildlife Opportunity	Connectivity - Regional Flow Opportunity	Riparian Forest Buffers Opportunity	Stream Restoration Opportunity	Future Threats – Nontidal Opportunity	Toxic Contaminants Opportunity
MD	0207000802	Piney Run-Potomac River	0	1	0	0	0	0	0
MD	0207000804	Tuscarora Creek-Potomac River	0	0	0	0	0	1	0
MD	0207000808	Seneca Creek	0	0	0	0	0	1	0
MD	0207000904	Double Pipe Creek	1	1	0	1	0	1	0
MD	0207000905	Upper Monocacy River	1	1	0	0	0	1	0
MD	0207000906	Middle Monocacy River	1	1	0	1	0	1	0
MD	0207000907	Lower Monocacy River	1	0	0	0	0	1	0
MD,WV	0207000208	Trading Run-North Branch Potomac River	0	1	0	0	0	0	0
MD,WV	0207000308	Long Hollow Run-Potomac River	0	1	0	0	0	0	0
MD	0206000304	Middle Gunpowder Falls	1	1	0	1	0	0	0
MD,PA	0207000301	Town Creek	0	1	0	0	0	0	0
MD,PA,WV	0207000405	Little Tonoloway Creek-Potomac River	0	1	0	0	0	0	0
MD,VA,WV	0207000703	Bullskin Run-Shenandoah River	0	0	0	0	0	0	0
MD,PA	0207000304	Sideling Hill Creek	0	0	0	0	0	0	0
MD,PA	0205030607	Codorus Creek	1	1	0	0	0	0	0
MD,PA	0205030615	Octoraro Creek	0	1	0	0	0	0	0
MD,PA	0207000406	West Branch Conococheague Creek	0	1	1	1	0	0	0
MD	0207000303	Fifteenmile Creek	0	0	0	0	0	0	0

Table 2. *Restoration Roadmap* for Maryland*:* Compilation of Opportunity Assessments (1 = yes; 0 = no) (non-estuarine subwatersheds) (continued)

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Conservation Opportunity	Water Stressor Analysis Opportunity	Healthy/ High Value Habitats at risk to Nontidal Threats (Policy) Opportunity	Times Identified as *Opportunity*	Times Identified as *Opportunity* including Fish Passage
MD,WV	0207000204	New Creek-North Branch Potomac River	1	0	0	2	2
MD,WV	0207000106	Lower South Branch Potomac River	0	0	0	4	4
MD,PA	0207000901	Rock Creek	0	1	0	3	3
MD,PA	0207000903	Toms Creek	0	0	0	1	1
MD,WV	0207000411	Rocky Marsh Run-Potomac River	0	1	0	5	6
MD,WV	0207000202	Stony River-North Branch Potomac River	0	0	0	4	4
MD	0205030616	Deer Creek	0	0	0	2	2
MD	0206000303	Upper Gunpowder Falls	1	0	1	3	3
MD	0206000309	Gwynns Falls	0	1	0	2	2
MD	0206000310	South Branch Patapsco River	0	1	0	2	2
MD,PA	0205030601	South Branch Conewago Creek	0	1	0	2	2
MD,PA	0205030613	Muddy Creek	0	0	0	1	1
MD,PA	0207000205	Wills Creek	0	0	0	3	3
MD,PA	0207000206	Evitts Creek	0	0	0	0	0
MD,PA	0207000401	Tonoloway Creek	0	0	0	1	1
MD,PA	0207000403	Licking Creek	0	0	0	4	5
MD,PA	0207000408	Conococheague Creek	0	1	0	5	5
MD,PA	0207000410	Antietam Creek	0	1	0	5	5
MD,PA	0207000902	Marsh Creek	0	1	0	2	2
MD	0206000601	Headwaters Patuxent River	0	0	0	0	0
MD	0206000602	Little Patuxent River	0	1	0	3	3
MD	0207000201	Savage River	1	0	0	3	4
MD	0207000203	Georges Creek	0	0	0	1	1
MD	0207000801	Catoctin Creek-MD	0	1	0	2	2
MD	0207000802	Piney Run-Potomac River	0	1	0	2	2

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Conservation Opportunity	Water Stressor Analysis Opportunity	Healthy/ High Value Habitats at risk to Nontidal Threats (Policy) Opportunity	Times Identified as *Opportunity*	Times Identified as *Opportunity* including Fish Passage
MD	0207000804	Tuscarora Creek-Potomac River	0	1	0	2	2
MD	0207000808	Seneca Creek	0	1	0	2	2
MD	0207000904	Double Pipe Creek	0	1	0	5	5
MD	0207000905	Upper Monocacy River	0	1	0	4	4
MD	0207000906	Middle Monocacy River	0	1	0	5	5
MD	0207000907	Lower Monocacy River	0	1	0	3	3
MD,WV	0207000208	Trading Run-North Branch Potomac River	0	0	0	1	1
MD,WV	0207000308	Long Hollow Run-Potomac River	0	0	0	1	1
MD	0206000304	Middle Gunpowder Falls	1	0	1	5	5
MD,PA	0207000301	Town Creek	0	0	0	1	1
MD,PA,WV	0207000405	Little Tonoloway Creek-Potomac River	0	0	0	1	1
MD,VA,WV	0207000703	Bullskin Run-Shenandoah River	0	1	0	1	1
MD,PA	0207000304	Sideling Hill Creek	0	0	0	0	0
MD,PA	0205030607	Codorus Creek	0	1	0	3	3
MD,PA	0205030615	Octoraro Creek	0	1	0	2	2
MD,PA	0207000406	West Branch Conococheague Creek	0	0	0	3	3
MD	0207000303	Fifteenmile Creek	0	0	0	0	0

Table 3. *Restoration Roadmap* for Maryland*:* Compilation of Opportunity Assessments (1 = yes; 0 = no) (estuarine subwatersheds)

Drainage states	Subwatershed (HUC 10) Number	Subwatershed Name	Tidal Wetlands Restoration Opportunity	Nontidal Wetlands Restoration Opportunity	Tidal/non-tidal Wetlands Restoration Opportunity to use Dredged Material	Wetlands Restoration Benefiting Avian Wildlife Opportunity	Connectivity - Regional Flow Opportunity	SAV Restoration Opportunity	Riparian Forest Buffers Opportunity	Stream Restoration Opportunity	Oyster Restoration Opportunity
MD,DE	0208010904	Upper Nanticoke River	0	1	1	1	0	0	1	1	0
MD,VA	0208010201	Great Wicomico River-Lower Chesapeake Bay	0	0	0	1	0	0	0	0	1
DE,MD,PA	0206000202	Elk River	0	1	0	1	0	0	1	1	0
MD,VA	0207000809	Broad Run-Potomac River	0	0	0	0	0	0	0	0	0
MD,VA	0207000810	Difficult Run-Potomac River	0	0	0	0	0	0	0	0	0
MD,VA	0207001101	Quantico Creek-Potomac River	0	0	0	1	0	1	1	1	0
MD,VA	0207001108	Nomini Creek-Potomac River	0	1	0	1	0	0	0	0	0
MD,VA	0208010100	Lower Chesapeake Bay	0	0	0	1	0	1	0	0	1
MD,VA	0208011006	Lower Tangier Sound	1	0	1	1	0	1	0	0	0
MD,VA	0208011104	Pitts Creek-Pocomoke River	0	0	0	1	0	0	0	0	0
MD,VA	0208011105	Marumsco Creek-Pocomoke Sound	1	0	0	1	0	0	0	0	0
MD,VA	0208011107	Deep Creek-Pocomoke Sound	0	0	0	1	0	1	0	0	0
MD	0206000100	Upper Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000201	North East River-Upper Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000205	Upper Chesapeake Bay	0	0	0	1	0	1	0	0	0
MD	0206000206	Eastern Bay	0	1	1	1	0	1	0	1	0
MD	0206000301	Winters Run-Bush River	0	0	0	0	0	0	0	0	0
MD	0206000302	Romney Creek-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000305	Lower Gunpowder Falls	0	0	0	0	0	0	0	0	0

Drainage states	Subwatershed (HUC 10) Number	Subwatershed Name	Tidal Wetlands Restoration Opportunity	Nontidal Wetlands Restoration Opportunity	Tidal/non-tidal Wetlands Restoration Opportunity to use Dredged Material	Wetlands Restoration Benefiting Avian Wildlife Opportunity	Connectivity - Regional Flow Opportunity	SAV Restoration Opportunity	Riparian Forest Buffers Opportunity	Stream Restoration Opportunity	Oyster Restoration Opportunity
MD	0206000306	Gunpowder River-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000307	Back River-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000308	North Branch Patapsco River	0	1	0	1	0	0	0	0	0
MD	0206000311	Patapsco River	0	0	0	1	0	0	0	0	0
MD	0206000312	Patapsco River-Chesapeake Bay	0	0	0	0	0	0	0	1	0
MD	0206000401	Magothy River-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000402	Severn River-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000403	South River-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000404	Herring Bay-Chesapeake Bay	0	0	0	1	0	0	0	0	0
MD	0206000501	Tuckahoe Creek	0	1	1	1	0	0	0	1	0
MD	0206000503	Middle Choptank	0	1	0	1	0	0	0	1	0
MD	0206000504	Little Choptank River	1	0	1	1	0	1	0	0	1
MD	0206000505	Lower Choptank River	1	1	1	1	0	1	0	1	1
MD	0206000506	Honga River-Chesapeake Bay	1	0	1	1	0	1	0	0	0
MD	0206000603	Western Branch Patuxent River	0	0	0	1	0	0	0	0	0
MD	0206000604	Upper Patuxent River	0	0	0	1	0	0	0	1	0
MD	0206000605	Middle Patuxent River	0	0	0	1	1	0	1	1	0
MD	0206000606	Lower Patuxent River	0	0	0	1	0	0	0	0	0
MD	0207001103	Nanjemoy Creek-Potomac River	0	0	0	1	0	0	0	1	0
MD	0207001104	Zekiah Swamp Run	0	0	0	1	0	0	0	1	0
MD	0207001105	Wicomico River	0	0	0	1	0	0	0	0	0
MD	0207001107	Saint Clements Bay-Potomac River	0	0	0	1	0	0	0	0	0

Drainage states	Subwatershed (HUC 10) Number	Subwatershed Name	Tidal Wetlands Restoration Opportunity	Nontidal Wetlands Restoration Opportunity	Tidal/non-tidal Wetlands Restoration Opportunity to use Dredged Material	Wetlands Restoration Benefiting Avian Wildlife Opportunity	Connectivity - Regional Flow Opportunity	SAV Restoration Opportunity	Riparian Forest Buffers Opportunity	Stream Restoration Opportunity	Oyster Restoration Opportunity
MD	0207001109	Saint Marys River	0	0	0	1	0	0	0	0	0
MD	0208011001	Transquaking River	1	0	0	1	0	0	0	1	0
MD	0208011002	Blackwater River	1	0	0	1	0	0	0	0	0
MD	0208011004	Manokin River	1	0	1	1	0	1	0	0	0
MD	0208011005	Upper Tangier Sound	0	0	0	1	0	1	0	0	0
MD	0208011101	Nassawango Creek	0	0	0	1	0	0	0	0	0
MD	0208011103	Dividing Creek-Pocomoke River	0	0	0	1	1	0	0	1	0
DC,MD,VA	0207001001	Rock Creek-Potomac River	0	0	0	0	0	0	0	0	0
DE,MD	0206000203	Sassafras River	0	0	0	1	0	0	0	0	0
DE,MD	0208010903	Marshyhope Creek	0	1	1	1	0	0	1	1	0
DE,MD	0208010905	Lower Nanticoke River	0	0	0	1	0	0	0	1	0
DE,MD	0208011003	Wicomico River	0	1	1	1	0	0	0	1	0
DE,MD	0208011102	Bald Cypress Branch-Pocomoke River	0	1	0	1	1	0	1	1	0
MD,VA	0207001008	Occoquan River-Potomac River	0	0	0	1	0	1	0	0	0
MD,VA	0207001102	Potomac Creek-Potomac River	0	0	0	1	0	0	0	0	0
MD,VA	0207001106	Machodoc Creek-Potomac River	0	0	0	1	0	0	0	0	0
DC,MD	0207001002	Anacostia River	0	0	0	0	0	0	0	0	0
DC,MD,VA	0207001003	Cameron Run-Potomac River	0	0	0	1	0	0	1	1	0
DE,MD	0206000204	Chester River	0	1	1	1	0	1	1	1	0
DE,MD	0206000502	Upper Choptank River	0	1	1	1	0	0	1	1	0
MD,DE	0208010902	Broad Creek	0	1	1	1	0	0	0	1	0
MD,VA	0207001110	0207001110-Potomac River	0	0	0	1	0	0	0	0	0
MD,PA	0205030617	Susquehanna River	0	1	0	1	1	0	1	1	0

Table 3. *Restoration Roadmap* for Maryland*:* Compilation of Opportunity Assessments (1 = yes; 0 = no) (estuarine subwatersheds) (continued)

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Future Threats – Tidal Opportunity	Eroding Shorelines Opportunity	Wetland Migration Opportunity	Toxic Contaminants Opportunity	Conservation Opportunity	Water Stressor Analysis Opportunity	Healthy/ High Value Habitats at risk to Nontidal Threats (Policy) Opportunity	Times Identified as *Opportunity*	Times Identified as *Opportunity* including Fish Passage
MD,DE	0208010904	Upper Nanticoke River	0	0	0	0	0	1	0	6	7
MD,VA	0208010201	Great Wicomico River-Lower Chesapeake Bay	1	1	0	0	0	1	0	5	5
DE,MD,PA	0206000202	Elk River	0	0	0	1	0	1	0	6	7
MD,VA	0207000809	Broad Run-Potomac River	0	0	0	0	0	1	0	1	1
MD,VA	0207000810	Difficult Run-Potomac River	0	0	0	0	0	1	0	1	1
MD,VA	0207001101	Quantico Creek-Potomac River	0	0	0	1	1	1	0	7	8
MD,VA	0207001108	Nomini Creek-Potomac River	0	1	1	0	0	0	0	4	4
MD,VA	0208010100	Lower Chesapeake Bay	0	0	0	0	0	0	0	3	3
MD,VA	0208011006	Lower Tangier Sound	1	0	0	0	0	1	0	6	6
MD,VA	0208011104	Pitts Creek-Pocomoke River	0	0	0	0	0	1	0	2	2
MD,VA	0208011105	Marumsco Creek-Pocomoke Sound	0	0	0	0	1	1	1	5	5
MD,VA	0208011107	Deep Creek-Pocomoke Sound	0	0	0	0	1	1	0	4	4
MD	0206000100	Upper Chesapeake Bay	0	0	0	0	0	0	0	1	1
MD	0206000201	North East River-Upper Chesapeake Bay	0	0	0	0	0	1	0	2	2
MD	0206000205	Upper Chesapeake Bay	0	1	0	0	0	1	0	4	4
MD	0206000206	Eastern Bay	0	1	1	0	0	1	0	8	9
MD	0206000301	Winters Run-Bush River	0	0	0	0	0	1	0	1	1
MD	0206000302	Romney Creek-Chesapeake Bay	0	0	0	0	0	1	0	2	2
MD	0206000305	Lower Gunpowder Falls	0	0	0	0	0	1	0	1	1

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Future Threats – Tidal Opportunity	Eroding Shorelines Opportunity	Wetland Migration Opportunity	Toxic Contaminants Opportunity	Conservation Opportunity	Water Stressor Analysis Opportunity	Healthy/ High Value Habitats at risk to Nontidal Threats (Policy) Opportunity	Times Identified as *Opportunity*	Times Identified as *Opportunity* including Fish Passage
MD	0206000306	Gunpowder River-Chesapeake Bay	0	0	0	0	0	1	0	2	2
MD	0206000307	Back River-Chesapeake Bay	0	0	0	1	0	1	0	3	3
MD	0206000308	North Branch Patapsco River	0	0	0	0	0	1	0	3	3
MD	0206000311	Patapsco River	0	0	0	0	0	1	0	2	2
MD	0206000312	Patapsco River-Chesapeake Bay	0	0	0	0	0	1	0	2	3
MD	0206000401	Magothy River-Chesapeake Bay	0	0	0	0	0	1	0	2	2
MD	0206000402	Severn River-Chesapeake Bay	0	1	0	0	0	1	0	3	3
MD	0206000403	South River-Chesapeake Bay	0	1	0	0	0	1	0	3	3
MD	0206000404	Herring Bay-Chesapeake Bay	0	1	0	0	0	1	0	3	3
MD	0206000501	Tuckahoe Creek	0	0	0	0	0	1	0	5	6
MD	0206000503	Middle Choptank	0	0	1	0	0	1	0	5	6
MD	0206000504	Little Choptank River	0	1	1	0	0	1	0	8	8
MD	0206000505	Lower Choptank River	1	1	1	0	0	1	0	11	11
MD	0206000506	Honga River-Chesapeake Bay	0	0	0	0	1	1	1	7	7
MD	0206000603	Western Branch Patuxent River	0	0	0	0	0	1	0	2	2
MD	0206000604	Upper Patuxent River	0	0	0	0	0	0	0	2	3
MD	0206000605	Middle Patuxent River	0	0	0	0	1	0	0	5	6
MD	0206000606	Lower Patuxent River	0	1	1	0	0	0	0	3	3
MD	0207001103	Nanjemoy Creek-Potomac River	0	1	0	0	1	1	0	5	6
MD	0207001104	Zekiah Swamp Run	0	0	0	0	0	0	0	2	3
MD	0207001105	Wicomico River	0	0	0	0	0	0	0	1	1
MD	0207001107	Saint Clements Bay-Potomac River	0	1	0	0	0	0	0	2	2
MD	0207001109	Saint Marys River	0	1	0	0	0	0	0	2	2

Drainage states	Subwatershed (HUC 10) Number	Subwateshed Name	Future Threats – Tidal Opportunity	Eroding Shorelines Opportunity	Wetland Migration Opportunity	Toxic Contaminants Opportunity	Conservation Opportunity	Water Stressor Analysis Opportunity	Healthy/ High Value Habitats at risk to Nontidal Threats (Policy) Opportunity	Times Identified as *Opportunity*	Times Identified as *Opportunity* including Fish Passage
MD	0208011001	Transquaking River	0	0	1	0	1	1	1	7	8
MD	0208011002	Blackwater River	1	0	1	0	1	1	1	7	7
MD	0208011004	Manokin River	1	0	0	0	0	1	1	7	7
MD	0208011005	Upper Tangier Sound	0	0	0	0	0	0	1	3	3
MD	0208011101	Nassawango Creek	0	0	0	0	0	0	0	1	1
MD	0208011103	Dividing Creek-Pocomoke River	0	0	0	0	0	1	0	4	4
DC,MD,VA	0207001001	Rock Creek-Potomac River	0	0	0	0	0	1	0	1	1
DE,MD	0206000203	Sassafras River	0	0	0	0	0	1	0	2	2
DE,MD	0208010903	Marshyhope Creek	0	0	0	0	0	1	0	6	7
DE,MD	0208010905	Lower Nanticoke River	1	0	1	0	0	1	1	6	7
DE,MD	0208011003	Wicomico River	0	0	0	0	0	1	1	6	7
DE,MD	0208011102	Bald Cypress Branch-Pocomoke River	0	0	0	0	0	1	0	6	6
MD,VA	0207001008	Occoquan River-Potomac River	0	0	0	0	0	1	0	3	3
MD,VA	0207001102	Potomac Creek-Potomac River	0	0	0	0	0	0	0	1	1
MD,VA	0207001106	Machodoc Creek-Potomac River	0	0	0	0	0	1	0	2	2
DC,MD	0207001002	Anacostia River	0	0	0	1	0	1	0	2	2
DC,MD,VA	0207001003	Cameron Run-Potomac River	0	0	0	0	0	1	0	4	5
DE,MD	0206000204	Chester River	0	1	1	0	0	1	0	9	10
DE,MD	0206000502	Upper Choptank River	0	0	0	0	0	1	0	6	7
MD,DE	0208010902	Broad Creek	0	0	0	0	0	1	0	5	6
MD,VA	0207001110	0207001110-Potomac River	0	0	0	0	0	1	0	2	2
MD,PA	0205030617	Susquehanna River	0	0	0	1	0	1	0	7	8

SECTION 5

STATE-SELECTED WATERSHED ACTION PLAN SUMMARY

The state-selected watershed action plans undertook a detailed analysis for each jurisdiction with the goal of identifying site-specific, projects for implementation. The watershed being evaluated in detail for Maryland is the Choptank River. The full action plan for the Choptank River watershed is provided in following attachment. Figure 52 depicts the results of the action plan investigation. Utilizing the results of the CBCP baywide analyses, local data, and candidate projects submitted by stakeholders, 9 areas are identified as focal points for developing projects that could address multiple CBA goals and outcomes. Table 4 summarizes the potential opportunities identified in each polygon.

Table 4. Summary of activities in state-selected watershed for project identification in the Choptank River watershed

Choptank River State-Selected Watershed									
Activity	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
Conservation	X	X	X	X	X	X	X	X	X
Oyster Restoration	X	X							
Stream Restoration				X	X		X		
Riparian Buffer Restoration	X	X	X	X	X	X	X	X	X
SAV Restoration	X	X							
Wetland Restoration	X	X	X				X		X
Living Shoreline	X	X	X						
Removal of Fish Blockages					X	X		X	X
Stakeholder-Submitted Candidate Project		X							X

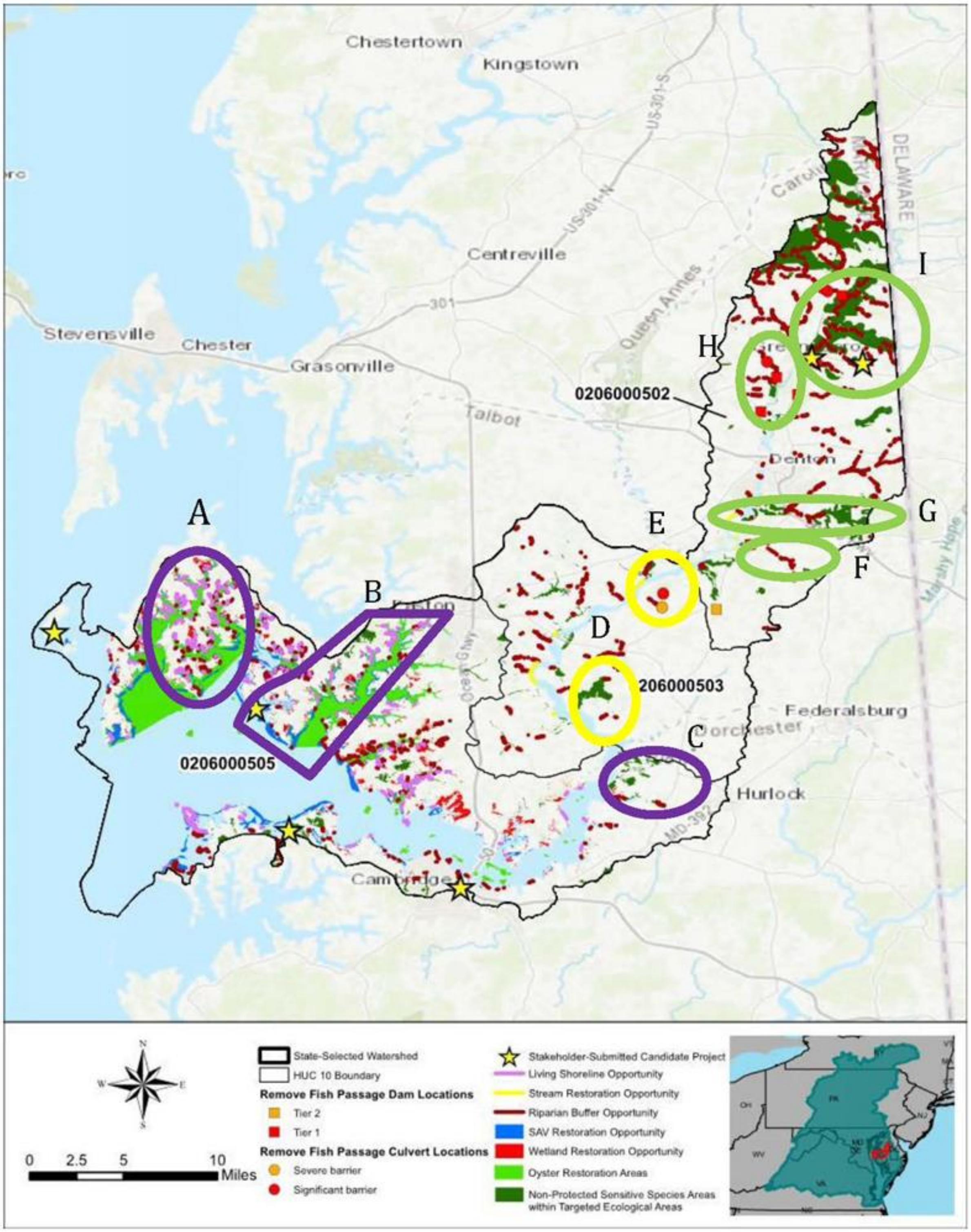

Figure 52. Proposed state-selected watershed for project identification in the Choptank River watershed

SECTION 6

FUNDING AND IMPLEMENTATION STRATEGY

The Federal Leadership Committee for the Chesapeake Bay, including EPA and the Departments of Agriculture, Commerce, Defense, and the Interior, invested more than $536 million in watershed restoration in fiscal year 2016. Funding is directed to state and local governments, educational institutions, nonprofit organizations, and territorial and tribal agencies. These groups often provide additional funding—cash or in-kind—to further facilitate restoration efforts.

This section details a summary of federal, state, and nongovernmental programs and organizations that could be pursued for assistance in implementation efforts.

6.1 Federal Funding

The *Catalog of Federal Funding Sources for Watershed Protection* is a searchable online database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of projects. The database may be searched by:

- Key word (e.g., wetlands, infrastructure, education, forestry);
- Type of organization (e.g., nonprofit groups, state, tribal, educational institution);
- Match requirement (yes or no); and
- Federal agency.

A search of all criteria provided programmatic information by agency that may be useful for different needs and opportunities identified in the CBCP. This information is available in the CBCP Existing Watershed Conditions and Threats Report in Table 39 of Section 12.3. Each program is linked to a web page that details the most current information regarding the funding source, including program overview, current and past funding levels, lowest/median/highest awards, match requirements, contact information, and eligible organizations.

6.2 Non-Governmental Resources

Outreach and public engagement, advocacy, volunteer and community support, monitoring, and research are examples of activities that many nongovernmental and nonprofit groups do as part of their mission. These groups often are more nimble than larger governmental agencies. They are on the ground and aware of opportunities and constraints at the parcel scale. Networking with community groups can bring much needed resources to the aid of communities with the capacity to facilitate restoration efforts. Tables 40 and 41 in Sections 12.4 and 12.5 of the CBCP Existing Watershed Conditions and Threats Report catalogs a list of groups that support habitat conservation, management, and restoration efforts that are complementary to Chesapeake Bay goals.

6.3 Public-Private Partnerships

A public-private partnership is typically a contractual agreement between a state or locality and a private organization or nongovernmental organization that commits them to provide an environmental or recreational service. Public/Private partnerships will be an essential component for implementation of various CBCP measures, including those associated with restoration, water quality, recreation, stewardship, and conservation. For example, public-private partnerships have become a popular and effective method to achieve stringent water quality standards required to meet stormwater initiatives in the Chesapeake Bay Watershed. Another successful and viable example of a public-private partnership approach is the execution of voluntary, long-term real estate protections by local citizens in the Chesapeake Bay Watershed. Other successful partnerships that have been implemented in the watershed are citizen water quality monitoring programs and programs where students grow oyster spat for reef restoration projects. Other public-private partnerships exist in which schools grow vegetation that they then plant at local restoration sites, providing a viable function for the school and promoting stewardship and interpretation throughout the watershed. Overall, the implementation of public-private partnerships will be an essential component to ensure successful implementation of the CBCP.

SECTION 7

REFERENCES

Source information for all geospatial data is provided in Annex 3 of the Planning Analyses Appendix.

U.S. Department of Health & Human Services (USDH&HS). 2017. What are the Superfund "NPL" statuses? https://toxmap.nlm.nih.gov/toxmap/faq/2009/08/what-are-the-superfund-site-npl-statuses.html

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ATTACHMENT A

STATE OF MARYLAND – TABLES

DATA TABLES SUPPORTING GEOSPATIAL ANALYSES AND OUTPUTS FROM OPPORTUNITY ASSESSMENTS

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Table A1. Summary of each hydrologic unit code 10 subwatershed in Maryland

Hydrologic Unit Code (HUC) 10 Number	HUC Name	Acres	Drainage States
0208010100	Lower Chesapeake Bay	684,865	MD,VA
0206000100	Upper Chesapeake Bay	484,990	MD
0206000204	Chester River	302,621	DE,MD
0205030617	Susquehanna River	267,013	MD,PA
0206000505	Lower Choptank River	192,137	MD
0207000202	Stony River-North Branch Potomac River	186,717	MD,WV
0207000410	Antietam Creek	186,136	MD,PA
0207000408	Conococheague Creek	178,126	MD,PA
0206000202	Elk River	172,346	DE,MD,PA
0206000502	Upper Choptank River	165,569	DE,MD
0207000205	Wills Creek	161,993	MD,PA
0207001101	Quantico Creek-Potomac River	161,706	MD,VA
0206000206	Eastern Bay	158,023	MD
0207001003	Cameron Run-Potomac River	153,721	DC,MD,VA
0208011003	Wicomico River	147,430	DE,MD
0207001110	Potomac River	145,617	MD,VA
0206000304	Middle Gunpowder Falls	143,611	MD
0208010903	Marshyhope Creek	140,636	DE,MD
0207001108	Nomini Creek-Potomac River	139,066	MD,VA
0207000411	Rocky Marsh Run-Potomac River	138,327	MD,WV
0208011102	Bald Cypress Branch-Pocomoke River	138,122	DE,MD
0206000605	Middle Patuxent River	138,084	MD
0207000403	Licking Creek	136,299	MD,PA
0207001103	Nanjemoy Creek-Potomac River	134,720	MD
0207000906	Middle Monocacy River	132,401	MD
0207000406	West Branch Conococheague Creek	127,184	MD,PA
0208011002	Blackwater River	123,617	MD
0207000904	Double Pipe Creek	123,438	MD
0207001102	Potomac Creek-Potomac River	123,030	MD,VA
0206000312	Patapsco River-Chesapeake Bay	120,837	MD
0206000606	Lower Patuxent River	118,604	MD
0208010905	Lower Nanticoke River	118,238	DE,MD
0207000905	Upper Monocacy River	117,333	MD
0207001002	Anacostia River	111,037	DC,MD
0205030616	Deer Creek	109,316	MD
0206000308	North Branch Patapsco River	108,996	MD
0206000404	Herring Bay-Chesapeake Bay	108,584	MD
0206000506	Honga River-Chesapeake Bay	107,814	MD

Hydrologic Unit Code (HUC) 10 Number	HUC Name	Acres	Drainage States
0208011004	Manokin River	106,542	MD
0206000602	Little Patuxent River	103,420	MD
0205030607	Codorus Creek	102,921	MD,PA
0207000301	Town Creek	100,543	MD,PA
0207000810	Difficult Run-Potomac River	99,646	MD,VA
0206000501	Tuckahoe Creek	98,760	MD
0207000907	Lower Monocacy River	98,502	MD
0207001107	Saint Clements Bay-Potomac River	91,482	MD
0206000301	Winters Run-Bush River	89,096	MD
0207000204	New Creek-North Branch Potomac River	88,639	MD,WV
0205030613	Muddy Creek	88,556	MD,PA
0207001105	Wicomico River	86,945	MD
0207001106	Machodoc Creek-Potomac River	85,296	MD,VA
0206000601	Headwaters Patuxent River	84,610	MD
0207000809	Broad Run-Potomac River	83,491	MD,VA
0208011107	Deep Creek-Pocomoke Sound	83,004	MD,VA
0207000808	Seneca Creek	82,919	MD
0207001008	Occoquan River-Potomac River	80,771	MD,VA
0206000503	Middle Choptank	77,825	MD
0207000801	Catoctin Creek-MD	77,141	MD
0206000604	Upper Patuxent River	77,105	MD
0207000804	Tuscarora Creek-Potomac River	76,876	MD
0208011103	Dividing Creek-Pocomoke River	76,839	MD
0205030615	Octoraro Creek	76,569	MD,PA
0207000201	Savage River	74,077	MD
0207001104	Zekiah Swamp Run	73,479	MD
0208011005	Upper Tangier Sound	73,351	MD
0207000401	Tonoloway Creek	72,968	MD,PA
0208011001	Transquaking River	72,680	MD
0207001001	Rock Creek-Potomac River	72,440	DC,MD,VA
0207000405	Little Tonoloway Creek-Potomac River	71,983	MD,PA,WV
0206000603	Western Branch Patuxent River	71,488	MD
0207000303	Fifteenmile Creek	70,915	MD
0206000201	North East River-Upper Chesapeake Bay	70,369	MD
0206000311	Patapsco River	70,366	MD
0206000205	Upper Chesapeake Bay	67,864	MD
0206000305	Lower Gunpowder Falls	66,903	MD
0207001109	Saint Marys River	66,768	MD
0206000203	Sassafras River	62,118	DE,MD

Hydrologic Unit Code (HUC) 10 Number	HUC Name	Acres	Drainage States
0206000504	Little Choptank River	60,756	MD
0207000206	Evitts Creek	60,420	MD,PA
0207000208	Trading Run-North Branch Potomac River	59,929	MD,WV
0208011006	Lower Tangier Sound	59,201	MD,VA
0207000308	Long Hollow Run-Potomac River	59,169	MD,WV
0206000302	Romney Creek-Chesapeake Bay	58,215	MD
0207000903	Toms Creek	56,786	MD,PA
0206000402	Severn River-Chesapeake Bay	54,981	MD
0206000310	South Branch Patapsco River	54,941	MD
0206000307	Back River-Chesapeake Bay	53,871	MD
0207000902	Marsh Creek	51,422	MD,PA
0206000303	Upper Gunpowder Falls	51,031	MD
0207000203	Georges Creek	47,494	MD
0205030601	South Branch Conewago Creek	46,999	MD,PA
0206000306	Gunpowder River-Chesapeake Bay	46,459	MD
0208011101	Nassawango Creek	44,566	MD
0206000309	Gwynns Falls	42,836	MD
0206000403	South River-Chesapeake Bay	42,230	MD
0207000901	Rock Creek	40,620	MD,PA
0207000802	Piney Run-Potomac River	32,122	MD
0206000401	Magothy River-Chesapeake Bay	30,168	MD
0208011104	Pitts Creek-Pocomoke River	28,797	MD,VA
0208011105	Marumsco Creek-Pocomoke Sound	12,010	MD,VA

Table A2. Watershed stressor score for subwatersheds in Maryland

NAME	Watershed Stressor Normalized Scores
Fifteenmile Creek	0.8889
Savage River	0.8333
Wills Creek	0.7222
Town Creek	0.7222
Tonoloway Creek	0.7222
Licking Creek	0.7222
Long Hollow Run-Potomac River	0.7222
Georges Creek	0.6667
Stony River-North Branch Potomac River	0.6111
Trading Run-North Branch Potomac River	0.6111
Evitts Creek	0.5556
Toms Creek	0.5556
Little Tonoloway Creek-Potomac River	0.5556
New Creek-North Branch Potomac River	0.5556
Upper Chesapeake Bay (HUC 0206000100)	0.5000
Upper Gunpowder Falls	0.5000
Zekiah Swamp Run	0.5000
Upper Tangier Sound	0.5000
Muddy Creek	0.5000
Potomac Creek-Potomac River	0.5000
Lower Chesapeake Bay	0.5000
Deer Creek	0.4444
Middle Gunpowder Falls	0.4444
Headwaters Patuxent River	0.4444
Upper Patuxent River	0.4444
Middle Patuxent River	0.4444
Lower Patuxent River	0.4444
Wicomico River (HUC 0207001105)	0.4444
Saint Clements Bay-Potomac River	0.4444
Saint Marys River	0.4444
Nassawango Creek	0.4444
West Branch Conococheague Creek	0.4444
Nomini Creek-Potomac River	0.4444
North East River-Upper Chesapeake Bay	0.3889
Lower Gunpowder Falls	0.3889
South River-Chesapeake Bay	0.3889
Tuckahoe Creek	0.3889
Little Choptank River	0.3889
Honga River-Chesapeake Bay	0.3889

NAME	Watershed Stressor Normalized Scores
Piney Run-Potomac River	0.3889
Nanjemoy Creek-Potomac River	0.3889
Occoquan River-Potomac River	0.3889
Quantico Creek-Potomac River	0.3889
Machodoc Creek-Potomac River	0.3889
Potomac River (HUC 0207001110)	0.3889
Upper Monocacy River	0.3333
Upper Chesapeake Bay	0.3333
Tuscarora Creek-Potomac River	0.3333
South Branch Patapsco River	0.3333
Seneca Creek	0.3333
Middle Monocacy River	0.3333
Middle Choptank	0.3333
Lower Monocacy River	0.3333
Lower Choptank River	0.3333
Herring Bay-Chesapeake Bay	0.3333
Catoctin Creek-MD	0.3333
Susquehanna River	0.3333
South Branch Conewago Creek	0.3333
Marsh Creek	0.3333
Marumsco Creek-Pocomoke Sound	0.3333
Lower Tangier Sound	0.3333
Deep Creek-Pocomoke Sound	0.3333
Upper Choptank River	0.2778
Sassafras River	0.2778
Lower Nanticoke River	0.2778
Elk River	0.2778
Winters Run-Bush River	0.2778
Western Branch Patuxent River	0.2778
Transquaking River	0.2778
Patapsco River	0.2778
Manokin River	0.2778
Magothy River-Chesapeake Bay	0.2778
Little Patuxent River	0.2778
Double Pipe Creek	0.2778
Blackwater River	0.2778
Rock Creek	0.2778
Octoraro Creek	0.2778
Conococheague Creek	0.2778
Antietam Creek	0.2778
Pitts Creek-Pocomoke River	0.2778

NAME	Watershed Stressor Normalized Scores
Marshyhope Creek	0.2222
Chester River	0.2222
Bald Cypress Branch-Pocomoke River	0.2222
Severn River-Chesapeake Bay	0.2222
Romney Creek-Chesapeake Bay	0.2222
North Branch Patapsco River	0.2222
Gunpowder River-Chesapeake Bay	0.2222
Eastern Bay	0.2222
Dividing Creek-Pocomoke River	0.2222
Codorus Creek	0.2222
Difficult Run-Potomac River	0.2222
Broad Run-Potomac River	0.2222
Rocky Marsh Run-Potomac River	0.2222
Anacostia River	0.1667
Rock Creek-Potomac River	0.1667
Cameron Run-Potomac River	0.1667
Wicomico River (HUC 0208011003)	0.1667
Patapsco River-Chesapeake Bay	0.1667
Gwynns Falls	0.1667
Back River-Chesapeake Bay	0.1667

Table A3. Priority fish passage blockages in Maryland

NAME	Number of Chesapeake Bay Program (CBP) Blockages within Anadromous Fish Focus Subwatersheds	Number of CBP Blockages within Brook Trout Focus Subwatersheds	Number of CBP Blockages within Resident Fish Focus Subwatersheds
Licking Creek		**0**	**1**
Nanjemoy Creek-Potomac River	4	0	2
Zekiah Swamp Run		0	2
Quantico Creek-Potomac River	8	0	3
Rocky Marsh Run-Potomac River		0	4
Savage River		2	
Tuckahoe Creek	2		
Middle Choptank	2		
Lower Nanticoke River	2		
Transquaking River	2		
Eastern Bay	2		
Patapsco River-Chesapeake Bay	2		
Marshyhope Creek	3		
Cameron Run-Potomac River	6		
Middle Patuxent River	7		
Susquehanna River	9		
Upper Choptank River	9		
Wicomico River (HUC 0208011003)	9		
Upper Patuxent River	13		
Elk River	14		
Chester River	52		

Table A4. Riparian Forest Buffer Opportunities Assessment for Maryland

NAME	30-Meter Riparian Buffer (Acres)	Resident Fish (Acres)	Eastern Brook Trout (Acres)	Nitrogen and Phosphorous (Acres)	Percent Forested Buffer
Chester River	26784	7182	0	229419	89.7%
Susquehanna River	26355	2606	14	210758	89.7%
Conococheague Creek	22608	29956	24932	133433	86.8%
Antietam Creek	21612	24521	11236	116456	84.4%
Upper Choptank River	21137	2083	0	118205	84.4%
Bald Cypress Branch-Pocomoke River	18914	5921	0	89445	80.1%
Marshyhope Creek	18638	1520	0	106676	79.7%
Wills Creek	17230	117631	16929	552	72.8%
Stony River-North Branch Potomac River	17142	133053	89836	2260	72.4%
Licking Creek	16599	68499	8	7109	71.2%
Quantico Creek-Potomac River	16421	49863	0	3585	70.4%
Cameron Run-Potomac River	16387	2935	0	55498	70.1%
Elk River	16266	4893	0	136271	69.3%
West Branch Conococheague Creek	15800	26184	4431	42625	67.6%
Middle Gunpowder Falls	15658	613	33058	1235	67.2%
Middle Monocacy River	15370	10376	9925	40287	65.1%
Rocky Marsh Run-Potomac River	15080	12666	0	45024	62.4%
Double Pipe Creek	14517	0	0	40565	58.5%
Middle Patuxent River	14414	16972	0	935	58.0%
Upper Monocacy River	14260	20522	15628	74955	57.5%
Deer Creek	13671	3	9109	72701	56.8%
Anacostia River	13597	2052	0	60855	56.2%
Wicomico River	13196	18396	0	86044	55.4%
Town Creek	12682	82136	5926	0	54.6%
Tuckahoe Creek	12418	0	0	79868	52.2%
Muddy Creek	10537	0	3717	85917	41.6%
Eastern Bay	9107	1103	0	82346	38.8%
Patapsco River-Chesapeake Bay	9084	0	1505	62048	38.1%
Lower Choptank River	8992	603	0	93273	37.5%
Lower Nanticoke River	8806	18852	0	61217	36.2%
Octoraro Creek	8690	722	0	76282	34.8%
Savage River	7568	54061	71167	0	31.2%
Middle Choptank	6904	17	0	75654	28.8%

Table A5. Stream Restoration Opportunities Assessment for Maryland

NAME	Watershed Degradation Scores	Anadromous Fish (Linear feet)	Eastern Brook Trout (Linear Feet)	National Fish Habitat Assessment (Linear Feet)	Index of Benthic Integrity (IBI) Scores
Muddy Creek	0.50	0	29473	0	VERY_POOR
Susquehanna River	0.33	371758	0	63078	POOR
Elk River	0.28	351657	0	125252	NO_SCORE
Chester River	0.22	470075	0	504976	NO_SCORE
Eastern Bay	0.22	225516	0	127000	FAIR
Upper Gunpowder Falls	0.50	0	136887	0	POOR
Patapsco River-Chesapeake Bay	0.17	210487	11694	52140	POOR
Tuckahoe Creek	0.39	184050	0	248528	FAIR
Upper Choptank River	0.28	267370	0	742006	NO_DATA
Middle Choptank	0.33	229803	0	225702	FAIR
Lower Choptank River	0.33	254152	0	76213	FAIR
Upper Patuxent River	0.44	180511	0	102143	FAIR
Middle Patuxent River	0.44	280461	0	568553	FAIR
Savage River	0.83	0	696899	162415	
Stony River-North Branch Potomac River	0.61	0	741746	336294	
Georges Creek	0.67	0	0	85066	EXCELLENT
New Creek-North Branch Potomac River	0.56	0	91272	264571	POOR
Wills Creek	0.72	0	145472	294576	FAIR
Evitts Creek	0.56	0	9556	158079	FAIR
Trading Run-North Branch Potomac River	0.61	0	0	188045	FAIR
Town Creek	0.72	0	92197	220740	FAIR
Fifteenmile Creek	0.89	0	0	39718	GOOD
Long Hollow Run-Potomac River	0.72	0	27350	131154	FAIR
Tonoloway Creek	0.72	0	0	495136	GOOD
Licking Creek	0.72	0	0	608348	FAIR

NAME	Watershed Degradation Scores	Anadromous Fish (Linear feet)	Eastern Brook Trout (Linear Feet)	National Fish Habitat Assessment (Linear Feet)	Index of Benthic Integrity (IBI) Scores
Little Tonoloway Creek-Potomac River	0.56	0	0	290989	GOOD
Rocky Marsh Run-Potomac River	0.22	0	0	353731	FAIR
Toms Creek	0.56	0	0	156882	POOR
Cameron Run-Potomac River	0.17	218381	0	200832	POOR
Quantico Creek-Potomac River	0.39	224177	0	433213	FAIR
Potomac Creek-Potomac River	0.50	119531	0	327698	GOOD
Nanjemoy Creek-Potomac River	0.39	236054	0	349345	GOOD
Zekiah Swamp Run	0.50	45910	0	447857	FAIR
Marshyhope Creek	0.22	229576	0	635685	NO_DATA
Lower Nanticoke River	0.28	330432	0	316033	POOR
Transquaking River	0.28	189207	0	272301	FAIR
Wicomico River (HUC 208011003)	0.17	229061	0	328386	POOR
Upper Tangier Sound	0.50	129470	0	0	FAIR
Bald Cypress Branch-Pocomoke River	0.22	152224	0	658245	
Dividing Creek-Pocomoke River	0.22	201037	0	318558	

Table A5 Stream Restoration Opportunities Assessment for Maryland

NAME	Enhance Stronghold (Linear Feet)	Restore Other Populations (Low Priority) (Linear Feet)	Restore other populations (Linear Feet)	Restore Persistent Populations and Habitats (Linear Feet)	Restore Unique Life History (Linear Feet)	Number of Chesapeake Bay Program (CBP) Blockages within Anadromous Fish Focus Subwatersheds	Number of CBP Blockages within Brook Trout Focus Subwatersheds	Number of CBP Blockages within Resident Fish Focus Subwatersheds
Muddy Creek		29309						
Susquehanna River		27481				9		
Elk River						14		
Chester River						52		
Eastern Bay						2		
Upper Gunpowder Falls		209352			34082			
Patapsco River-Chesapeake Bay		33384				2		
Tuckahoe Creek						2		
Upper Choptank River						9		
Middle Choptank						2		
Upper Patuxent River						13		
Middle Patuxent River						7		
Savage River	326060	43176	21790	272138			2	
Stony River-North Branch Potomac River		131511	22257	733245				
Georges Creek		74442	5774	88768				
New Creek-North Branch Potomac River		18284		80558				
Wills Creek		256352		280905				

NAME	Enhance Stronghold (Linear Feet)	Restore Other Populations (Low Priority) (Linear Feet)	Restore other populations (Linear Feet)	Restore Persistent Populations and Habitats (Linear Feet)	Restore Unique Life History (Linear Feet)	Number of Chesapeake Bay Program (CBP) Blockages within Anadromous Fish Focus Subwatersheds	Number of CBP Blockages within Brook Trout Focus Subwatersheds	Number of CBP Blockages within Resident Fish Focus Subwatersheds
Evitts Creek		12629			48742			
Town Creek		32073						
Long Hollow Run-Potomac River				27358				
Tonoloway Creek		53030						
Licking Creek							0	1
Rocky Marsh Run-Potomac River							0	4
Toms Creek		30936						
Quantico Creek-Potomac River						8	0	3
Nanjemoy Creek-Potomac River						4	0	2
Zekiah Swamp Run							0	2
Marshyhope Creek						3		
Lower Nanticoke River						2		
Transquaking River						2		
Wicomico River (HUC 0208011003)						9		

US Army Corps of Engineers

Table A6. Acres of existing tidal and nontidal wetlands and acres of wetland restoration opportunities in Maryland

NAME	Tidal Existing Wetland Area (Acres)	Nontidal Existing Wetland Area (Acres)	Combined Restoration Opportunities Area (Acres)	Tidal Restoration Opportunities (Acres)	Nontidal Restoration Opportunities (Acres)
Bald Cypress Branch-Pocomoke River	5	45,444	47,336	3	47,333
Dividing Creek-Pocomoke River	895	36,959	22,201	58	22,144
Chester River	1,606	34,854	122,841	22	122,820
Upper Choptank River	291	32,260	72,165	2	72,163
Marshyhope Creek	229	28,708	62,213	3	62,209
Manokin River	13,021	23,951	15,023	151	14,872
Wicomico River (HUC 0208011003)	10,246	22,634	33,444	60	33,384
Nassawango Creek	3	17,261	8,535	0	8,535
Blackwater River	44,343	16,805	9,763	1,490	8,273
Lower Nanticoke River	12,421	16,175	24,345	26	24,319
Pitts Creek-Pocomoke River	2,530	14,775	12,254	44	12,212
Tuckahoe Creek	392	14,639	48,871	1	48,869
Transquaking River	8,747	11,862	24,353	896	23,455
Zekiah Swamp Run	466	9,630	12,412	1	12,412
Romney Creek-Chesapeake Bay	61	9,276	4,088	0	4,088
Eastern Bay	919	9,146	42,360	28	42,336
Quantico Creek-Potomac River	769	8,846	13,813	1	13,812
Marumsco Creek-Pocomoke Sound	10,424	8,784	5,427	201	5,228
Little Choptank River	5,840	8,397	9,558	638	8,922
Saint Clements Bay-Potomac River	472	8,224	17,800	31	17,769
Herring Bay-Chesapeake Bay	458	7,350	11,580	53	11,528
Middle Patuxent River	1,213	6,985	26,226	51	26,174
Upper Patuxent River	245	6,403	14,519	14	14,506
Wicomico River (HUC 0207001105)	1,019	6,313	18,698	8	18,691
Deep Creek-Pocomoke Sound	5,633	6,132	6,940	48	6,891
Lower Choptank River	1,522	5,977	39,957	106	39,858

NAME	Tidal Existing Wetland Area (Acres)	Nontidal Existing Wetland Area (Acres)	Combined Restoration Opportunities Area (Acres)	Tidal Restoration Opportunities (Acres)	Nontidal Restoration Opportunities (Acres)
Potomac Creek-Potomac River	883	5,863	15,980	9	15,972
Elk River	551	5,511	53,696	5	53,691
Nomini Creek-Potomac River	1,085	4,887	39,499	34	39,468
Middle Choptank	2,070	4,800	39,212	10	39,202
Nanjemoy Creek-Potomac River	1,700	4,787	14,277	36	14,241
Machodoc Creek-Potomac River	874	4,449	13,625	19	13,604
Little Patuxent River	0	4,440	24,320	0	24,320
Saint Marys River	602	4,241	9,425	30	9,394
Upper Chesapeake Bay (HUC 0206000205)	474	4,197	22,618	18	22,603
Cameron Run-Potomac River	222	4,120	22,432	8	22,424
Honga River-Chesapeake Bay	20,848	4,030	1,495	787	708
Lower Patuxent River	331	3,755	15,874	21	15,853
Conococheague Creek	0	3,565	57,649	0	57,649
Western Branch Patuxent River	107	3,284	13,841	2	13,840
Sassafras River	209	3,072	27,906	3	27,903
Broad Run-Potomac River	0	3,043	17,148	1	17,148
Susquehanna River	1	2,887	80,861	0	80,861
Marsh Creek	0	2,819	14,560	0	14,560
West Branch Conococheague Creek	0	2,636	31,306	0	31,306
Gunpowder River-Chesapeake Bay	47	2,407	4,760	2	4,758
Seneca Creek	0	2,288	22,669	0	22,669
Upper Monocacy River	0	2,238	42,371	0	42,371
Anacostia River	10	2,227	18,485	4	18,481
Winters Run-Bush River	137	2,207	19,021	2	19,019
Difficult Run-Potomac River	0	2,143	23,884	0	23,884
Occoquan River-Potomac River	751	2,103	12,195	13	12,182
Rock Creek	0	1,955	14,057	0	14,057

NAME	Tidal Existing Wetland Area (Acres)	Nontidal Existing Wetland Area (Acres)	Combined Restoration Opportunities Area (Acres)	Tidal Restoration Opportunities (Acres)	Nontidal Restoration Opportunities (Acres)
South Branch Conewago Creek	0	1,859	20,933	0	20,933
Headwaters Patuxent River	0	1,707	24,780	0	24,780
Tuscarora Creek-Potomac River	0	1,658	30,370	0	30,370
South River-Chesapeake Bay	78	1,579	6,281	13	6,269
Middle Monocacy River	0	1,524	48,166	0	48,166
Toms Creek	0	1,475	12,370	0	12,370
Double Pipe Creek	0	1,436	54,037	0	54,037
Codorus Creek	0	1,381	34,707	0	34,707
North Branch Patapsco River	0	1,362	33,773	0	33,773
Lower Monocacy River	0	1,330	33,934	0	33,934
Stony River-North Branch Potomac River	0	1,294	27,414	0	27,414
Wills Creek	0	1,291	21,303	0	21,303
Antietam Creek	0	1,249	60,507	0	60,507
Licking Creek	0	1,246	23,133	0	23,133
Severn River-Chesapeake Bay	69	1,236	8,244	18	8,228
North East River-Upper Chesapeake Bay	29	1,220	17,612	1	17,610
Patapsco River-Chesapeake Bay	21	1,033	15,935	9	15,926
Muddy Creek	0	964	36,112	0	36,112
South Branch Patapsco River	0	958	18,588	0	18,588
Octoraro Creek	0	956	23,578	0	23,578
Middle Gunpowder Falls	0	852	41,387	0	41,387
Deer Creek	0	822	37,557	0	37,557
Patapsco River	14	780	12,175	0	12,175
Upper Tangier Sound	4,937	736	247	12	235
Piney Run-Potomac River	0	677	14,633	0	14,633
Lower Tangier Sound	7,236	654	713	143	571
Back River-Chesapeake Bay	1	624	6,541	3	6,539

NAME	Tidal Existing Wetland Area (Acres)	Nontidal Existing Wetland Area (Acres)	Combined Restoration Opportunities Area (Acres)	Tidal Restoration Opportunities (Acres)	Nontidal Restoration Opportunities (Acres)
Lower Gunpowder Falls	24	616	18,559	0	18,559
Rock Creek-Potomac River	7	593	13,189	2	13,187
Magothy River-Chesapeake Bay	31	538	5,352	13	5,341
Rocky Marsh Run-Potomac River	0	532	45,364	0	45,364
Catoctin Creek-MD	0	452	26,103	0	26,103
Town Creek	0	418	8,799	0	8,799
Tonoloway Creek	0	388	15,503	0	15,503
Savage River	0	368	6,338	0	6,338
Evitts Creek	0	319	6,614	0	6,614
Upper Gunpowder Falls	0	291	15,968	0	15,968
Gwynns Falls	0	221	7,700	0	7,700
New Creek-North Branch Potomac River	0	169	8,803	0	8,803
Trading Run-North Branch Potomac River	0	115	6,452	0	6,452
Little Tonoloway Creek-Potomac River	0	101	10,290	0	10,290
Long Hollow Run-Potomac River	0	56	3,178	0	3,178
Georges Creek	0	29	7,228	0	7,228
Fifteenmile Creek	0	22	1,392	0	1,392
Lower Chesapeake Bay	0	0	1	0	1

Table A7. Acres of nontidal and tidal wetland restoration opportunities with the potential to benefit avian wildlife in Maryland

NAME	Presence of Black Duck	Presence of Audubon Important Bird Areas	Presence of Nesting for Wading and Water Birds	Nontidal Restoration Opportunities (Acres)	Tidal Restoration Opportunities (Acres)
Chester River	yes	yes	yes	122,820	22
Susquehanna River	no	yes	yes	80,861	0
Upper Choptank River	yes	no	yes	72,163	2
Marshyhope Creek	yes	yes	yes	62,209	3
Antietam Creek	no	yes	no	60,507	0
Conococheague Creek	no	yes	no	57,649	0
Double Pipe Creek	no	yes	no	54,037	0
Elk River	yes	no	yes	53,691	5
Tuckahoe Creek	yes	yes	no	48,869	1
Middle Monocacy River	no	yes	no	48,166	0
Bald Cypress Branch-Pocomoke River	yes	yes	yes	47,333	3
Rocky Marsh Run-Potomac River	no	yes	no	45,364	0
Upper Monocacy River	no	yes	no	42,371	0
Eastern Bay	yes	no	yes	42,336	28
Middle Gunpowder Falls	no	yes	no	41,387	0
Lower Choptank River	yes	no	yes	39,858	106
Nomini Creek-Potomac River	yes	no	yes	39,468	34
Middle Choptank	no	no	yes	39,202	10
Deer Creek	no	yes	no	37,557	0
Muddy Creek	no	no	no	36,112	0
Codorus Creek	no	yes	no	34,707	0
Lower Monocacy River	no	no	no	33,934	0
North Branch Patapsco River	no	yes	no	33,773	0
Wicomico River (HUC 0208011003)	yes	yes	yes	33,384	60
Transquaking River	yes	yes	yes	23,455	896

NAME	Presence of Black Duck	Presence of Audubon Important Bird Areas	Presence of Nesting for Wading and Water Birds	Nontidal Restoration Opportunities (Acres)	Tidal Restoration Opportunities (Acres)
Honga River-Chesapeake Bay	yes	yes	yes	708	787
Little Choptank River	yes	yes	yes	8,922	638
Marumsco Creek-Pocomoke Sound	yes	yes	no	5.228	201
Manokin River	yes	yes	yes	14,872	151
Lower Tangier Sound	yes	yes	yes	571	143
Dividing Creek-Pocomoke River	yes	yes	yes	22,144	58
Herring Bay-Chesapeake Bay	yes	yes	yes	11,528	53
Middle Patuxent River	yes	yes	yes	26,174	51
Deep Creek-Pocomoke Sound	yes	yes	yes	6,891	48
Pitts Creek-Pocomoke River	yes	no	no	12,212	44
Nanjemoy Creek-Potomac River	yes	yes	yes	14,241	36
Saint Clements Bay-Potomac River	yes	yes	yes	17,769	31
Saint Marys River	yes	yes	yes	9,394	30
Lower Nanticoke River	yes	yes	yes	24,319	26
Lower Patuxent River	yes	yes	yes	15,853	21
Machodoc Creek-Potomac River	yes	no	yes	13,604	19
Severn River-Chesapeake Bay	no	no	yes	8,228	18
Upper Chesapeake Bay (HUC 0206000205)	yes	no	yes	22,603	18
Upper Patuxent River	yes	yes	yes	14,506	14
South River-Chesapeake Bay	no	yes	yes	6,269	13
Occoquan River-Potomac River	yes	yes	yes	12,182	13
Magothy River-Chesapeake Bay	no	no	yes	5,341	13
Upper Tangier Sound	yes	yes	yes	235	12
Patapsco River-Chesapeake Bay	no	no	no	15,926	9
Potomac Creek-Potomac River	yes	yes	yes	15,972	9
Cameron Run-Potomac River	yes	no	yes	22,424	8
Wicomico River (HUC 0207001105)	yes	no	yes	18,691	8

NAME	Presence of Black Duck	Presence of Audubon Important Bird Areas	Presence of Nesting for Wading and Water Birds	Nontidal Restoration Opportunities (Acres)	Tidal Restoration Opportunities (Acres)
Anacostia River	no	no	no	18,481	4
Sassafras River	yes	yes	yes	27,903	3
Back River-Chesapeake Bay	no	yes	no	6,539	3
Gunpowder River-Chesapeake Bay	no	no	yes	4,758	2
Winters Run-Bush River	no	no	no	19,019	2
Rock Creek-Potomac River	no	no	no	13,187	2
Western Branch Patuxent River	yes	yes	yes	13,187	2
North East River-Upper Chesapeake Bay	no	no	yes	17,610	1
Quantico Creek-Potomac River	yes	yes	yes	13,812	1
Zekiah Swamp Run	yes	yes	yes	12,412	1
Broad Run-Potomac River	no	no	no	17,148	1
Patapsco River	no	yes	no	12,175	0
Nassawango Creek	yes	yes	yes	8,535	0
Difficult Run-Potomac River	no	no	no	23,884	0
Romney Creek-Chesapeake Bay	no	no	yes	4,088	0
Lower Chesapeake Bay	yes	no	no	1	0
Lower Gunpowder Falls	no	no	no	18,559	0
West Branch Conococheague Creek	no	yes	no	31,306	0
Tuscarora Creek-Potomac River	no	no	no	30,370	0
Stony River-North Branch Potomac River	no	yes	no	27,414	0
Catoctin Creek-MD	no	yes	no	26,103	0
Headwaters Patuxent River	no	no	no	24,780	0
Little Patuxent River	no	yes	yes	24,320	0
Octoraro Creek	no	no	yes	23,578	0
Licking Creek	no	yes	no	23,133	0
Seneca Creek	no	no	no	22,669	0
Wills Creek	no	yes	no	21,303	0

NAME	Presence of Black Duck	Presence of Audubon Important Bird Areas	Presence of Nesting for Wading and Water Birds	Nontidal Restoration Opportunities (Acres)	Tidal Restoration Opportunities (Acres)
South Branch Conewago Creek	no	yes	no	20,933	0
South Branch Patapsco River	no	yes	no	18,588	0
Upper Gunpowder Falls	no	yes	no	15,968	0
Tonoloway Creek	no	no	no	15,503	0
Piney Run-Potomac River	no	yes	no	14,633	0
Marsh Creek	no	yes	no	14,560	0
Rock Creek	no	yes	no	14,057	0
Toms Creek	no	yes	no	12,370	0
Little Tonoloway Creek-Potomac River	no	yes	no	10,290	0
New Creek-North Branch Potomac River	no	yes	no	8,803	0
Town Creek	no	yes	no	8,799	0
Gwynns Falls	no	no	no	7,700	0
Georges Creek	no	yes	no	7,228	0
Evitts Creek	no	no	no	6,614	0
Trading Run-North Branch Potomac River	no	yes	no	6,452	0
Savage River	no	yes	no	6,338	0
Long Hollow Run-Potomac River	no	yes	no	3,178	0
Fifteenmile Creek	no	no	no	1,392	0

Table A8. Potential beneficial use of dredged material sites and nontidal and tidal wetland enhancement and restoration opportunities in Maryland

NAME	Existing Wetlands in Protected Lands within U.S. Army Corps of Engineers (USACE) Channel (Acres)	Restoration Opportunities in Protected Lands within USACE Channel (Acres)	Tidal Existing Wetlands within USACE Channel (Acres)	Tidal Restoration Opportunities within USACE Channel (Acres)	Nontidal Restoration Opportunities within USACE Channel (Acres)	Nontidal Existing Wetlands within USACE Channel (Acres)
Lower Choptank River	888	3,845	1,053	78	31,855	4,901
Upper Choptank River	900	4,673	240	2	22,799	4,932
Wicomico River (HUC 0208011003)	9,671	950	9,975	56	16,561	11,373
Marshyhope Creek	2,016	3,180	132	2	15,113	4,842
Tuckahoe Creek	662	5,219	286	1	14,788	1,638
Chester River	1,963	3,069	488	7	13,641	4,326
Eastern Bay	1,336	2,439	735	20	11,634	2,653
Nomini Creek-Potomac River	643	1,135	543	16	9,225	2,581
Saint Clements Bay-Potomac River	843	494	270	27	7,604	4,188
Upper Chesapeake Bay (HUC 0206000205)	866	1,876	235	16	7,179	2,268
Cameron Run-Potomac River	570	557	208	6	6,470	529
Machodoc Creek-Potomac River	277	356	625	9	6,389	2,478
Manokin River	11,002	875	11,051	134	5,749	6,007
Deep Creek-Pocomoke Sound	4,131	51	5,608	37	5,720	5,954
Herring Bay-Chesapeake Bay	744	900	274	39	5,460	4,219
Occoquan River-Potomac River	1,081	917	587	12	4,611	959
Patapsco River-Chesapeake Bay	261	211	16	8	4,220	601
Anacostia River	184	390	10	4	4,212	271
Magothy River-Chesapeake Bay	196	25	28	11	3,504	404

NAME	Existing Wetlands in Protected Lands within U.S. Army Corps of Engineers (USACE) Channel (Acres)	Restoration Opportunities in Protected Lands within USACE Channel (Acres)	Tidal Existing Wetlands within USACE Channel (Acres)	Tidal Restoration Opportunities within USACE Channel (Acres)	Nontidal Restoration Opportunities within USACE Channel (Acres)	Nontidal Existing Wetlands within USACE Channel (Acres)
North East River-Upper Chesapeake Bay	119	182	23	1	3,409	275
Rock Creek-Potomac River	61	437	7	2	2,991	57
Saint Marys River	625	387	214	23	2,973	2,209
Lower Nanticoke River	7,984	390	5,661	3	2,850	6,538
Severn River-Chesapeake Bay	123	398	48	11	2,766	260
Wicomico River (HUC 0207001105)	588	874	103	6	2,765	1,684
Middle Choptank	255	0	0	2,589	146	146
Lower Patuxent River	990	34	1	2,531	361	361
Back River-Chesapeake Bay	73	0	3	2,442	471	471
Little Choptank River	202	3,968	508	2,361	4,863	4,863
Nanjemoy Creek-Potomac River	1,002	625	601	27	2,004	1,377
Difficult Run-Potomac River	57	107	0	0	1,883	58
Dividing Creek-Pocomoke River	3,450	167	424	24	1,803	5,589
Pitts Creek-Pocomoke River	579	168	1,911	29	1,446	1,133
Gunpowder River-Chesapeake Bay	393	12	2	1	1,259	593
Quantico Creek-Potomac River	412	164	344	1	1,257	304
Blackwater River	7,359	5	15,142	72	1,204	3,540
Romney Creek-Chesapeake Bay	1,431	114	41	0	1,138	1,419
Nassawango Creek	63	253	3	0	1,127	160
Middle Patuxent River	14	99	0	0	1,103	331

NAME	Existing Wetlands in Protected Lands within U.S. Army Corps of Engineers (USACE) Channel (Acres)	Restoration Opportunities in Protected Lands within USACE Channel (Acres)	Tidal Existing Wetlands within USACE Channel (Acres)	Tidal Restoration Opportunities within USACE Channel (Acres)	Nontidal Restoration Opportunities within USACE Channel (Acres)	Nontidal Existing Wetlands within USACE Channel (Acres)
Marumsco Creek-Pocomoke Sound	14	6,807	64	951	3,270	3,270
Transquaking River	24	0	0	899	309	309
South River-Chesapeake Bay	26	10	5	806	85	85
Elk River	7	3	0	757	77	77
Susquehanna River	7	0	0	738	11	11
Potomac Creek-Potomac River	22	141	4	709	196	196
Bald Cypress Branch-Pocomoke River	2	1	1	688	226	226
Lower Tangier Sound	26	7,196	136	571	653	653
Patapsco River	17	14	0	481	89	89
Gwynns Falls	48	0	0	395	0	0
Honga River-Chesapeake Bay	7	10,863	367	266	1,561	1,561
Upper Tangier Sound	1	2,975	12	235	546	546

Table A9. Acreage of threats to wetland restoration opportunities in Maryland

NAME	Nontidal Threat Impacting Restoration Opportunities (Acres)	Nontidal Threat Impacting Restoration Opportunities within Protected Land (Acres)
Upper Gunpowder Falls	390	53
Middle Gunpowder Falls	1,358	521
Gwynns Falls	1,024	36
South Branch Patapsco River	402	72
Patapsco River	1	0
Headwaters Patuxent River	1,173	611
Little Patuxent River	4,128	928
Georges Creek	1	0
Fifteenmile Creek	1	0
Catoctin Creek-MD	928	45
Piney Run-Potomac River	591	25
Tuscarora Creek-Potomac River	2,974	762
Seneca Creek	1,681	438
Double Pipe Creek	3,081	710
Upper Monocacy River	2,385	201
Middle Monocacy River	5,206	289
Lower Monocacy River	3,384	415
South Branch Conewago Creek	832	2
Codorus Creek	899	24
Muddy Creek	855	9
Octoraro Creek	343	37
Susquehanna River	1	0
Wills Creek	10	0
Evitts Creek	2	0
Town Creek	2	0
Tonoloway Creek	3	0
Licking Creek	83	0
West Branch Conococheague Creek	831	8
Conococheague Creek	2,677	153
Antietam Creek	2,912	131
Rock Creek	968	66
Marsh Creek	492	18
Toms Creek	307	8
Little Tonoloway Creek-Potomac River	4	0
New Creek-North Branch Potomac River	15	0
Trading Run-North Branch Potomac River	4	0
Rocky Marsh Run-Potomac River	1,510	244

Table A10: Hydrologic unit code 10 subwatersheds that drain to oyster projects and watershed acreage

NAME	Watershed Degradation Score	Hydrologic Unit Code 10 (Acres)
Little Choptank River	0.39	60,775
Lower Choptank River	0.33	192,220

Table A11. Submerged aquatic vegetation lost in Maryland

NAME	SAV Lost (Acres)
Anacostia River	3515.0
Cameron Run-Potomac River	4877.0
Rock Creek-Potomac River	3515.0
Chester River	13681.0
Sassafras River	3943.0
Lower Nanticoke River	3.0
Elk River	4757.0
Eastern Bay	11588.0
Upper Tangier Sound	11361.0
Honga River-Chesapeake Bay	9204.0
Little Choptank River	8431.0
Lower Choptank River	6827.0
Manokin River	6679.0
Upper Chesapeake Bay (HUC 206000205)	6124.0
Gunpowder River-Chesapeake Bay	5288.0
Back River-Chesapeake Bay	5225.0
Blackwater River	4798.0
Romney Creek-Chesapeake Bay	4606.0
Winters Run-Bush River	4183.0
Lower Gunpowder Falls	3898.0
Upper Chesapeake Bay	3865.0
Nanjemoy Creek-Potomac River	3620.0
North East River-Upper Chesapeake Bay	3140.0
Saint Clements Bay-Potomac River	1534.0
Zekiah Swamp Run	1417.0
Wicomico River (HUC 207001105)	1417.0
Saint Marys River	1332.0
Magothy River-Chesapeake Bay	728.0
Herring Bay-Chesapeake Bay	602.0
Severn River-Chesapeake Bay	586.0
Middle Patuxent River	571.0
Patapsco River-Chesapeake Bay	509.0
Patapsco River	509.0

NAME	SAV Lost (Acres)
Lower Patuxent River	439.0
South River-Chesapeake Bay	109.0
Upper Patuxent River	79.0
Western Branch Patuxent River	79.0
Susquehanna River	4288.0
Lower Chesapeake Bay	17216.0
Deep Creek-Pocomoke Sound	14383.0
Lower Tangier Sound	10741.0
Occoquan River-Potomac River	8378.0
Quantico Creek-Potomac River	6894.0
Potomac Creek-Potomac River	5532.0
Marumsco Creek-Pocomoke Sound	4145.0
0207001110-Potomac River	1534.0
Machodoc Creek-Potomac River	698.0
Nomini Creek-Potomac River	662.0

Table A12. Acreage affected by toxic contaminants in relation to restoration and conservation opportunities in Maryland.

NAME	Existing Wetlands (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Habitat Restoration Compilation (Yes= presence in the Hydrologic Unit Code 10)	Number of National Priority List (NPL) Superfund Sites per Hydrologic Unit Code 10	Number of Resources Conservation and Recovery Act (RCRA) Sites per Hydrologic Unit Code 10
Quantico Creek-Potomac River	9616	13813	2002	yes	3	0
Romney Creek-Chesapeake Bay	9340	4088	0	yes	1	0
Saint Clements Bay-Potomac River	8698	17800	727	yes	1	0
Herring Bay-Chesapeake Bay	7806	11580	0	yes	1	0
Nanjemoy Creek-Potomac River	6503	14277	4243	yes	1	0
Elk River	6063	53696	0	yes	4	0
Nomini Creek-Potomac River	6004	39499	0	yes	1	0
Little Patuxent River	4440	24320	2	no	1	0
Cameron Run-Potomac River	4345	22432	0	yes	1	1
Broad Run-Potomac River	3043	17148	0	no	1	0
Susquehanna River	2887	80861	118	yes	3	0
Gunpowder River-Chesapeake Bay	2453	4760	0	yes	1	0
Winters Run-Bush River	2344	19021	0	yes	1	0
Anacostia River	2237	18485	0	yes	2	1
Rock Creek	1955	14057	0	no	3	0
South Branch Conewago Creek	1859	20933	0	no	1	0
Middle Monocacy River	1524	48166	86	yes	1	0
Codorus Creek	1381	34707	0	no	1	0
Severn River-Chesapeake Bay	1306	8244	0	yes	1	1

NAME	Existing Wetlands (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Habitat Restoration Compilation (Yes= presence in the Hydrologic Unit Code 10)	Number of National Priority List (NPL) Superfund Sites per Hydrologic Unit Code 10	Number of Resources Conservation and Recovery Act (RCRA) Sites per Hydrologic Unit Code 10
North East River-Upper Chesapeake Bay	1250	17612	0	yes	1	0
Antietam Creek	1249	60507	116	yes	1	0
Patapsco River-Chesapeake Bay	1054	15935	0	yes	1	0
Octoraro Creek	956	23578	0	yes	1	0
Patapsco River	794	12175	0	yes	1	0
Back River-Chesapeake Bay	625	6541	0	yes	3	0
Rock Creek-Potomac River	600	13189	0	yes	0	2
Evitts Creek	319	6614	6	yes	1	0
Gwynns Falls	221	7700	0	no	1	0
New Creek-North Branch Potomac River	169	8803	664	yes	1	0

Table A13. Acreage of healthy/high value habitats by hydrologic unit code 10 subwatersheds in Maryland

NAME	AREA (ACRES)
Savage River	50,178.78
Quantico Creek-Potomac River	38,002.81
Nanjemoy Creek-Potomac River	37,207.77
Blackwater River	34,668.68
Potomac Creek-Potomac River	23,818.73
Wills Creek	21,436.05
Conococheague Creek	20,863.59
Stony River-North Branch Potomac River	20,125.46
Middle Gunpowder Falls	11,118.71
Fifteenmile Creek	10,046.84
Town Creek	9,904.23
Lower Patuxent River	9,193.65
Lower Nanticoke River	8,681.40
Transquaking River	7,691.73
Antietam Creek	7,473.62
Upper Monocacy River	7,114.72
Middle Patuxent River	7,098.74
Honga River-Chesapeake Bay	6,864.79
Upper Gunpowder Falls	6,031.11
Zekiah Swamp Run	5,969.01
Occoquan River-Potomac River	5,814.36
Manokin River	5,731.36
Dividing Creek-Pocomoke River	5,588.28
Middle Monocacy River	5,277.89
Wicomico River (HUC 208011003)	5,185.68
New Creek-North Branch Potomac River	4,150.85
Saint Clements Bay-Potomac River	4,095.72
Upper Patuxent River	4,017.98
Deer Creek	3,513.10
North Branch Patapsco River	3,344.46
Marumsco Creek-Pocomoke Sound	3,270.32
Chester River	2,515.45
Upper Tangier Sound	2,166.51
Nassawango Creek	1,745.37
Deep Creek-Pocomoke Sound	1,580.46
Marshyhope Creek	1,508.06

NAME	AREA (ACRES)
Catoctin Creek-MD	1,100.21
Licking Creek	1,004.24
Bald Cypress Branch-Pocomoke River	867.12
Long Hollow Run-Potomac River	856.75
Tuckahoe Creek	848.21
Lower Tangier Sound	827.90
Susquehanna River	783.15
Marsh Creek	696.86
Georges Creek	663.51
Little Choptank River	659.81
South Branch Patapsco River	378.22
Toms Creek	354.10
Evitts Creek	242.78
Gwynns Falls	176.53
Saint Marys River	109.45
Sassafras River	26.31
Little Patuxent River	22.32
Western Branch Patuxent River	20.43
Headwaters Patuxent River	7.69
Rocky Marsh Run-Potomac River	5.98
Trading Run-North Branch Potomac River	5.28
Machodoc Creek-Potomac River	3.79
Pitts Creek-Pocomoke River	3.59
Double Pipe Creek	1.52
Upper Choptank River	1.47
Elk River	1.06
Cameron Run-Potomac River	0.98
Lower Gunpowder Falls	0.62
Anacostia River	0.54
Nomini Creek-Potomac River	0.28
Muddy Creek	0.12
Octoraro Creek	0.07

Table A14a. Acreage of wetland restoration and conservation opportunities in Maryland

NAME	Existing Wetland (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Oyster Restoration Presence	SAV Presence	Stream Restoration Presence	Riparian Buffer Presence
Blackwater River	61,201	9,763	2,465	no	yes	no	no
Transquaking River	20,622	24,353	531	no	no	yes	no
Dividing Creek-Pocomoke River	37,854	22,201	407	no	no	yes	no
Honga River-Chesapeake Bay	24,928	1,495	325	no	yes	no	no
Lower Nanticoke River	28,646	24,345	405	no	yes	yes	yes
Wicomico River (HUC 0208011003)	32,938	33,444	320	no	no	yes	yes
Nanjemoy Creek-Potomac River	6,503	14,277	4,243	no	yes	yes	no
Zekiah Swamp Run	10,100	12,412	697	no	yes	yes	no
Deep Creek-Pocomoke Sound	11,786	6,940	180	no	yes	no	no
Marumsco Creek-Pocomoke Sound	19,231	5,427	239	no	yes	no	no
Chester River	36,464	122,841	334	no	yes	yes	yes
Potomac Creek-Potomac River	6,750	15,980	3,022	no	yes	yes	no
Saint Clements Bay-Potomac River	8,698	17,800	727	no	yes	no	no
Tuckahoe Creek	15,032	48,871	115	no	no	yes	yes
Quantico Creek-Potomac River	9,616	13,813	2,002	no	yes	yes	yes
Lower Patuxent River	4,090	15,874	1,170	no	yes	no	no
Little Choptank River	14,250	9,558	76	yes	yes	no	no
Manokin River	37,067	15,023	69	no	yes	no	no
Nassawango Creek	17,264	8,535	80	no	no	no	no
Middle Patuxent River	8,201	26,226	820	no	yes	yes	yes
Wills Creek	1,291	21,303	2,739	no	no	yes	yes
Savage River	368	6,338	3,993	no	no	yes	yes
Occoquan River-Potomac River	2,861	12,195	333	no	yes	no	no
Lower Tangier Sound	7,942	713	28	no	yes	no	no
Conococheague Creek	3,565	57,649	476	no	no	no	yes

NAME	Existing Wetland (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Oyster Restoration Presence	SAV Presence	Stream Restoration Presence	Riparian Buffer Presence
Stony River-North Branch Potomac River	1,294	27,414	3,085	no	no	yes	yes
North Branch Patapsco River	1,362	33,773	414	no	no	no	no
Middle Gunpowder Falls	852	41,387	1,495	no	no	no	yes
Bald Cypress Branch-Pocomoke River	45,449	47,336	41	no	no	yes	yes
Upper Gunpowder Falls	291	15,968	867	no	no	yes	no
Marshyhope Creek	28,938	62,213	54	no	no	yes	yes
Antietam Creek	1,249	60,507	116	no	no	no	yes
Town Creek	418	8,799	450	no	no	yes	yes
Upper Patuxent River	6,648	14,519	42	no	yes	yes	no
Marsh Creek	2,819	14,560	35	no	no	no	no
Upper Tangier Sound	5,713	247	8	no	yes	yes	no
West Branch Conococheague Creek	2,636	31,306	201	no	no	no	yes
Deer Creek	822	37,557	321	no	no	no	yes
Pitts Creek-Pocomoke River	17,314	12,254	1	no	no	no	no
Catoctin Creek-MD	452	26,103	128	no	no	no	no
Sassafras River	3,281	27,906	1	no	yes	no	no
Western Branch Patuxent River	3,391	13,841	2	no	yes	no	no
New Creek-North Branch Potomac River	169	8,803	664	no	no	yes	no
South Branch Patapsco River	958	18,588	19	no	no	no	no
Upper Monocacy River	2,238	42,371	389	no	no	no	yes
Susquehanna River	2,887	80,861	118	no	yes	yes	yes
Upper Choptank River	32,552	72,165	0	no	no	yes	yes
Evitts Creek	319	6,614	6	no	no	yes	no
South Branch Conewago Creek	1,859	20,933	0	no	no	no	no
Codorus Creek	1,381	34,707	0	no	no	no	no

NAME	Existing Wetland (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Oyster Restoration Presence	SAV Presence	Stream Restoration Presence	Riparian Buffer Presence
Muddy Creek	964	36,112	0	no	no	yes	yes
Octoraro Creek	956	23,5787	0	no	no	no	yes
Upper Chesapeake Bay	0	0	0	no	yes	yes	no
North East River-Upper Chesapeake Bay	1,250	17,612	0	no	yes	no	no
Elk River	6,063	53,696	0	no	yes	yes	yes
Upper Chesapeake Bay (HUC 0206000205)	4,672	22,618	0	no	yes	no	no
Eastern Bay	10,067	42,360	0	no	yes	yes	yes
Winters Run-Bush River	2,344	19,021	0	no	yes	no	no
Romney Creek-Chesapeake Bay	9,340	4,088	0	no	yes	no	no
Lower Gunpowder Falls	640	18,559	0	no	yes	no	no
Gunpowder River-Chesapeake Bay	2,453	4,760	0	no	yes	no	no
Back River-Chesapeake Bay	625	6,541	0	no	yes	no	no
Gwynns Falls	221	7,700	0	no	no	no	no
Patapsco River	794	12,175	0	no	yes	no	no
Patapsco River-Chesapeake Bay	1,054	15,935	0	no	yes	yes	yes
Magothy River-Chesapeake Bay	569	5,352	0	no	yes	no	no
Severn River-Chesapeake Bay	1,306	8,244	0	no	yes	no	no
South River-Chesapeake Bay	1,657	6,281	0	no	yes	no	no
Herring Bay-Chesapeake Bay	7,806	11,580	0	no	yes	no	no
Middle Choptank	6,871	39,212	0	no	no	yes	yes
Lower Choptank River	7,512	39,957	0	yes	yes	yes	yes
Headwaters Patuxent River	1,707	24,780	0	no	no	no	no
Little Patuxent River	4,440	24,320	2	no	no	no	no
Georges Creek	29	7,228	12	no	no	yes	no
Trading Run-North Branch Potomac River	115	6,452	0	no	no	yes	no
Fifteenmile Creek	22	1,392	130	no	no	yes	no

NAME	Existing Wetland (Acres)	Wetland Restoration Opportunities (Acres)	Conservation Opportunities (Acres)	Oyster Restoration Presence	SAV Presence	Stream Restoration Presence	Riparian Buffer Presence
Long Hollow Run-Potomac River	56	3,178	158	no	no	yes	no
Tonoloway Creek	388	15,503	0	no	no	yes	no
Licking Creek	1,246	23,133	102	no	no	yes	yes
Little Tonoloway Creek-Potomac River	101	10,290	0	no	no	yes	no
Rocky Marsh Run-Potomac River	532	45,364	0	no	no	yes	yes
Piney Run-Potomac River	677	14,633	0	no	no	no	no
Tuscarora Creek-Potomac River	1,658	30,370	0	no	no	no	no
Seneca Creek	2,288	22,669	0	no	no	no	no
Broad Run-Potomac River	3,043	17,148	0	no	no	no	no
Difficult Run-Potomac River	2,143	23,884	0	no	no	no	no
Rock Creek	1,955	14,057	0	no	no	no	no
Toms Creek	1,475	12,370	65	no	no	yes	no
Double Pipe Creek	1,436	54,037	0	no	no	no	yes
Middle Monocacy River	1,524	48,166	86	no	no	no	yes
Lower Monocacy River	1,330	33,934	0	no	no	no	no
Rock Creek-Potomac River	600	13,189	0	no	yes	no	no
Anacostia River	2,237	18,485	0	no	yes	no	yes
Cameron Run-Potomac River	4,345	22,432	0	no	yes	yes	yes
Wicomico River (HUC 0207001105)	7,337	18,698	0	no	yes	no	no
Machodoc Creek-Potomac River	5,332	13,625	0	no	yes	no	no
Nomini Creek-Potomac River	6,004	39,499	0	no	yes	no	no
Saint Marys River	4,845	9,425	16	no	yes	no	no
Potomac River (HUC 0207001110)	0	0	0	no	yes	no	no
Lower Chesapeake Bay	0	1	0	yes	yes	yes	no

Table A14b. Acreage of wetland restoration and conservation opportunities in Maryland

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Blackwater River	yes	2,195	31	2,226	0	0	0
Transquaking River	yes	367	17	384	0	0	0
Dividing Creek-Pocomoke River	yes	277	2	280	0	0	0
Honga River-Chesapeake Bay	yes	277	6	283	0	0	0
Lower Nanticoke River	yes	248	2	250	29	1	0
Wicomico River (HUC 0208011003)	yes	233	1	234	2	0	0
Nanjemoy Creek-Potomac River	yes	229	193	422	0	0	0
Zekiah Swamp Run	yes	210	8	218	0	0	0
Deep Creek-Pocomoke Sound	yes	158	1	159	0	0	0
Marumsco Creek-Pocomoke Sound	yes	153	3	155	0	0	0
Chester River	yes	136	3	139	2	82	0
Potomac Creek-Potomac River	yes	100	61	161	0	0	0
Saint Clements Bay-Potomac River	yes	90	13	103	0	0	0
Tuckahoe Creek	yes	72	0	72	0	0	0
Quantico Creek-Potomac River	yes	68	73	140	0	0	0

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Lower Patuxent River	yes	64	19	83	129	6	0
Little Choptank River	yes	62	0	62	168	9	0
Manokin River	yes	55	0	55	0	0	0
Nassawango Creek	no	47	0	48	0	0	0
Middle Patuxent River	yes	33	31	64	0	0	0
Wills Creek	yes	27	47	74	68	9	0
Savage River	yes	27	416	443	0	0	0
Occoquan River-Potomac River	yes	25	2	27	2	0	0
Lower Tangier Sound	yes	22	0	22	0	0	0
Conococheague Creek	yes	20	19	40	0	0	0
Stony River-North Branch Potomac River	yes	17	96	113	0	0	0
North Branch Patapsco River	no	15	116	130	0	0	0
Middle Gunpowder Falls	yes	14	284	299	0	0	0
Bald Cypress Branch-Pocomoke River	yes	11	0	11	0	0	0

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Upper Gunpowder Falls	yes	11	224	235	0	44	0
Marshyhope Creek	yes	6	1	7	0	0	0
Antietam Creek	yes	4	2	5	0	0	0
Town Creek	yes	3	2	5	0	35	0
Upper Patuxent River	yes	2	1	3	0	0	0
Marsh Creek	no	2	0	2	0	35	4
Upper Tangier Sound	yes	2	0	2	0	0	0
West Branch Conococheague Creek	yes	1	0	2	0	0	0
Deer Creek	yes	1	51	52	0	0	0
Pitts Creek-Pocomoke River	no	1	0	1	1	1	0
Catoctin Creek-MD	no	0	1	1	18	18	0
Sassafras River	yes	0	0	0	11	38	0
Western Branch Patuxent River	yes	0	0	0	241	16	0
New Creek-North Branch Potomac River	yes	0	3	3	56	10	0
South Branch Patapsco River	no	0	3	3	0	0	0

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Upper Monocacy River	yes	0	11	12	2	0	0
Susquehanna River	yes	0	4	4	27	16	0
Upper Choptank River	yes	0	0	0	0	0	0
Evitts Creek	yes	0	0	0	0	0	0
South Branch Conewago Creek	no	0	0	0	1	1	0
Codorus Creek	no	0	0	0	0	0	0
Muddy Creek	yes	0	0	0	0	0	0
Octoraro Creek	yes	0	0	0	0	0	0
Upper Chesapeake Bay (HUC 0206000205)	yes	0	0	0	1	0	0
North East River-Upper Chesapeake Bay	yes	0	0	0	0	0	0
Elk River	yes	0	0	0	0	1	0
Upper Chesapeake Bay (HUC 206000100)	yes	0	0	0	11	12	0
Eastern Bay	yes	0	0	0	1	2	0
Winters Run-Bush River	yes	0	0	0	0	0	0
Romney Creek-Chesapeake Bay	yes	0	0	0	1	0	0

US Army Corps of Engineers

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Lower Gunpowder Falls	yes	0	0	0	0	0	0
Gunpowder River-Chesapeake Bay	yes	0	0	0	0	0	0
Back River-Chesapeake Bay	yes	0	0	0	0	0	0
Gwynns Falls	no	0	0	0	0	0	0
Patapsco River	yes	0	0	0	0	0	0
Patapsco River-Chesapeake Bay	yes	0	0	0	0	0	0
Magothy River-Chesapeake Bay	yes	0	0	0	0	1	0
Severn River-Chesapeake Bay	yes	0	0	0	1	0	0
South River-Chesapeake Bay	yes	0	0	0	0	0	0
Herring Bay-Chesapeake Bay	yes	0	0	0	7	0	0
Middle Choptank	yes	0	0	0	1	0	0
Lower Choptank River	yes	0	0	0	0	0	0
Headwaters Patuxent River	no	0	0	0	0	0	0
Little Patuxent River	no	0	0	0	0	0	0
Georges Creek	yes	0	0	0	0	0	0

US Army Corps of Engineers

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Trading Run-North Branch Potomac River	yes	0	0	0	1	15	0
Fifteenmile Creek	yes	0	0	0	44	40	0
Long Hollow Run-Potomac River	yes	0	1	1	39	54	0
Tonoloway Creek	yes	0	0	0	119	137	0
Licking Creek	yes	0	1	1	5	128	0
Little Tonoloway Creek-Potomac River	yes	0	0	0	0	0	0
Rocky Marsh Run-Potomac River	yes	0	0	0	0	0	0
Piney Run-Potomac River	no	0	0	0	8	54	0
Tuscarora Creek-Potomac River	no	0	0	0	0	0	0
Seneca Creek	no	0	0	0	4	0	0
Broad Run-Potomac River	no	0	0	0	0	0	0
Difficult Run-Potomac River	no	0	0	0	0	0	0
Rock Creek	no	0	0	0	1	3	0
Toms Creek	yes	0	2	2	1	123	0
Double Pipe Creek	yes	0	0	0	0	131	11

NAME	Habitat Restoration Compilation	Combined Existing Wetland that Intersect with Conservation Opportunities (Acres)	Combined Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	All Existing Wetland and Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)	Nontidal Existing Wetland that Intersect with Conservation Opportunities (Acres)	Tidal Wetland Restoration Opportunities that Intersect with Conservation Opportunities (Acres)
Middle Monocacy River	yes	0	1	1	1	633	18
Lower Monocacy River	no	0	0	0	0	112	0
Rock Creek-Potomac River	yes	0	0	0	0	11	0
Anacostia River	yes	0	0	0	0	0	0
Cameron Run-Potomac River	yes	0	0	0	0	1	0
Wicomico River (HUC 207001105)	yes	0	0	0	0	29	0
Machodoc Creek-Potomac River	yes	0	0	0	0	6	0
Nomini Creek-Potomac River	yes	0	0	0	2	173	0
Saint Marys River	yes	0	6	6	0	0	0
Potomac River (HUC 0207001110)	yes	0	0	0	2	20	0
Lower Chesapeake Bay	yes	0	0	0	1	56	0

Table A15. Acreage of conservation opportunities that may add societal benefits in Maryland

NAME	Conservation Opportunities that Could Provide Societal Benefits (Acres)
Chester River	15
Lower Nanticoke River	28
Marshyhope Creek	11
Wicomico River (HUC 208011003)	1
Blackwater River	533
Catoctin Creek-MD	6
Deer Creek	10
Dividing Creek-Pocomoke River	58
Fifteenmile Creek	77
Honga River-Chesapeake Bay	138
Lower Patuxent River	15
Manokin River	17
Middle Gunpowder Falls	1
Middle Monocacy River	11
Middle Patuxent River	349
Nanjemoy Creek-Potomac River	1,181
North Branch Patapsco River	65
Saint Clements Bay-Potomac River	61
Savage River	78
Transquaking River	56
Tuckahoe Creek	26
Upper Gunpowder Falls	4
Upper Monocacy River	8
Upper Patuxent River	4
Western Branch Patuxent River	1
Zekiah Swamp Run	107
Antietam Creek	1
Evitts Creek	2
Town Creek	119
West Branch Conococheague Creek	14
Wills Creek	20
Deep Creek-Pocomoke Sound	44
Lower Tangier Sound	17
Marumsco Creek-Pocomoke Sound	13
Occoquan River-Potomac River	172
Potomac Creek-Potomac River	34
Quantico Creek-Potomac River	753
Long Hollow Run-Potomac River	93
New Creek-North Branch Potomac River	397
Stony River-North Branch Potomac River	281

Table A16. Acreage of nontidal and tidal threats in Maryland

NAME	Tidal Threat (Acres)	Nontidal Threat (Acres)
Upper Gunpowder Falls	0	16
Middle Gunpowder Falls	0	12
Upper Monocacy River	0	0
Fifteenmile Creek	0	0
Wills Creek	0	0
Blackwater River	185	0
Honga River-Chesapeake Bay	132	0
Marumsco Creek-Pocomoke Sound	87	0
Deep Creek-Pocomoke Sound	56	0
Wicomico River (HUC 0208011003)	40	0
Manokin River	33	0
Lower Nanticoke River	21	0
Transquaking River	19	0
Lower Tangier Sound	17	0
Potomac Creek-Potomac River	6	0
Upper Tangier Sound	5	0
Little Choptank River	2	0
Occoquan River-Potomac River	1	0

Table A17. Wetland migration cost for Maryland

NAME	Wetland Migration Low Cost (Acres)
Eastern Bay	4,314
Lower Choptank River	4,191
Transquaking River	4,137
Chester River	3,688
Blackwater River	2,969
Nomini Creek-Potomac River	2,166
Little Choptank River	2,082
Lower Patuxent River	1,815
Middle Choptank	1,694
Lower Nanticoke River	1,639
Upper Chesapeake Bay	1,305
Manokin River	1,278
Wicomico River (HUC 208011003)	887
Pitts Creek-Pocomoke River	876
Herring Bay-Chesapeake Bay	856
Nanjemoy Creek-Potomac River	847
Honga River-Chesapeake Bay	747
Dividing Creek-Pocomoke River	742
Middle Patuxent River	662
Saint Clements Bay-Potomac River	595
Wicomico River (HUC 207001105)	594
Machodoc Creek-Potomac River	566
Sassafras River	457
Elk River	452
Saint Marys River	437
Marumsco Creek-Pocomoke Sound	433
Deep Creek-Pocomoke Sound	390
Severn River-Chesapeake Bay	371
Marshyhope Creek	368
Tuckahoe Creek	316
Romney Creek-Chesapeake Bay	274
Occoquan River-Potomac River	260
Upper Choptank River	202
Potomac Creek-Potomac River	190
Magothy River-Chesapeake Bay	174
Bald Cypress Branch-Pocomoke River	172
Zekiah Swamp Run	156
Patapsco River-Chesapeake Bay	150
Back River-Chesapeake Bay	145

NAME	Wetland Migration Low Cost (Acres)
Cameron Run-Potomac River	140
South River-Chesapeake Bay	137
Quantico Creek-Potomac River	134
Gunpowder River-Chesapeake Bay	127
North East River-Upper Chesapeake Bay	99
Nassawango Creek	98
Lower Tangier Sound	86
Winters Run-Bush River	73
Upper Tangier Sound	53
Upper Patuxent River	46
Anacostia River	41
Patapsco River	23
Lower Gunpowder Falls	20
Rock Creek-Potomac River	15
Susquehanna River	9
Western Branch Patuxent River	6
Lower Chesapeake Bay	1

Table A18. Acres of wetland restoration opportunities that could beneficially impact regional flow in Maryland

NAME	Wetland Restoration Opportunities Intersecting Regional Flow (Acres)
Codorus Creek	549
Muddy Creek	477
Octoraro Creek	1,277
Deer Creek	1,281
Susquehanna River	5,958
North East River-Upper Chesapeake Bay	2,174
Elk River	2,968
Sassafras River	299
Chester River	2,825
Upper Chesapeake Bay (HUC 0206000205)	137
Eastern Bay	361
Winters Run-Bush River	498
Romney Creek-Chesapeake Bay	237
Upper Gunpowder Falls	1,235
Middle Gunpowder Falls	2,408
Lower Gunpowder Falls	1,992
Gunpowder River-Chesapeake Bay	231
Back River-Chesapeake Bay	4
North Branch Patapsco River	2,180
Gwynns Falls	0
South Branch Patapsco River	203
Patapsco River	321
Severn River-Chesapeake Bay	109
South River-Chesapeake Bay	406
Herring Bay-Chesapeake Bay	2,594
Tuckahoe Creek	417
Upper Choptank River	2,143
Middle Choptank	333
Little Choptank River	571
Lower Choptank River	9
Honga River-Chesapeake Bay	849
Headwaters Patuxent River	2,508
Little Patuxent River	567
Western Branch Patuxent River	551
Upper Patuxent River	3,602
Middle Patuxent River	6,733
Lower Patuxent River	3,832
Savage River	3,669
Stony River-North Branch Potomac River	15,711

NAME	Wetland Restoration Opportunities Intersecting Regional Flow (Acres)
Georges Creek	2,173
New Creek-North Branch Potomac River	3,902
Wills Creek	11,921
Evitts Creek	1,801
Patterson Creek	16,725
Trading Run-North Branch Potomac River	3,311
Town Creek	4,361
Long Hollow Run-Potomac River	1,898
Tonoloway Creek	4,953
Licking Creek	10,184
Little Tonoloway Creek-Potomac River	4,958
West Branch Conococheague Creek	5,871
Conococheague Creek	1,043
Opequon Creek	1,595
Antietam Creek	3,446
Rocky Marsh Run-Potomac River	2,741

Table A19. Shoreline erosion in Maryland

NAME	Combined Existing Wetland Affected by Shoreline Erosion (Acres)	Combined Wetland Restoration Opportunities Affected by Shoreline Erosion (Acres)	Conservation Opportunities Affected by Shoreline Erosion (Acres)	Shoreline that Have High Erosion Rates (Acres)
Little Choptank River	241	327	0	2,857
Honga River-Chesapeake Bay	224	8	1	820
Eastern Bay	169	464	0	4,069
Nomini Creek-Potomac River	149	484	0	4,103

Maryland State-Selected Watershed Action Plan

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Section 1

Introduction

As part of the Chesapeake Bay Comprehensive Water Resources and Restoration Plan (CBCP) watershed assessment, a multi-scalar geospatial analysis approach was completed. As part of the scoping effort to develop this approach, each state initially identified a watershed in which geospatial analyses would be completed at the local watershed scale to further define ecological problems, needs, and opportunities. For Maryland, the watershed for the smaller scale analyses was the Choptank River watershed. The purpose of this refined, smaller scale geospatial analysis was to evaluate the unique problems and opportunities within the Choptank River watershed and ultimately guide the implementation of future projects at a smaller scale.

This report builds upon the CBCP baywide and statewide analyses, which corroborated the Choptank River watershed for selection as part of the CBCP smaller scale watershed analyses. The analysis findings are rooted in the geospatial analysis conducted with available data as well as feedback and collaboration from local, state, and federal agencies and NGOs. Feedback was solicited through interactive webinars and stakeholder reviews of draft deliverable products. Additionally, the summary of the analysis findings present potential projects to pursue within the Choptank River watershed at a conceptual level of detail, and does not present detailed designs, detailed costs, or National Environmental Policy Act documentation. Projects selected for advancement are recommended to be evaluated further with follow-on studies to develop additional details and confirm feasibility as well as to avoid duplication of ongoing or planned actions by other federal, state, and local agencies and nongovernmental organizations (NGOs). Although this analysis aims to identify projects that may be implemented by the U.S. Army Corps of Engineers (USACE), maximizing value added by USACE expertise and resources, it also identifies actions or projects that may be generated by other agencies.

The Choptank River watershed in eastern Maryland encompasses parts of Queen Anne's, Caroline, Talbot, and Dorchester counties. The Choptank River watershed falls within the jurisdiction of the USACE Baltimore District. **Figure 1** illustrates the extent of the Choptank River watershed in Maryland. **Figure 2** illustrates the counties and incorporated areas within the Choptank River watershed. The headwaters of the watershed extend into Kent County in Delaware. The focus of this study is on the Maryland portion of the watershed, which is 579 acres. An additional 101 acres fall within Delaware, which was not included in this analysis. Further coordination between states should be considered as efforts progress toward project implementation.

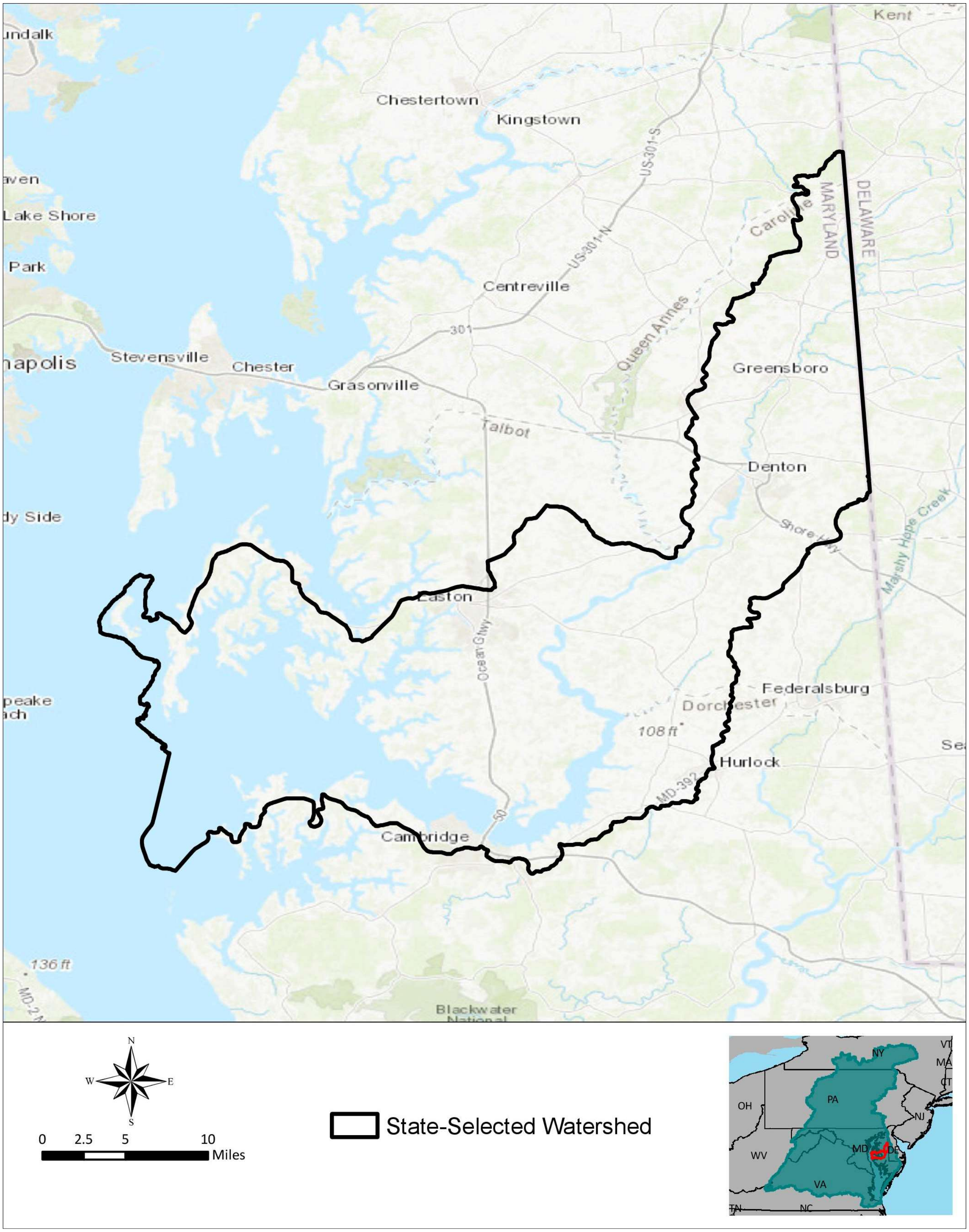

Figure 1. Choptank River watershed

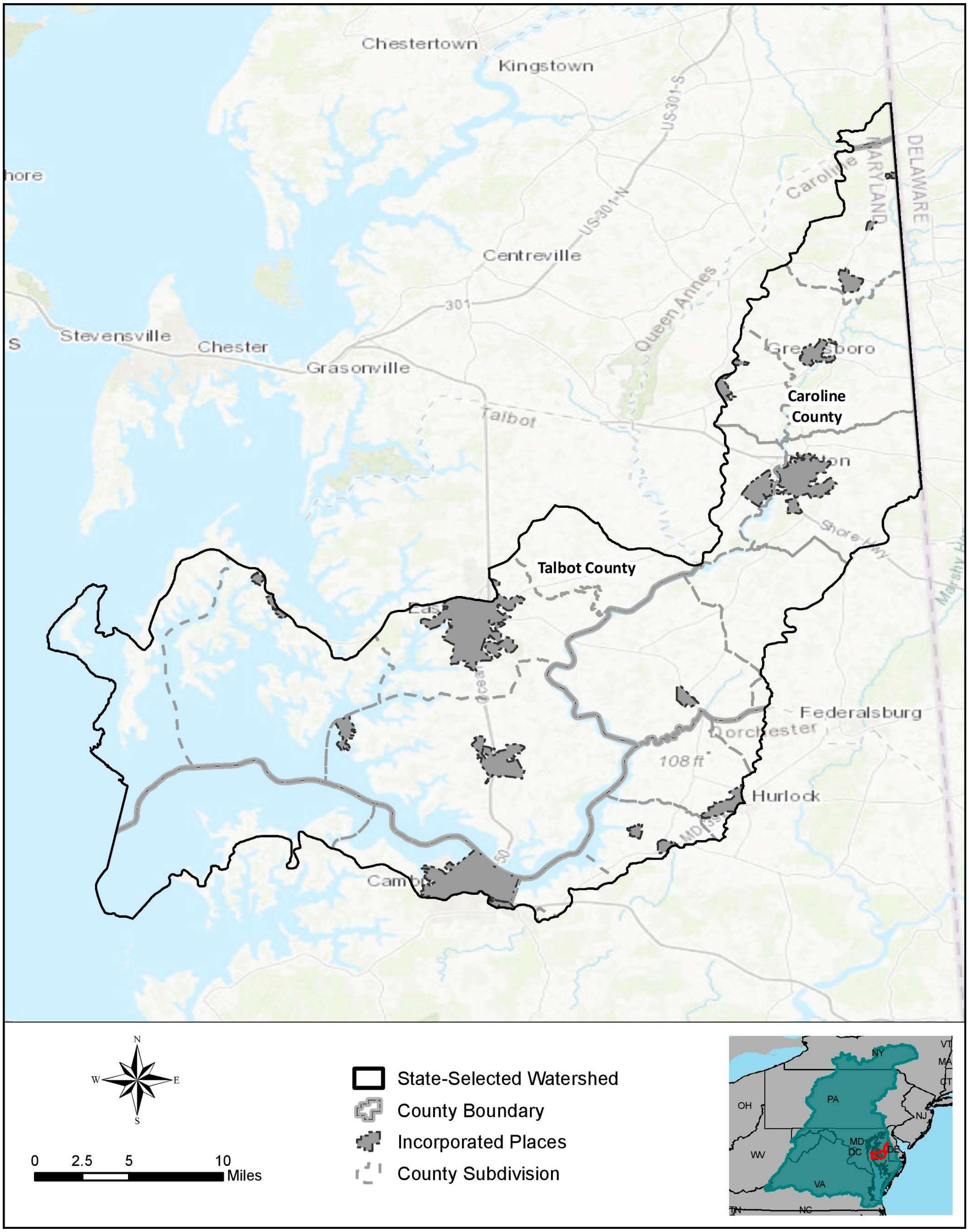

Figure 2. Municipalities within the Choptank River watershed

The Choptank River watershed comprises three smaller hydrologic unit code (HUC) areas, or HUC 10 areas (subwatersheds): Lower Choptank, Middle Choptank, and Upper Choptank rivers. These subwatersheds within the Choptank River watershed are illustrated in **Figure 3**. The Choptank River watershed is a part of the larger Upper Chesapeake HUC 6 area. The Choptank River watershed includes drainage areas to the Choptank River, Balls Creek, Barker Creek, Blinkhorn Creek, Bolingbroke Creek, Broad Creek, Cabin Creek, Chapel Branch, Eagle Creek, Grace Creek, Goldsborough Creek, Harris Creek, Hog Creek, Hunting Creek, Island Creek, Kings Creek, La Trappe Creek, Leadenham Creek, Little Creek, Little Gravelly Branch, Marsh Creek, Miles Creek, Peachblossom Creek, Plaindealing Creek, San Domingo Creek, Tred Avon River, Tripple Creek, Tuckahoe Creek, Warwick River, and other small brooks and streams. There are 682.6 miles of streams in the watershed (U.S. Geological Survey no date [n.d.]).

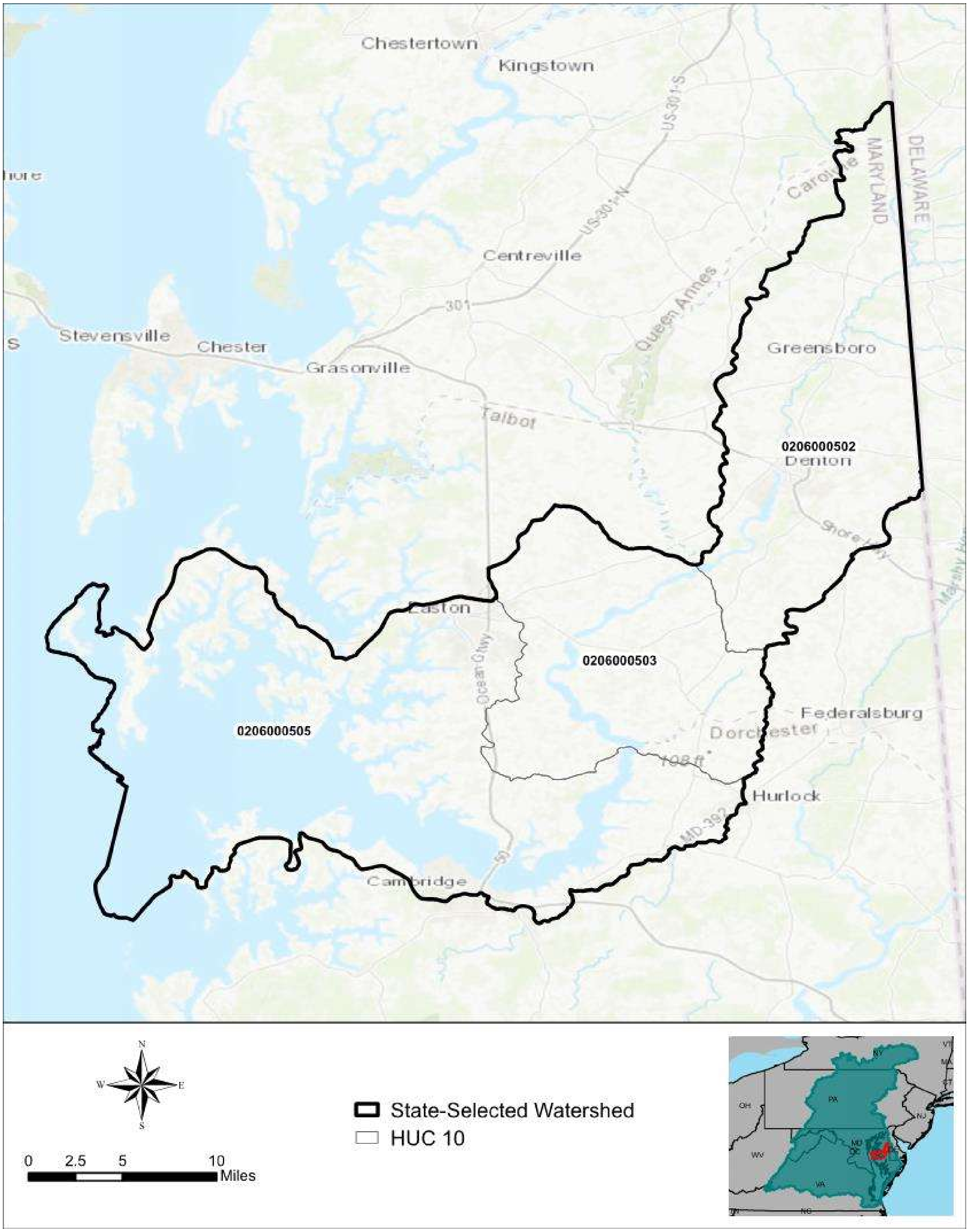

Figure 3. Subwatersheds within the Choptank River watershed

Climate within the region experiences annual mean precipitation of 45.1 inches with 13.2 inches of mean annual snowfall, based on gage data from Salisbury, MD (National Oceanic and Atmospheric Administration [NOAA] Earth System Research Laboratory [ESRL] n.d.). **Figure 4** illustrates the variability in mean daily maximum and minimum temperature at the Salisbury, MD gage based on data from 1961 through 1990.

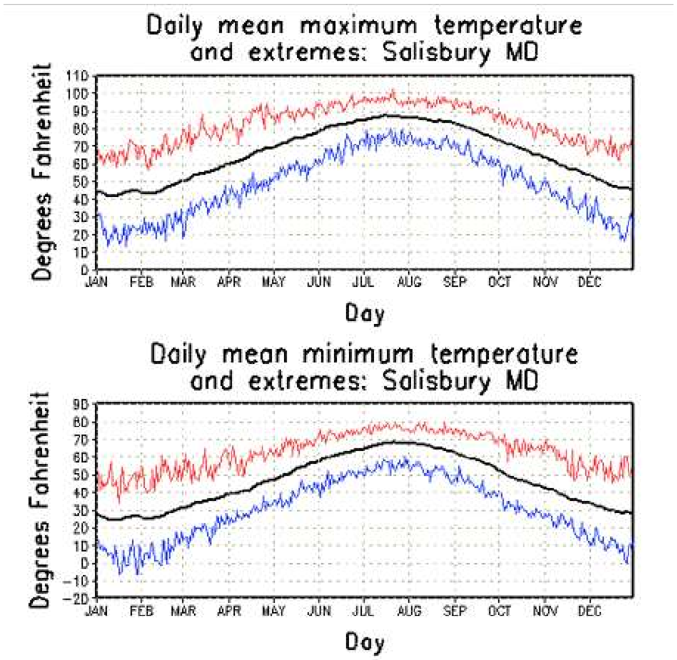

Figure 4. Mean maximum and minimum temperatures at Salisbury, MD (NOAA ESRL n.d.)

Soils within the Choptank River watershed are predominantly Ultisols, with areas surrounding the river banks of Entisols and Histosols. **Figure 5** shows the variability of soil type within the Choptank River watershed. **Figure 6** shows the topography in the Choptank River watershed, illustrating little topographic relief within the watershed.

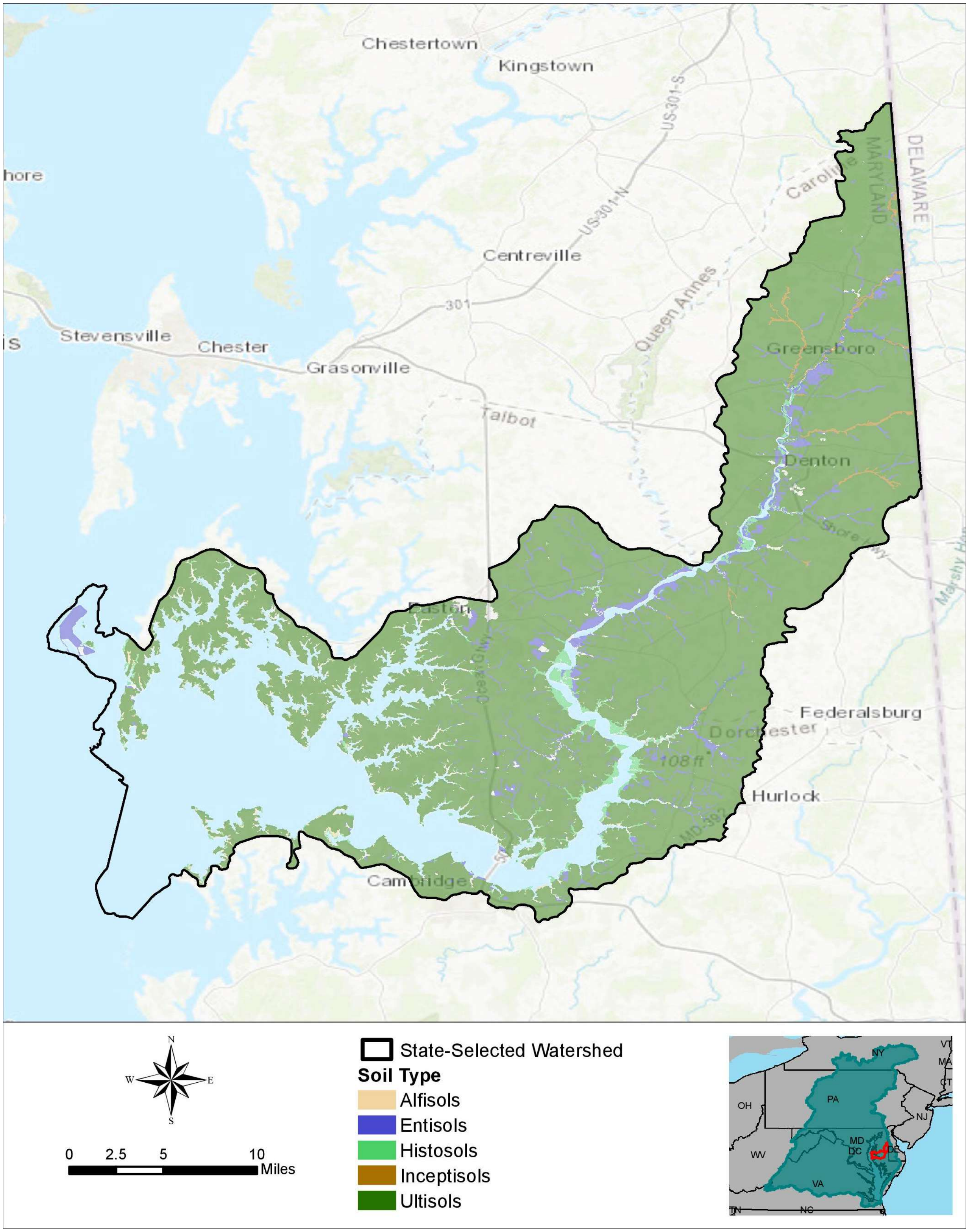

Figure 5. Soil types within the Choptank River watershed (U.S. Department of Agriculture [USDA] Natural Resources Conservation Service [NRCS] n.d.)

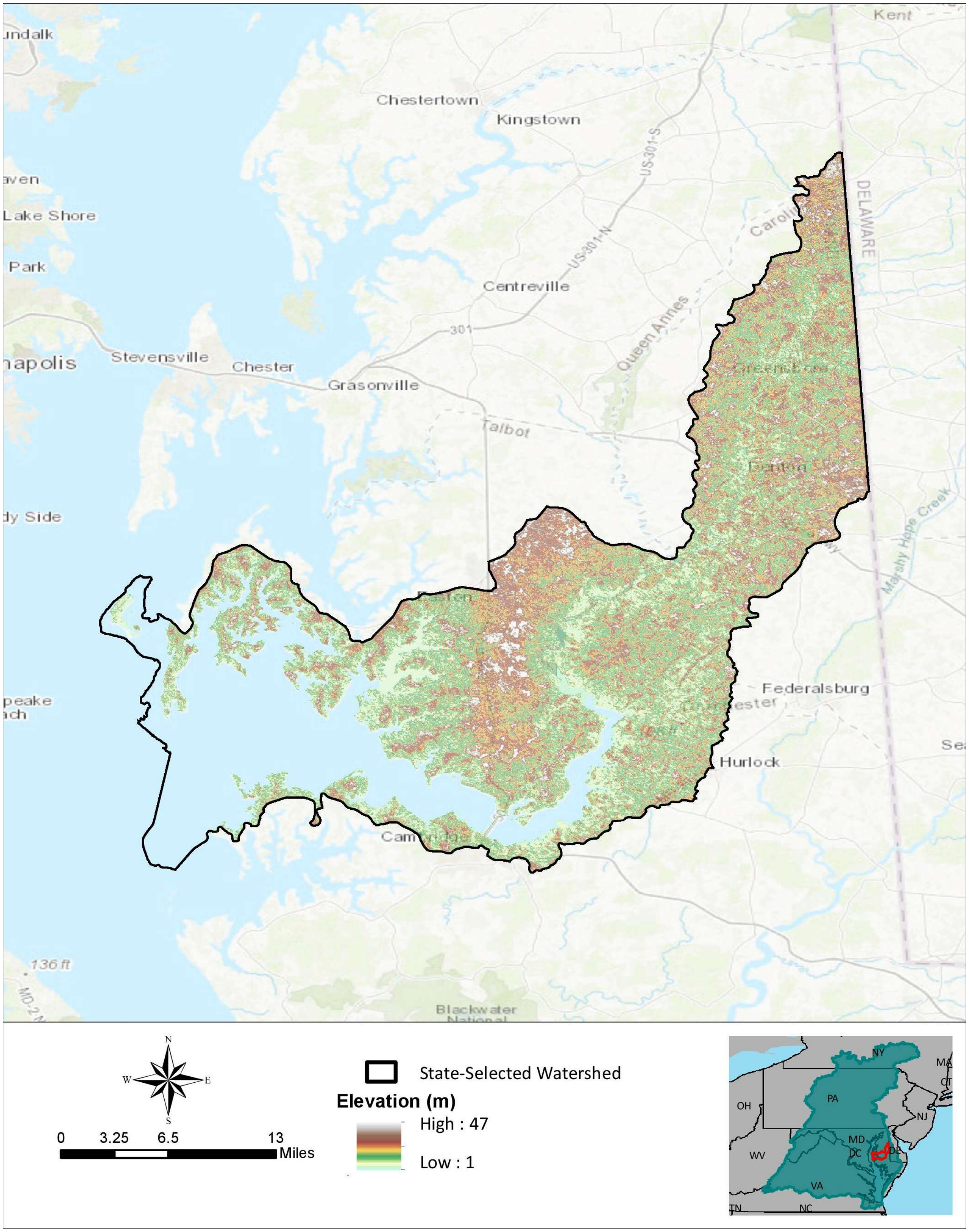

Figure 6. Choptank River watershed topography (Advanced Spaceborne Thermal Emission and Reflection Radiometer 2009)

The Choptank River watershed contains several major highways, rail, dams, fire stations, law enforcement offices, a hospital, and several wastewater treatment facilities. These critical facilities are highlighted on **Figure 7.** Much of the critical infrastructure in the Choptank River watershed aligns with population hubs, such as Easton and Cambridge. The population density throughout this watershed is shown in **Figure 8**. The population in the Choptank River watershed is predominantly white and middle aged as illustrated on **Figures 9** and **10**. The median household income of Choptank River watershed residents is $60,000 to $90,000 as illustrated on **Figure 11**.

This plan highlights the problems and risks to the Choptank River watershed and identifies restoration and conservation opportunities for consideration to improve the watershed's overall ecological health. Additional feasibility studies will be required to investigate the application of the restoration and conservation measures within the Choptank River watershed identified in this plan. The identified opportunities are not exhaustive, and there may be others to consider for future funding and feasibility study.

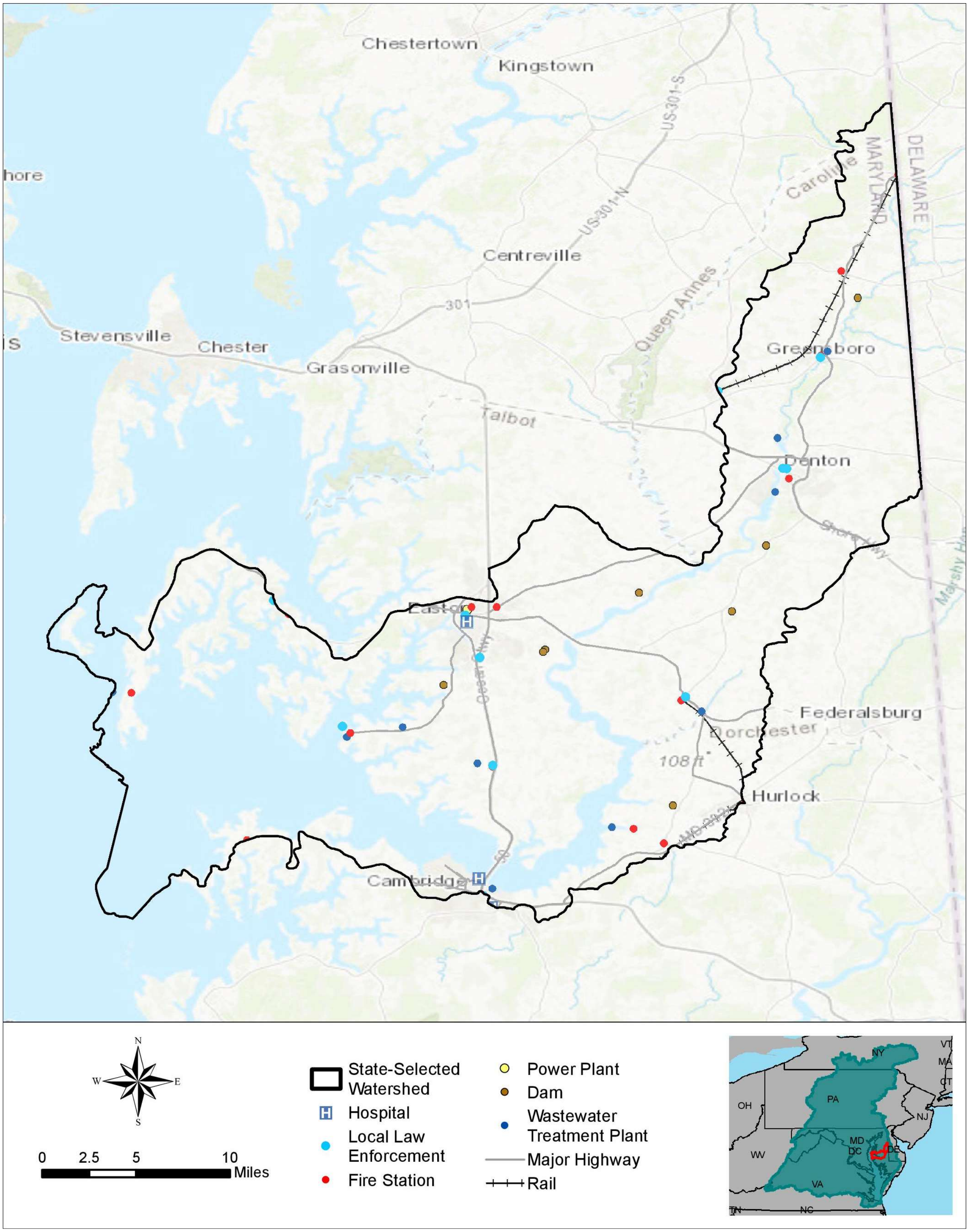

Figure 7. Critical infrastructure in the Choptank River watershed (U.S. Department of Homeland Security 2016)

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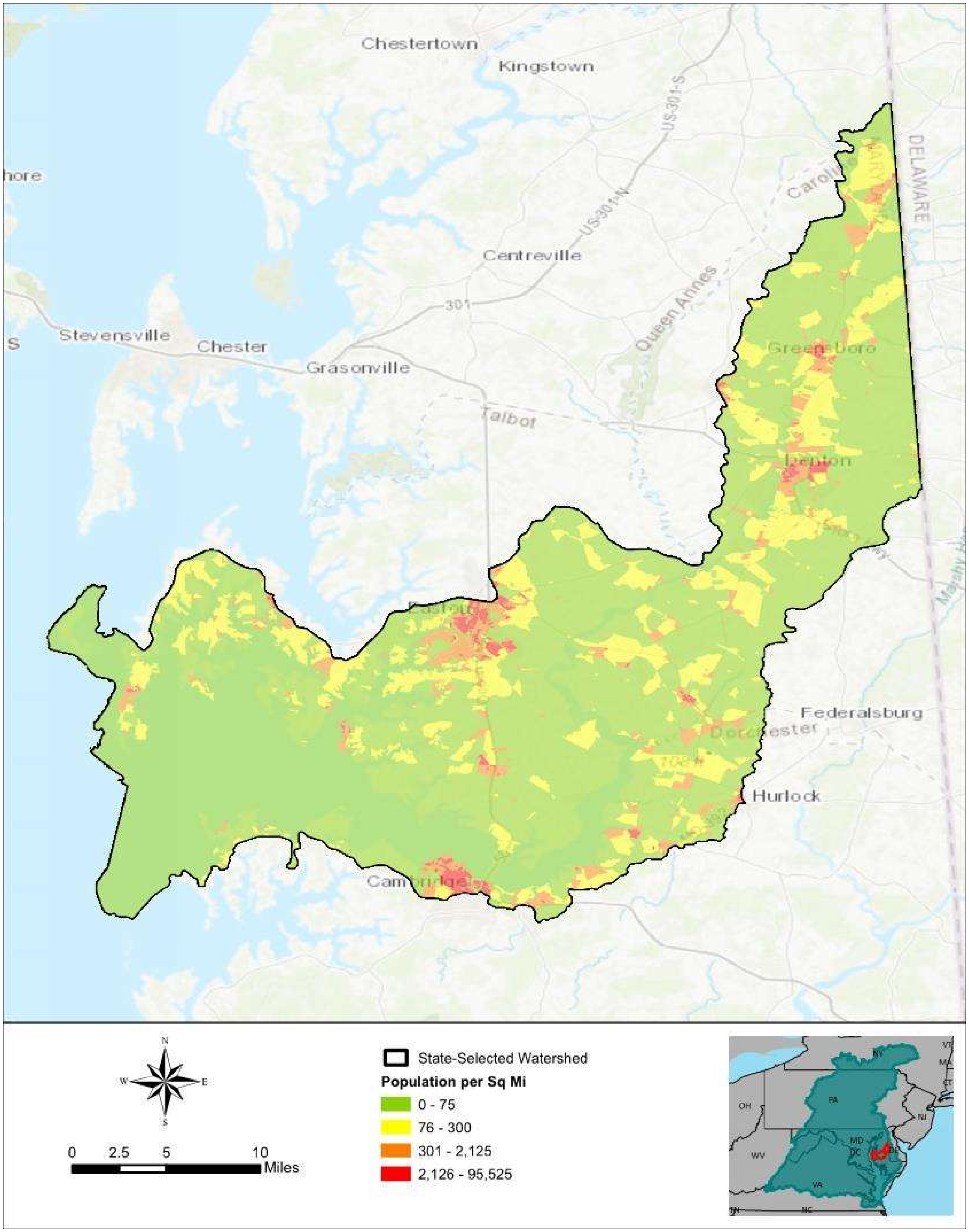

Figure 8. Choptank River watershed population density (U.S. Census Bureau 2010)

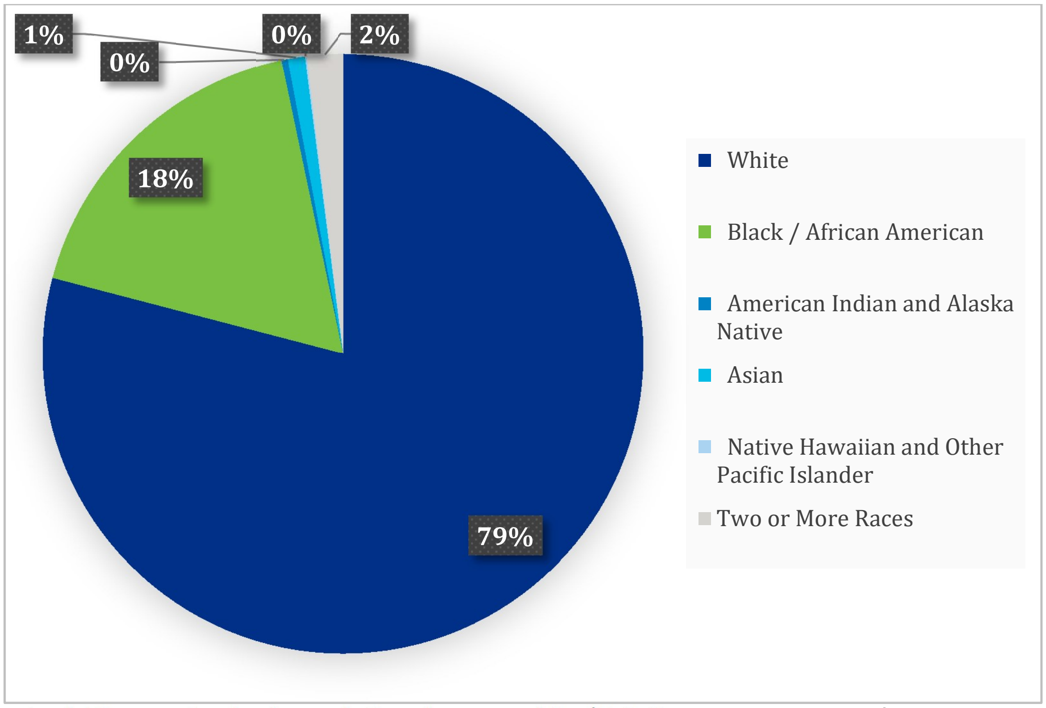

Figure 9. Choptank River watershed population demographics (U.S. Census Bureau 2010)

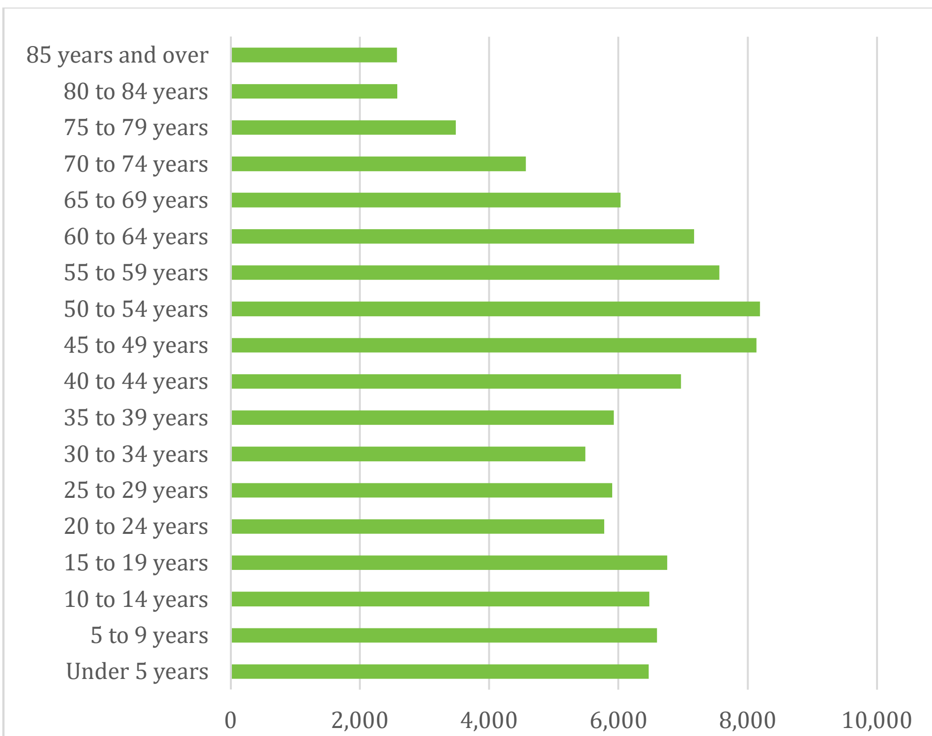

Figure 10. Choptank River watershed age demographics (U.S. Census Bureau 2010)

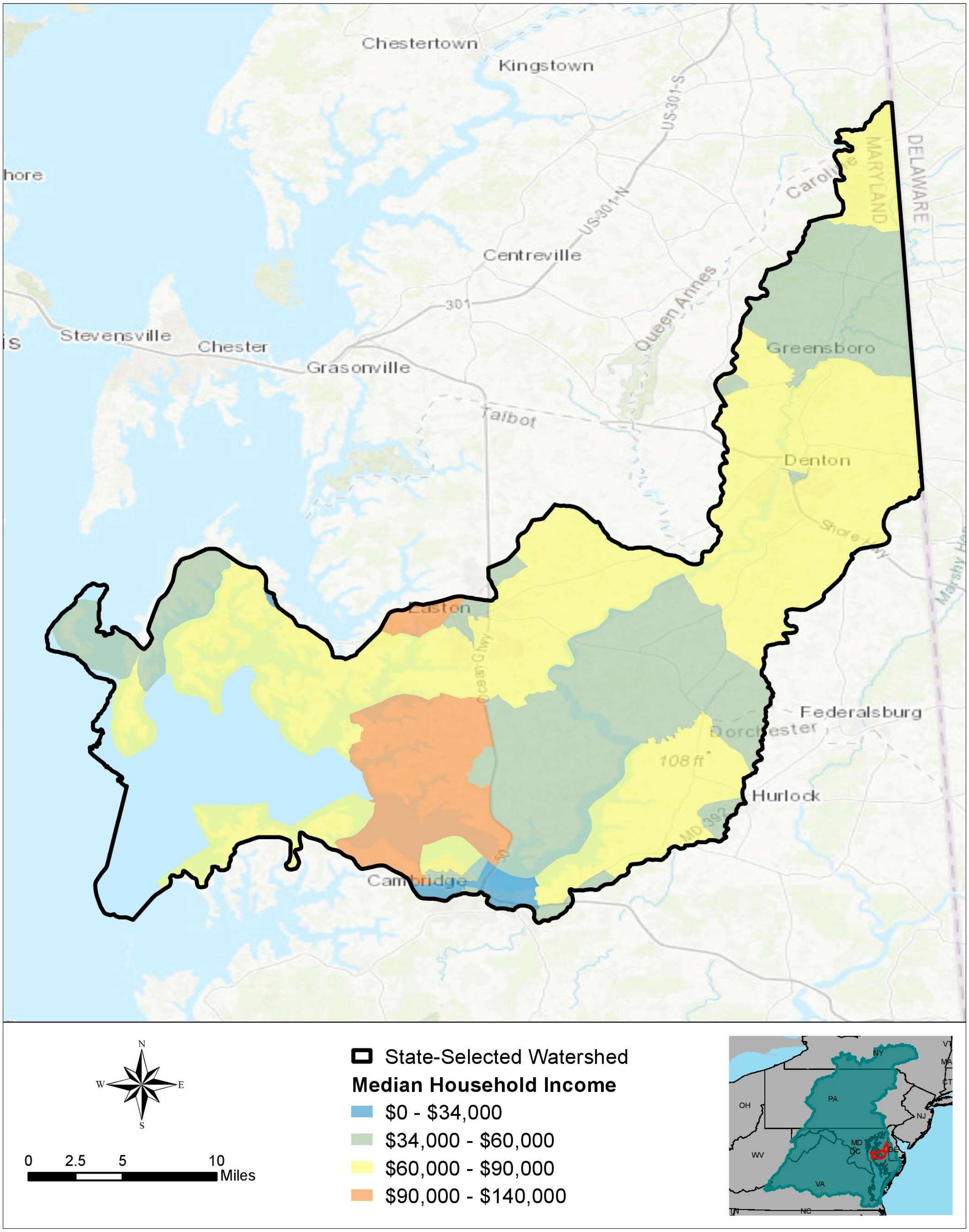

Figure 11. Median household income in the Choptank River watershed (U.S. Census Bureau 2010)

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Section 2

Baywide and Statewide Analyses Results Summary for the Choptank River Watershed

2.1 Problems and Needs

The Chesapeake Bay baywide analysis was conducted to evaluate problems, needs, and opportunities in the Chesapeake Bay Watershed through geospatial analysis. The problems identified in the baywide and statewide analyses are refined at the watershed scale, which are discussed further in Section 3. This section summarizes the problems and needs identified for the Choptank River watershed from the baywide analysis. For more information on the baywide analysis, see the Chesapeake Bay Comprehensive Water Resources and Restoration Plan Main Report and Planning Analyses Appendix.

Several problems and needs within the Choptank River watershed were identified from the baywide and statewide analysis. Maryland State Chapter **Figure 3** highlights the areas of relative watershed stress in Maryland on a subwatershed scale. This analysis illustrates that the three subwatershed areas that make up the Choptank River watershed are all relatively stressed areas. A low percentage of forest cover, high modeled nitrogen and phosphorous loadings, limited riparian buffer areas, moderate imperviousness, impaired stream sections based on the 303(d) impaired waterways list, and moderate scoring based on the index of biotic integrity (Chesapeake Bay Program 2012) are responsible for the watershed being stressed.

Poor habitat connectivity was identified from the Chesapeake Bay baywide and statewide analysis in the Choptank River watershed based on the regional conservation opportunity areas, critical habitats, cores, and connectors (North Atlantic Landscape Conservation Cooperative [NALCC], 2016) (see Chesapeake Bay Comprehensive Water Resources and Restoration Plan Planning Analyses Appendix **Figure 13**). Threatened and endangered species were identified in the Choptank River watershed from the baywide analysis. Work through Envision the Choptank (Trentacoste 2017) identified 72 threatened and endangered species in the Choptank River watershed, with 22 animal and 50 plant threatened and endangered species (Conn 2017) within the watershed.

Proximity to the ocean via the Chesapeake Bay makes the lower portions of the Choptank River watershed susceptible to tidal threats. These threats include coastal storm risks and associated flooding, coastal erosion, impacts from potential future development, and relative sea level change. Sea level rise in the Chesapeake Bay is doubled from land subsidence and erosion (Lerner et al. 2013). The relative risk of tidal threats in the Chesapeake Bay is illustrated on the Maryland State Chapter **Figure 31**, which shows the lower portions of the Choptank River watershed as being one of the areas with the highest tidal treats.

As illustrated on Maryland State Chapter **Figure 22**, there have been significant reductions in submerged aquatic vegetation (SAV) in the Choptank River watershed. This figure compares areas of SAV habitat between 1971 and 2015, highlighting those areas where SAV habitat has been lost between 2015 and 1971. SAV plays a vital role in the Chesapeake Bay ecosystem, improving water quality in the bay, trapping lose sediment in their roots, removing pollutants such as excess nitrogen, providing habitat for spawning fish and other aquatic animals, and providing food for waterfowl (Maryland Sea Grant n.d.). The reductions in SAV habitats are apparent, primarily in the lower portions of the Choptank River watershed.

Although this section summarizes the findings from the Chesapeake Bay baywide analysis, further discussion of the problems and needs within the Choptank River watershed, explored through more localized datasets, can be found in Section 3.

2.2 Opportunities

Several restoration opportunities were identified in the baywide analysis to address the problems and needs identified in Section 2.1. The types of restoration opportunities considered in the baywide analysis include:

- Riparian buffer development and restoration
- Fish passage improvements
- Stream restoration
- Wetland restoration and enhancement
- SAV restoration
- Oyster restoration
- Conservation
- Shoreline stabilization
- Living shorelines
- Marsh migration
- Beneficial reuse of dredged material

Although not exhaustive, these restoration opportunities address several of the problems and needs identified in the baywide analysis. Additional restoration opportunities for the Choptank River watershed are explored and discussed in Section 3.

As shown on Maryland State Chapter **Figures 25** to **27**, the Choptank River watershed was considered a high priority area for restoration and conservation based on engagement from several agencies in the area. The greatest engagement within the watershed is in the lower portion of the watershed where the Choptank River drains into Chesapeake Bay, providing opportunities to address aquatic habitat impairments, land-water connections, and landscape features that affect the health of the river. NOAA has identified the Choptank River and its watershed as one of their Habitat Focus Areas. Additionally, Harris Creek and the Tred Avon

River, two tributaries within the lower Choptank River watershed, have been selected for large-scale oyster restoration efforts to meet Chesapeake Bay Restoration and Protection Executive Order 13509 and 2014 Chesapeake Bay Agreement oyster restoration goals and outcomes.

Another initiative active is 'Envision the Choptank'. Envision the Choptank is a collaborative effort, commenced in 2015, that works to bring nonprofits, government agencies, scientists, and community groups together to identify solutions "to restore swimmable, fishable waters to the Choptank River and support healthy and productive native oyster reefs" (Envisionthechoptank.org).

Within the Choptank River watershed, opportunities were identified to improve fish habitat, including stream restoration and culvert and fish passage (dam) removal to benefit anadromous fish. The Choptank River watershed is home to anadromous fish that need unrestricted access from the bay to the upper reaches of freshwater rivers. Seven fish blockages were identified within the Choptank River watershed as part of the Chesapeake Bay baywide analysis (see Maryland State Chapter **Figure 5**). Maryland State Chapter **Figure 7** highlights the opportunity for stream restoration in the Choptank River watershed based on the presence of anadromous fish habitat and the watershed stressor analysis score.

As illustrated on Maryland State Chapter **Figure 7,** the Choptank River watershed is an area of high nitrogen and phosphorous loadings based on SPARROW (Spatially Referenced Regression on Watershed) modeling conducted at the baywide scale. Maryland State Chapter **Figure 6** highlights the opportunities to restore riparian buffers and increase forested areas to progress toward the goal of 70 percent forested riparian buffer goal that would have added value of reducing nitrogen and phosphorous loading and stress within the watershed.

Maryland State Chapter **Figure 21** highlights oyster restoration opportunities within the tidal portions of Chesapeake Bay. Restored oyster habitats not only support much-needed oysters but can also attract fish and restore ecosystem services to the area (NOAA n.d.-a). Two large areas of oyster restoration prioritization shown on Maryland State Chapter **Figure 21** are Harris Creek and Tred Avon River. These ongoing restoration activities within the Choptank River watershed are discussed further in Section 3.

Wetland restoration was highlighted as an opportunity within the Choptank River watershed based on the Chesapeake Bay baywide analysis. This is illustrated on Maryland State Chapter **Figures 11** and **12**, which shows that the best opportunity for wetland restoration within the Choptank River watershed occurs in the lower reaches of the watershed. Restoration of marshes and wetlands can be achieved through beneficial reuse of dredged material, depositing soil on marshes to support the elevation of the marshes to keep pace with rising sea levels and land subsidence impacts, and shoreline stabilization to minimize the impacts of erosion. Restored wetlands and marshes provide ecosystem benefits, expand habitat, improve water quality, and can help mitigate the threats and risks of coastal storms and sea level rise. This area also presents opportunities for establishing marsh migration corridors that would enable wetlands to move inland as sea level rises.

2.3 Summary of Baywide Analysis Results in the Choptank River Watershed

In summary, the baywide analysis identified the following problems and needs within the Choptank River watershed:

- The Choptank River watershed is one of the highest stressed areas of Chesapeake Bay based on the following considerations:
  - Percentage of impervious area
  - Percentage of forested land cover
  - Nitrogen and phosphorous loading
  - Extent of riparian buffers
  - 303(d) impaired waterways
  - Benthic index of biotic integrity
- There is poor habitat connectivity within the Choptank River watershed.
- The Choptank River watershed is vulnerable to tidal threats such as:
  - Relative sea level change
  - Frequent flooding
  - Coastal storm risk
  - Erosion
  - Future development
- There has been loss of SAV habitat.

Opportunities to address the problems and needs identified in the Chesapeake Bay baywide analysis include:

- Stream restoration to benefit anadromous fish
- Removal of barriers to fish passages within the Choptank River watershed
- Opportunities to implement riparian buffers to reduce nitrogen and phosphorous loading to the Choptank River
- Opportunities for oyster habitat restoration
- Opportunities for SAV restoration

- Opportunities for wetland and marsh restoration, including:
  - Shoreline stabilization
  - Marsh migration
  - Beneficial reuse of dredged material and restoration through soil deposition
- Conservation

Each of these opportunities is discussed and explored further in the more detailed watershed analysis in Section 3.

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Section 3

Choptank River, MD Watershed Analysis

3.1 Choptank River Watershed Problems and Needs

Building upon the findings of the Chesapeake Bay baywide and statewide analyses, this section utilizes localized geospatial datasets, where available, to execute a refined analysis to identify problems, needs, and opportunities within the Choptank River watershed. This section also leverages existing reports, studies, projects, and stakeholder information specific to the Choptank River watershed to inform the findings and analysis.

Stakeholders were engaged to help define the known problems, needs, and opportunities within their watershed. In addition, collaborators working to connect various agencies operating in Chesapeake Bay were engaged to ensure consistency and information sharing. **Attachment A** to this report includes a list of the stakeholders contacted to support the development of this analysis.

The Choptank River watershed is considered an important ecological resource, with habitat for commercial and recreational fisheries and oysters. It is considered a high priority tidal fisheries watershed, which provides spawning and nursery habitat for commercial and recreational anadromous fish (Conn n.d.).

In recent decades, there has been a decline in ecological health, including a loss of wetland areas, variation in SAV habitat, loss of oyster habitat, poor water quality, and overfishing (NOAA n.d.-a). Habitats within the Choptank River watershed are impacted by anthropogenic influences such as continued population growth and land development changes (NOAA n.d.-a). Excessive nitrogen and phosphorous in the watershed's water column has resulted in algal blooms, loss of habitat, reduced dissolved oxygen, and decreased water clarity (Ator and Denver 2015). In addition, relative sea level change and coastal storm risks threaten many of the habitats within the coastal areas of the Choptank River watershed.

Land cover within the Choptank River watershed is dominated by cultivated agricultural land. **Figure 12** shows the breakdown of land cover by area within the watershed based on the high-resolution land cover data from the Chesapeake Conservancy (2016) that were developed for the Chesapeake Bay Program. **Figure 13** illustrates a map of land cover within the Choptank River watershed. **Figure 14** illustrates the land use along the Choptank River shoreline. This shoreline land use information was obtained from the Maryland Shoreline Inventory – Riparian Land Use data layer (Maryland GIS Data Catalog 2006b), which describes the conditions in the immediate riparian zone, the bank, and along the shoreline. For visualization purposes, the shoreline land use data were consolidated into four groups: (1) commercial, residential, or paved; (2) forest or scrub-shrub; (3) agriculture; and (4) grass and barren land use. Shoreline miles of each land use classification were computed using the USA Contiguous Albers Equal Area Conic U.S. Geological Survey projection to ensure that miles were not skewed by the projection of the dataset. The full breakdown of land use along the shoreline of the Choptank River, based on the Maryland

Shoreline Inventory – Riparian Land Use dataset (Maryland GIS Data Catalog 2006), is summarized on **Figure 15**. This shows that a large portion of the land along the streambanks of the Choptank River is residential property, whereas only 20 percent of the total area is forested. Agricultural lands comprise a large percentage of the land along the streambanks of the Choptank River.

Land use practices and natural hydrogeologic and soil conditions result in high nitrogen and phosphorous yields in this area of Chesapeake Bay (Ator and Denver 2015). The tidal conditions at the downstream end of the Choptank River watershed limit the removal of the nutrients from the watershed (Ator and Denver 2015). Nitrogen is transported to receiving waterbodies as nitrate through groundwater, whereas phosphorous primarily is transported over land as runoff attached to sediment (Ator and Denver 2015). More than 90 percent of nitrogen and phosphorous from the Eastern Shore of Chesapeake Bay is applied as inorganic fertilizer or manure or fixed from the atmosphere through cropland, and the remaining 10 percent comes from other sources such as septic systems, wastewater treatment plants, or other urban sources (Ator and Denver 2015). Nitrogen and phosphorous concentrations, highlighted on **Figure 16**, are taken from Ator and Denver (2015) and illustrate that the water quality criteria to protect aquatic organisms are exceeded for nitrogen and phosphorous in the Choptank River watershed. Increased nutrient loading in the watershed also can impact tidal wetlands.

Understanding the sources and dynamics of nitrogen and phosphorous loadings within the watershed can help identify appropriate management measures.

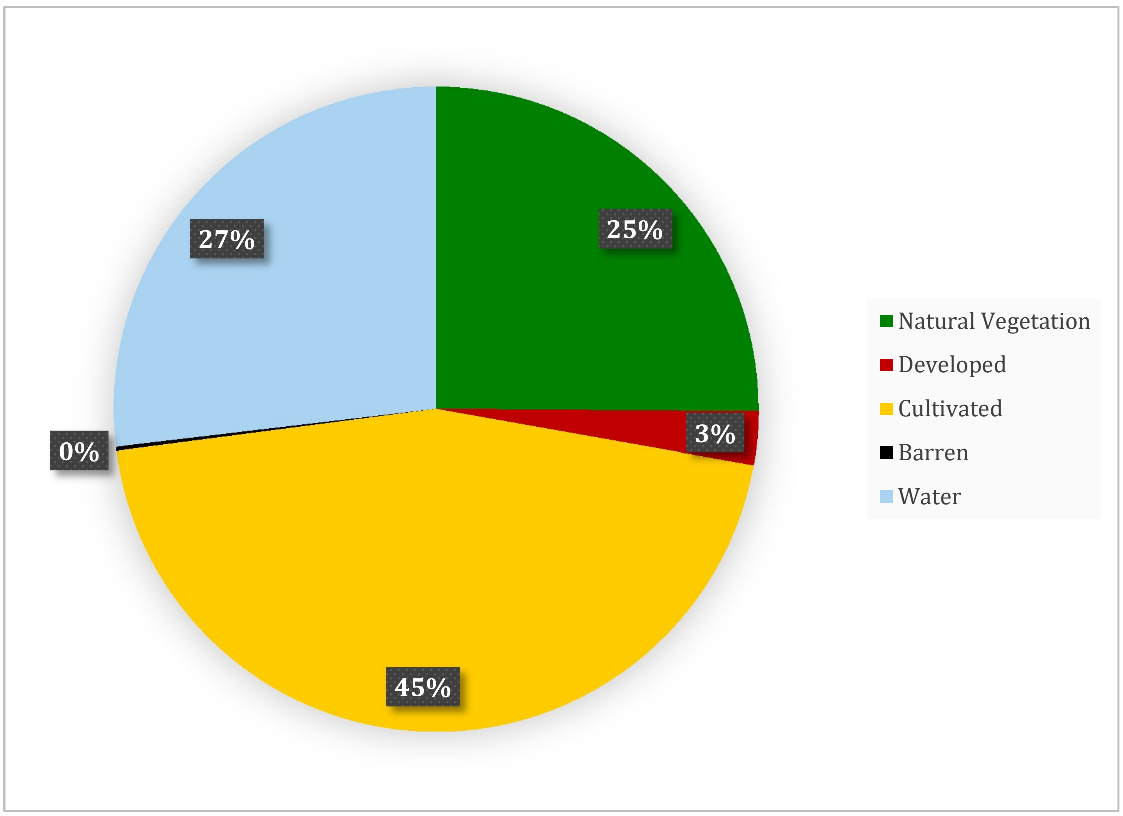

Figure 12. Choptank River watershed land cover (Chesapeake Conservancy 2016)

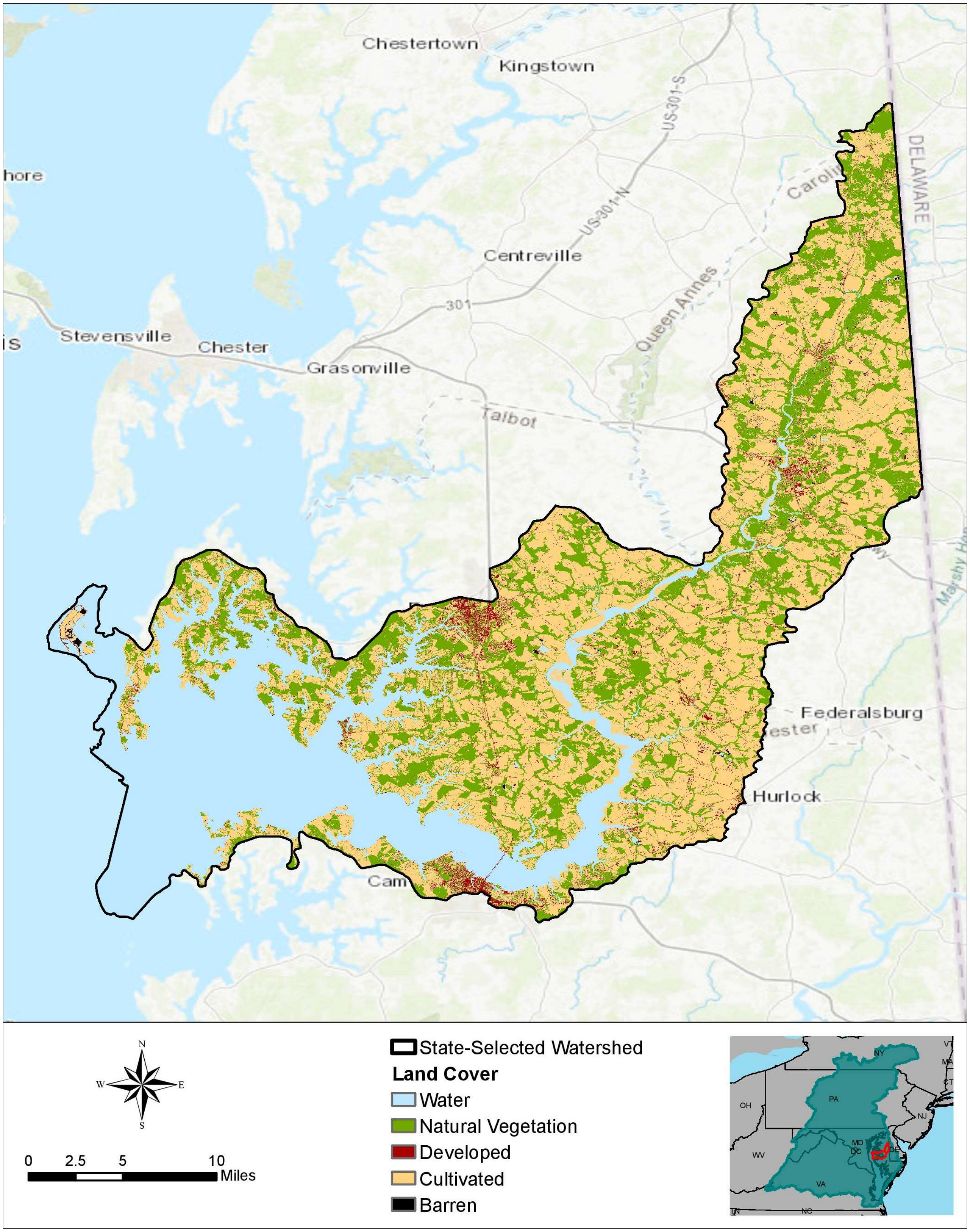

Figure 13. High resolution land cover data in the Choptank River watershed (Chesapeake Conservancy 2016)

Agriculture	Bare	Commerical	Forest	Grass	Paved	Residential	Scrub-Shrub
120.5 Mi	1 Mi	10.1 Mi	101.3 Mi	31.9 Mi	4.5 Mi	198.7 Mi	51.9 Mi

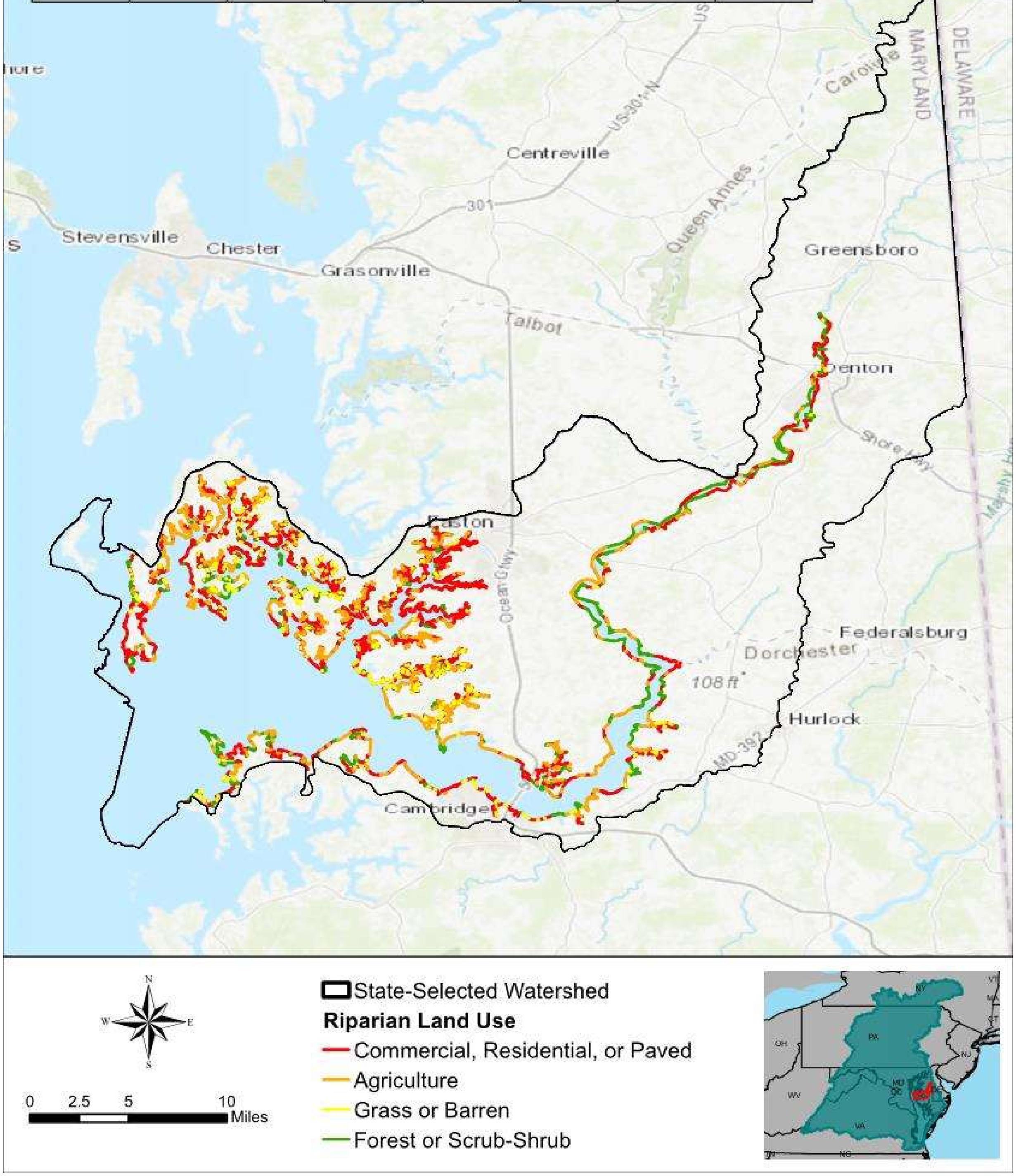

Figure 14. Riparian land use in the Choptank River watershed (Maryland GIS Data Catalog 2006b)

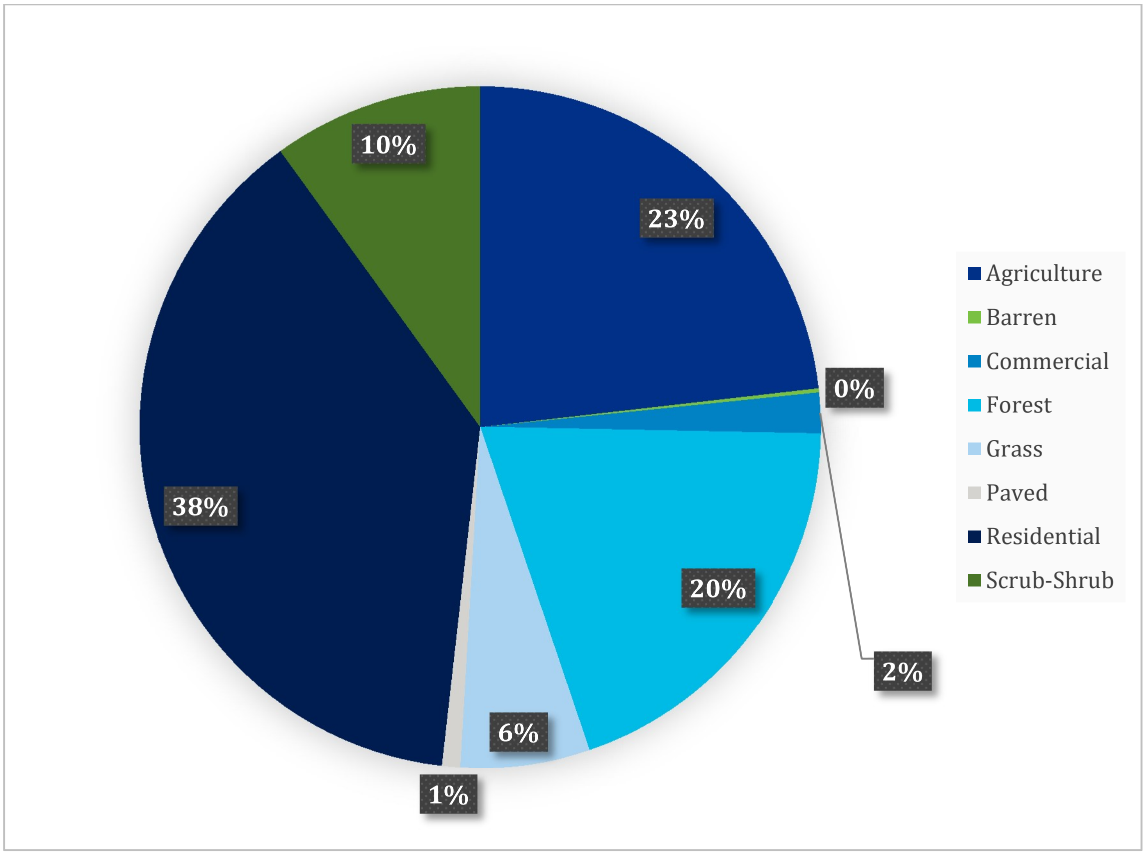

Figure 15. Choptank River shoreline land use (Maryland GIS Data Catalog 2006b)

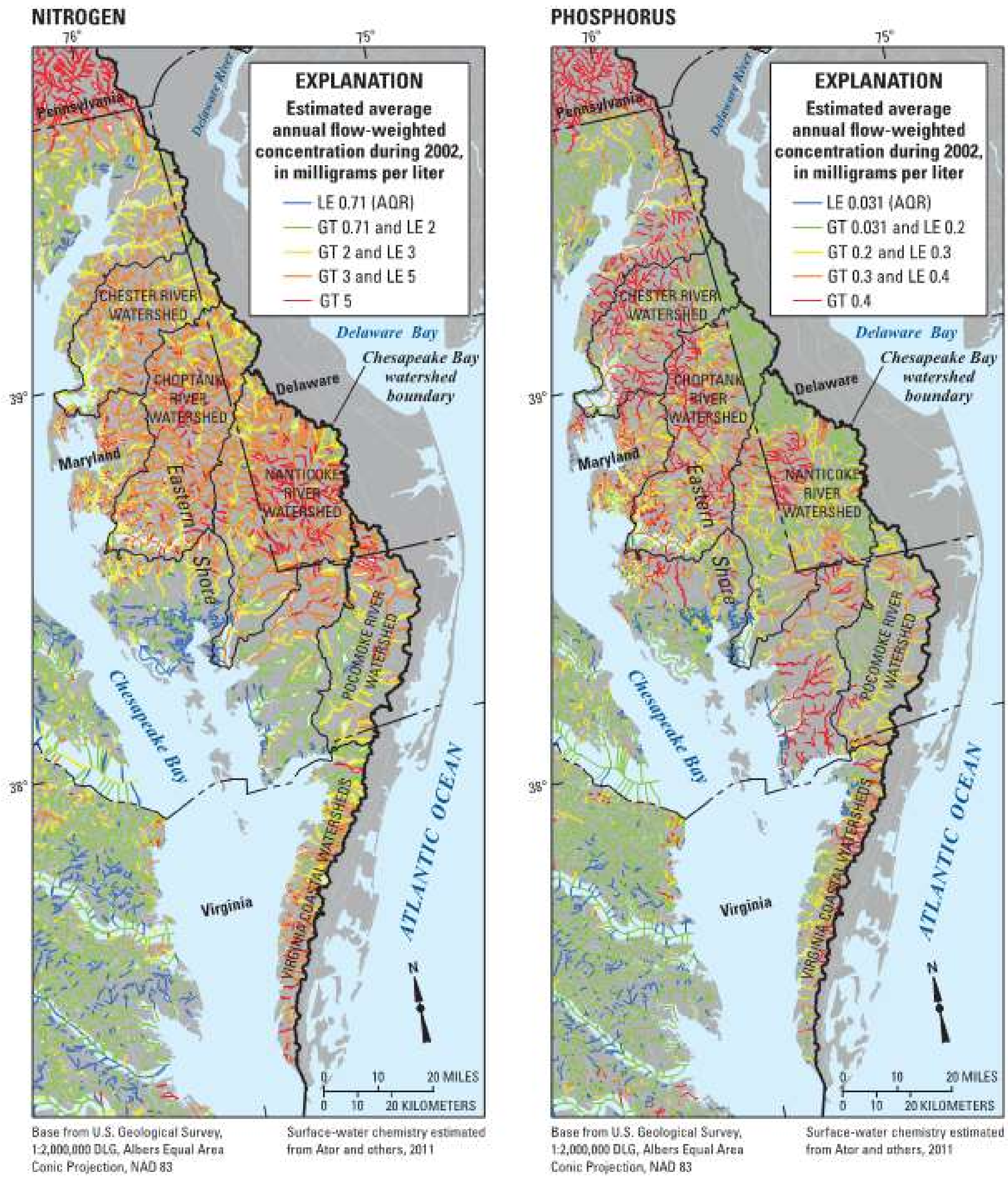

Figure 16. Nitrogen and phosphorous concentrations in the Eastern Shore of Chesapeake Bay (United States Environmental Protection Agency [EPA] 2000; taken from Ator and Denver 2015)

As illustrated on **Figure 17**, the loadings of nitrogen and phosphorous in the Choptank River watershed have resulted in impairments for nutrients based on the EPA's 303(d) list. In addition, waterbodies within the Choptank River watershed are impaired for biological and suspended sediment concentrations. Many of these areas of impaired streams are also areas of sensitive species or waterfowl habitat. **Figure 17** was generated by displaying data from EPA's 303(d) Impaired Waters geospatial data layer (EPA 2015) with the information classified by the data layer's detailed cause of impairment. This information was overlaid with Maryland GIS Data Catalog's Living Resources – Waterfowl Areas data layer (Maryland GIS Data Catalog 2010b) and Sensitive Species Project Review Areas (Maryland GIS Data Catalog 2010a). The waterfowl areas delineated on the map highlight areas of waterfowl concentrations and staging areas. The Sensitive Species Project Review Areas layer buffers areas with rare, threatened, and endangered species and rare natural communities. Therefore, **Figure 18** illustrates the locations where sensitive species and bird habitats may exist along impaired streams.

Similarly, **Figure 18** highlights areas of good, fair, and poor biotic integrity throughout the Choptank River watershed based on the Maryland Stream Health Stream Reaches data layer (Maryland GIS Data Catalog 2017b). This data layer is the average of the fish index of biotic integrity and the benthic index of biotic integrity. This average is considered the combined index of biotic integrity (CIBI). This data layer was created as part of the Maryland Biological Stream Survey (MBSS), which was Maryland's first probability-based or random design stream sampling program. CIBI can be used to assess stream health and quality. Any streams with a CIBI between 1 and 3 were classified as being in poor health and are shown as red on **Figure 18**. Streams with CIBI values between 3 and 3.9 were considered fair health (shown as yellow on **Figure 18**), and those with CIBI between 4 and 5 were considered in good health (shown as green on **Figure 18**). These classifications are overlaid with the Maryland GIS Data Catalog Sensitive Species Project Review Areas (2010a) data layer and Waterfowl Areas (Maryland GIS Data Catalog 2010b). Like **Figure 17**, this figure highlights areas where streams may be in poor or fair health adjacent to critical habitat areas within the watershed.

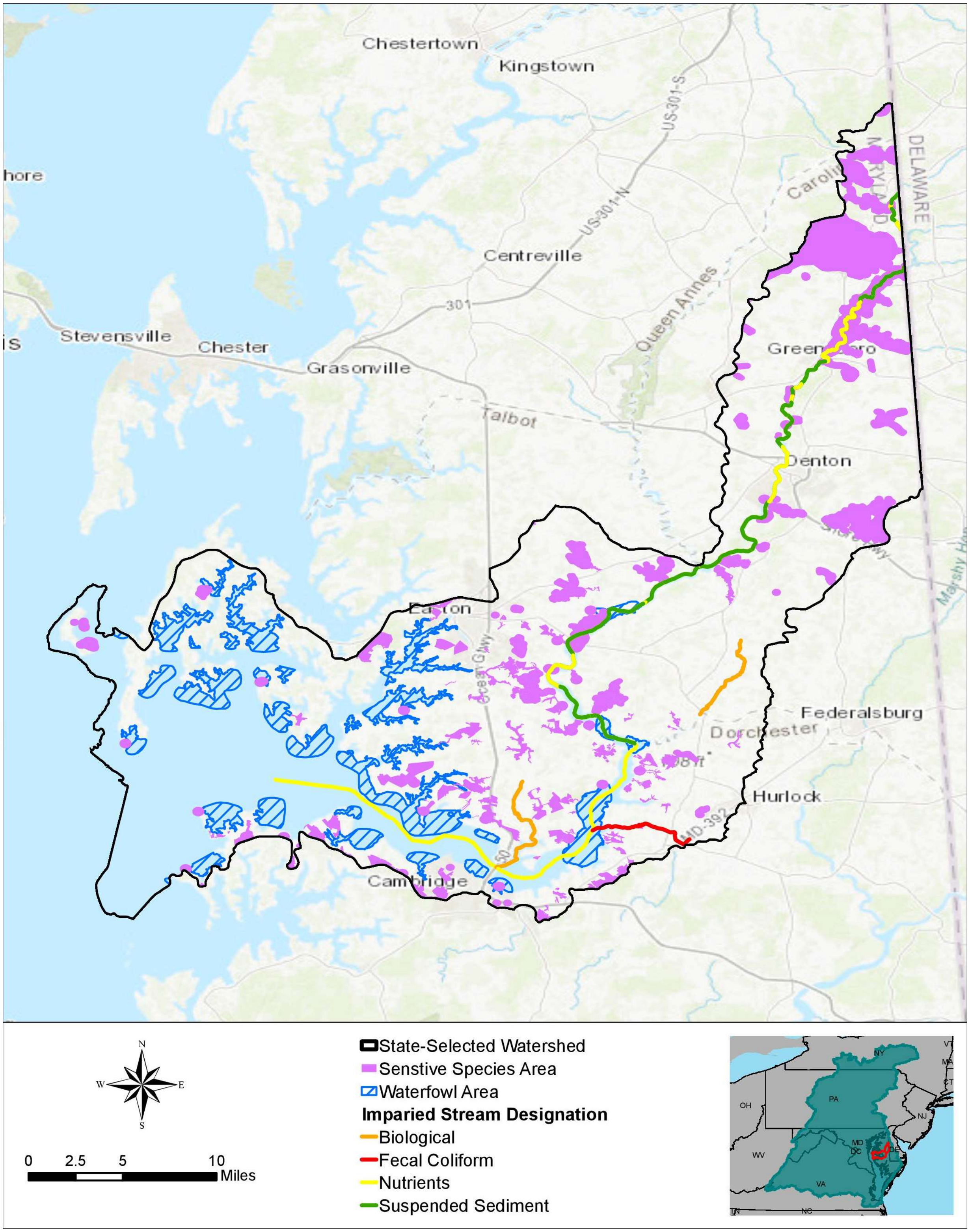

Figure 17. 303(d) impaired streams designation (EPA 2015)

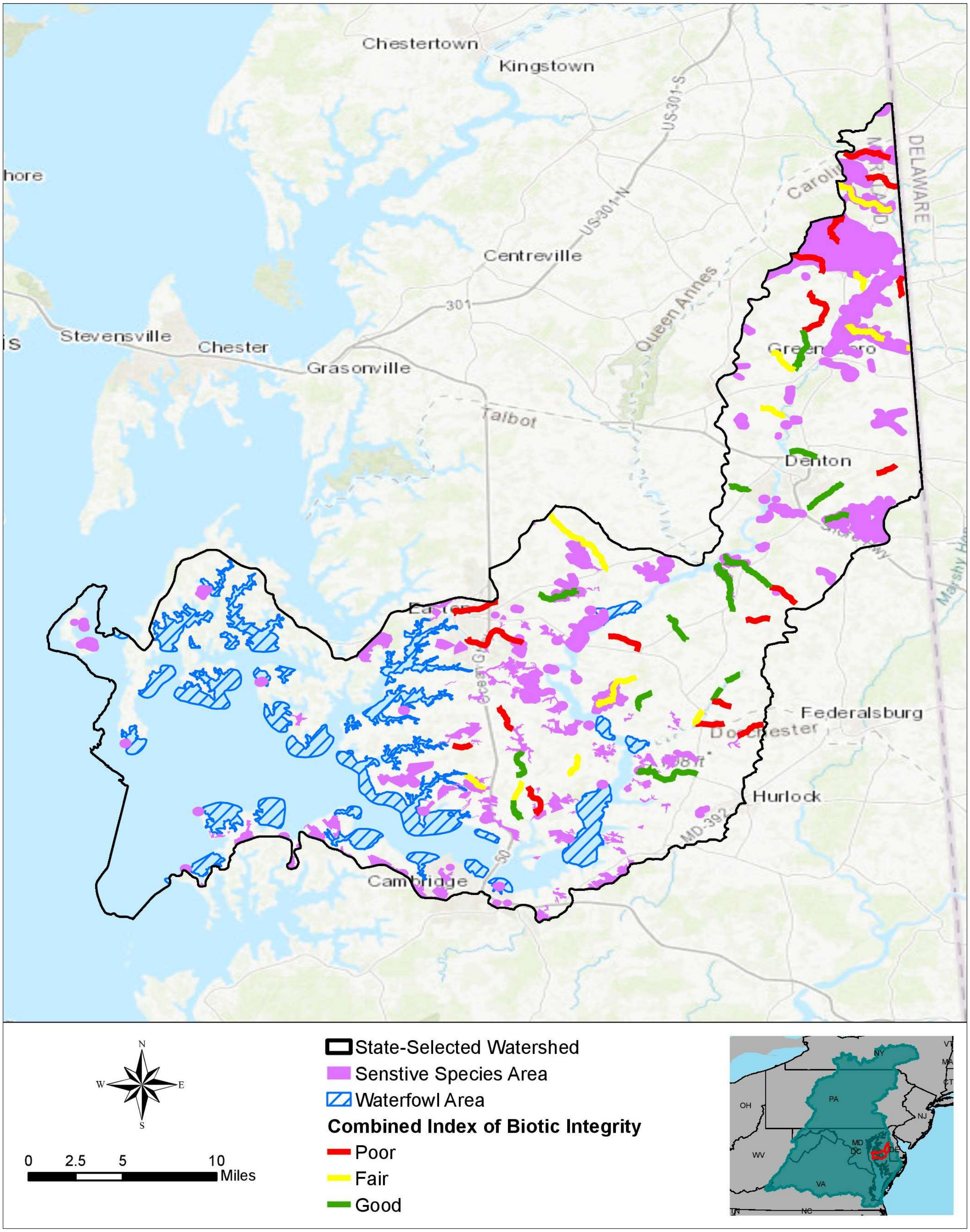

Figure 18. Combined index of biotic integrity for streams surveyed as part of the Maryland Biological Stream Survey (MBSS) (Maryland GIS Data Catalog 2017b)

Figure 19, taken from the Ecological Landscape of Choptank Watershed: In-Water (NOAA n.d.-b), highlights the historic variability in SAV habitat areas within the Choptank River watershed. The presence of SAV is influenced by water quality and temperature (NOAA n.d.-a). Water quality monitoring conducted between 2001 and 2003 in the Choptank River watershed indicated fair and poor secchi depths, which can inhibit growth of SAV (Caroline County 2007). Similarly, areas of high total suspended solids within the watershed can inhibit the growth of SAV (Caroline County 2007).

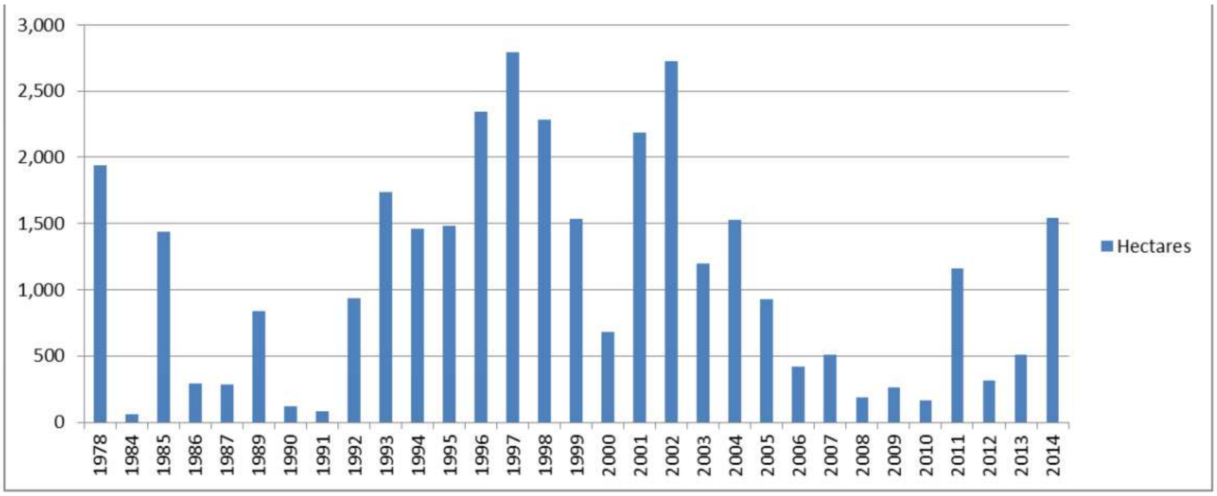

Figure 19. Choptank River hectares of SAV by year (taken from NOAA n.d.-b)

Oysters are a critical species to the Chesapeake Bay, and their populations have declined drastically over the last century, including in the Choptank River watershed. Oysters help improve water quality and provide food and habitat to other animals (Chesapeake Bay Program n.d.-a). They filter sediment and algae and absorb nitrogen from the water, providing feeding grounds to rockfish, crabs, and other marine life (The Nature Conservancy [TNC] 2017). Oyster restoration was part of the 2014 Chesapeake Bay Watershed Agreement goals.

The Choptank River watershed is also a habitat area for spawning commercial and recreational anadromous fisheries. Fish blockages at seven existing dams have been identified within the Choptank River watershed as part of the baywide analysis (TNC 2013). Similarly, fish passage conditions at culverts and stream crossings were assessed within the Choptank River watershed by the North Atlantic Aquatic Connectivity Collaborative (NAACC) (2015). This stream crossings assessment considered high velocities, outlet drop, shallow waters, flow constrictions, inlet drop, and scour as well as other adverse conditions to fish habitat (Martin and Levine 2016). **Figure 20** shows the seven fish blockages at dams in the Choptank River watershed —identified in a six-tier classification by the Chesapeake Bay Fish Passage Workgroup (TNC, 2013) and included in the baywide analysis—classified by priority for removal, with Tier 1 indicating dams with a highest priority for removal for anadromous fish. This figure also shows the stream crossings classified by their severity in being a barrier for fish habitat. The extent of anadromous fish habitat is also displayed on the map based on data from the Chesapeake Bay Program (Atlantic States Marine Fisheries Commission [ASMFC] 2004).

US Army Corps of Engineers

The baywide analysis also highlighted the Choptank River watershed as an area subject to tidal threats. This includes coastal flooding, wave action, and relative sea level change. These threats can have adverse impacts on tidal wetlands, particularly when wetlands cannot build elevation at a rate to keep pace with relative sea level change, which is exacerbated by land subsidence and erosion. Shoreline development can also impact erosion hazards and limit marsh migration. An assessment of shoreline condition in Harris Creek, Tred Avon River, and Broad Creek shows that they are 34 to 44 percent hardened (NOAA n.d.-b).

In summary, there are several problems and needs in the Choptank River watershed, including:

- High nutrient loading and poor water quality, including total suspended solids and clarity
- Stream impairments for biological, fecal coliform, nutrients, and suspended sediment
- Decline of oyster and SAV populations
- Loss of wetlands
- Shoreline erosion, coastal storm risks, and relative sea level change
- Lack of riparian (including shoreline) buffers

Several projects have been completed or are ongoing to address some of these problems and needs within the watershed. **Figure 21** shows the existing and ongoing projects within the Choptank River watershed. This analysis of the Choptank River watershed will avoid the duplication of ongoing efforts and activities within the watershed.

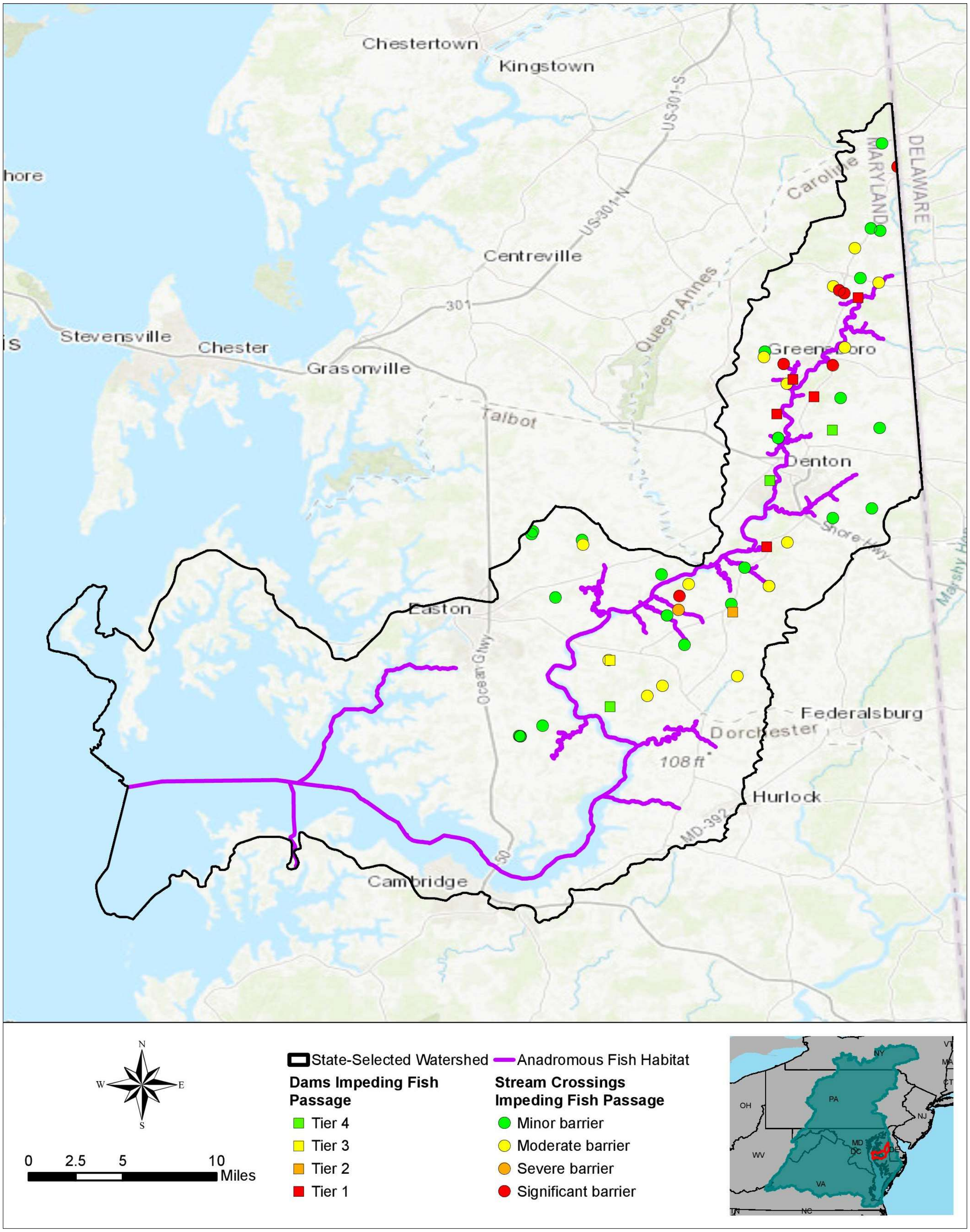

Figure 20. Dam and culvert locations Impeding Fish Passage (TNC 2013; NAACC 2015)

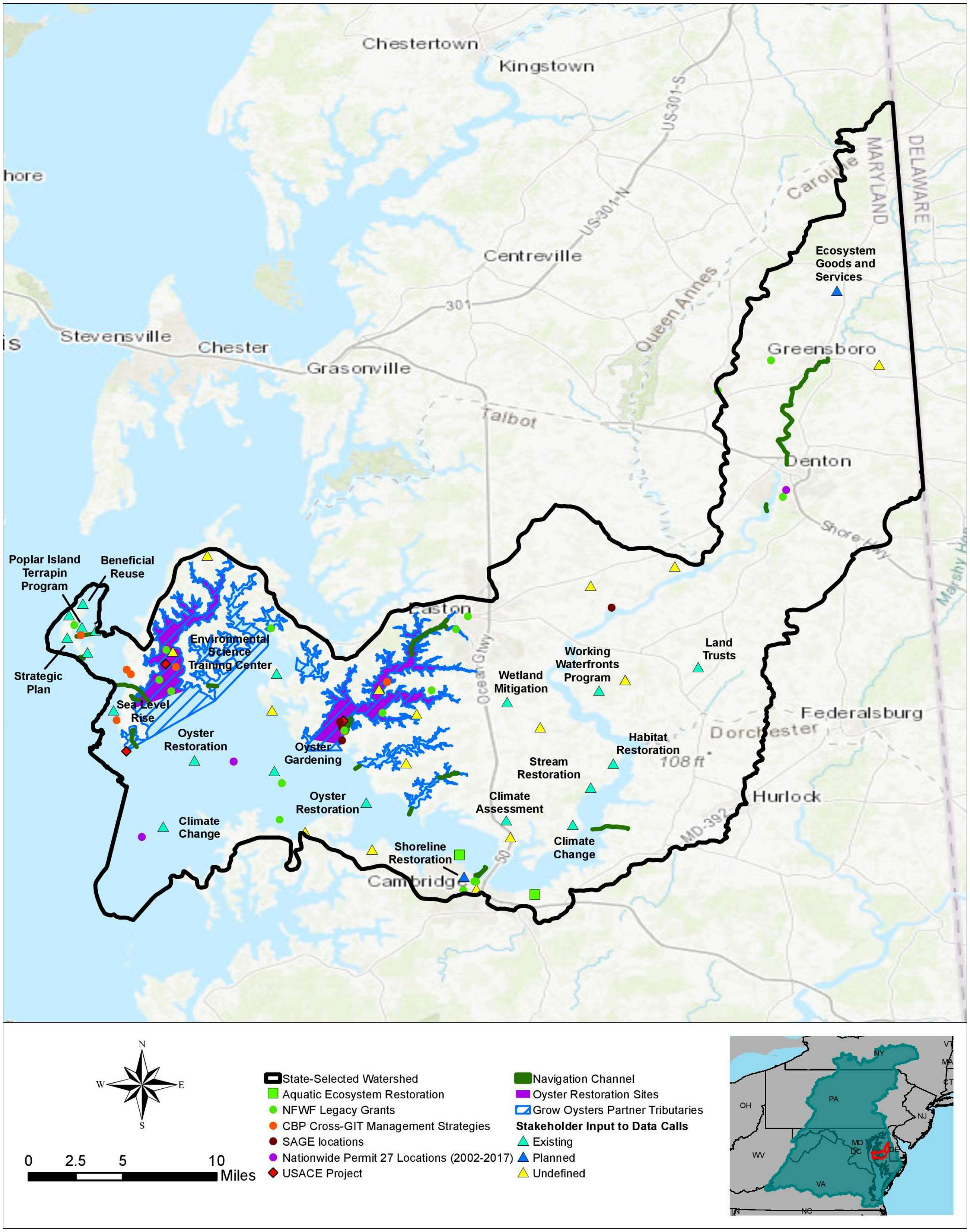

Figure 21. Existing and ongoing projects in the Choptank River watershed

3.2 Choptank River Watershed Opportunities

There are several measures that can be implemented to restore ecosystems and address problems and needs within the watershed. Several activities are underway by state and federal agencies to improve ecosystem health within the Choptank River watershed. This section discusses select restoration activities to consider for future investigation and planning. Information is provided for each restoration measure based on available data, including existing projects, ongoing studies, or completed projects within the watershed.

3.2.1 Oyster Restoration

3.2.1.1 Summary of the Oyster Restoration Need

Overfishing, habitat loss as result of poor water quality, and disease have been responsible for the decline of oyster habitats in the Choptank River watershed (NOAA n.d.-a). Oyster populations are estimated to be less than 1 percent of historic high populations (NOAA n.d.-a). In Harris Creek, within the Choptank River watershed, 1,500 acres of oyster reefs once existed; in 2011, only a couple of acres remained (Chesapeake Bay Foundation n.d.). Significant multi-agency oyster restoration efforts have been underway in recent years in Harris Creek and Tred Avon River within the Choptank River watershed. This restoration project is an ongoing effort and includes monitoring and evaluation of restored reefs.

3.2.1.2 Existing and Ongoing Oyster Restoration

Large-scale oyster restoration efforts are led by the Maryland Oyster Restoration Interagency Team, which includes NOAA, USACE, the State of Maryland, and the Oyster Recovery Partnership. TNC, cooperating scientists, the Chesapeake Bay Foundation, and local stakeholders are all incorporated into the effort through outreach and coordination.

As part of the Maryland Oyster Restoration Interagency oyster restoration effort, 350 acres of oyster reef habitat in Harris Creek was seeded with more than 2 billion oysters in 2013. These oysters were bred at the University of Maryland's Horn Point Hatchery (TNC 2017). Monitoring since 2013 has shown the Harris Creek restoration project to be highly successful, with 2016 monitoring showing 97 percent of the restored reefs meeting requirements of oyster density of 15 oysters per square meter (TNC 2017). The success of this restoration project shows promise for additional restoration efforts underway in the Tred Avon River tributary of the Choptank River watershed. The Tred Avon River restoration project will target restoration of 147 acres of oyster reef. As of spring 2018, 86 acres of the 147 acres have been completed. In addition to these efforts, 8 acres of reef habitat were established in the Cook Point Sanctuary within the Lower Choptank River in 2010.

Restoration efforts extend outside the large multi-agency efforts. Over 1,500 waterfront property owners have been engaged in restoring oysters along the Maryland coastline as part of the Maryland Grow Oysters program, managed by the Maryland Department of Natural Resources through collaboration with the Oyster Recovery Partnership, University of Maryland Center of Environmental Science, Maryland Department of Public Safety and Corrections (Maryland Department of Natural Resources [DNR] n.d.-a). The program began in 2008 in Tred Avon River and has since expanded to over 30 different tributaries in Maryland, including Island Creek and La Trappe Creek in the Choptank River watershed (Maryland DNR n.d.-a).

Figure 22 summarizes recent oyster restoration efforts in the lower Choptank River region. The map includes areas of oyster plantings from 2000 to 2014 based on the Maryland Shellfish – Oyster Plantings data layer (Maryland GIS Data Catalog 2014b), areas of the multi-agency restoration effort in Harris Creek and Tred Avon River (Chesapeake Conservancy n.d.), and areas where property owners are engaged in the Maryland Grow Oysters program (Maryland DNR n.d.-a).

3.2.1.3 Oyster Restoration Opportunities

With much ongoing oyster restoration work in the Choptank River watershed, opportunities exist to continue to monitor and complete the ongoing restoration projects and maintain these projects into the future.

3.2.1.4 Oyster Restoration Costs

Costs for oyster plantings (1-foot height for each substrate type), including mobilization and demobilization, with a 30 percent contingency, range from $147,000 per acre for mineral substrate to $205,000 per acre for shell substrate in 2017 U.S. dollars.

The cost estimate for the completion of the entire plan within the Tred Avon River Oyster Sanctuary is estimated at $14.5 million (Maryland Oyster Restoration Interagency Workgroup 2014). Between 2012 and 2016, $29.6 million were invested on reef construction, material transport, and spat-on-shell (baby oysters) in Tred Avon River and Harris Creek (Chesapeake Bay Program 2018).

Monitoring of the restoration projects will be less costly than the initial restoration efforts.

3.2.1.5 Implementation Barriers to Oyster Restoration

Funding can be an implementation barrier to oyster restoration. The oyster restoration projects underway have been successful but require significant investments to complete.

Impacts of climate change, including temperature changes, potential acidification, changes in salinity, poaching, and disease, are all threats to oyster habitat. Navigation, overfishing, and anthropogenic influences, such as management decisions, all affect the success of oyster restoration. Water quality also may impact oyster restoration success because excess sediments can smother oysters (USACE 2015). Therefore, other restoration efforts in the watershed may be important to support oyster restoration. Natural hard bottom or shell substrates and brackish salinities are necessary for oyster restoration efforts to be successful (USACE 2015). The primary impediment to reaching the oyster restoration targets established for Tred Avon River is an acceptable alternate substrate to use for restoring reef habitat.

Developing stakeholder buy-in and participation can also affect the pace of restoration.

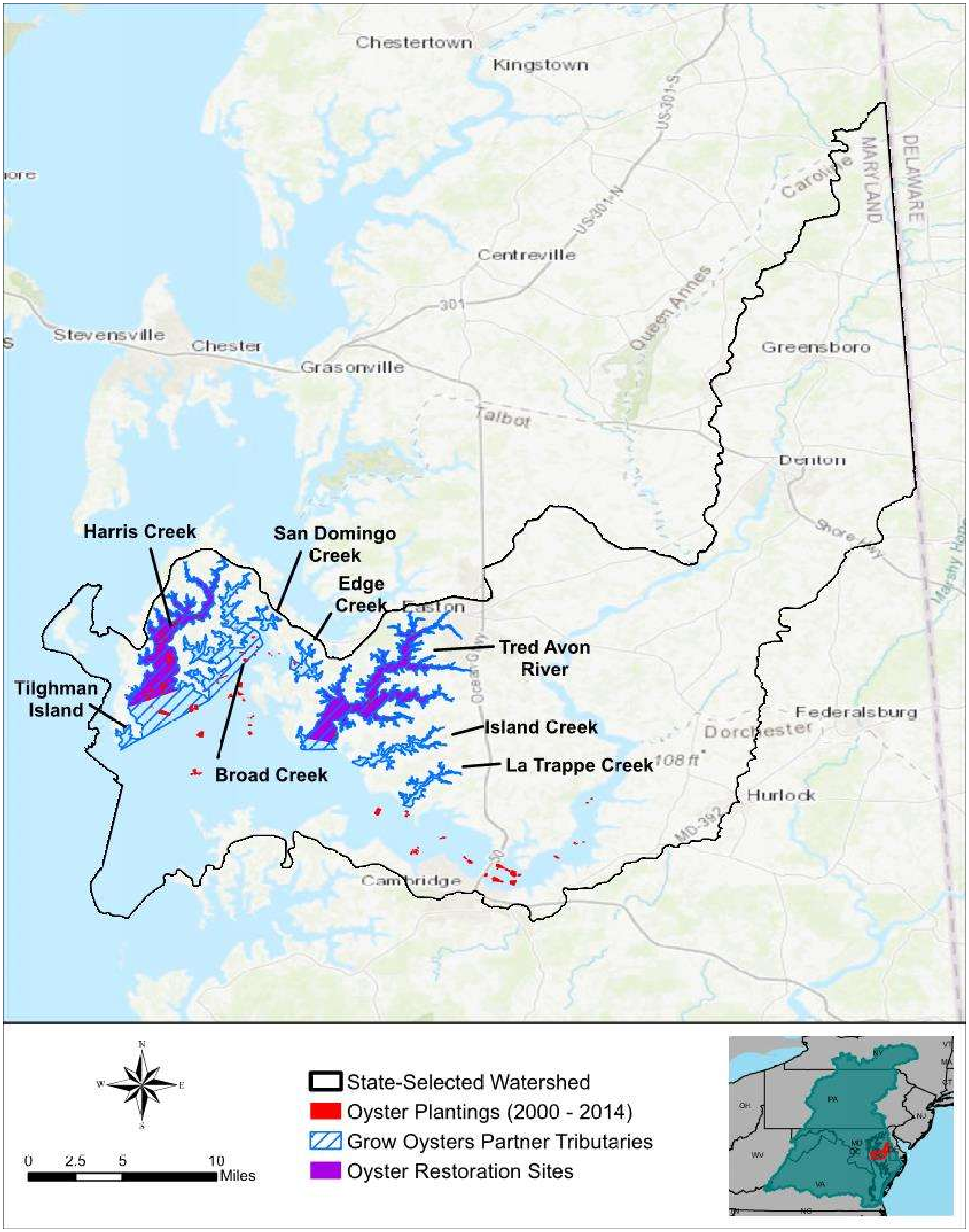

Figure 22. Oyster plantings and oyster restoration areas within the Choptank River watershed (Maryland GIS Data Catalog 2014b; Maryland DNR n.d.-a; Chesapeake Conservancy n.d.)

3.2.2 Streambank Stabilization and Living Shorelines

3.2.2.1 Summary of Streambank Stabilization and Living Shoreline Need

The shoreline of the Choptank River has been subject to historic erosion from streamflow and coastal erosion. **Figure 23** displays areas of stabilized shoreline and highlights those areas of high erosion. This figure was created by combining two geospatial datasets: (1) the Maryland Shoreline Inventory – Stabilization Structures (Maryland GIS Data Catalog 2006d) and (2) the Maryland Shoreline Inventory – Shoreline Bank Height and Condition (Maryland GIS Data Catalog 2006c). The Shoreline Structures data layer was used to identify structured shorelines versus unstructured shorelines using the "STRUCTURE" attribute field. Those sections of shoreline where the STRUCTURE classification was set to "NULL" were considered to be unstructured. The Shoreline Bank Height and Condition dataset was used to identify areas of "High" or "Undercut" erosion. These two data layers were intersected to identify areas of unstabilized shoreline with high evidence of erosion.

Living shorelines use plants or other natural elements, sometimes combined with hardened shoreline features, to stabilize shorelines of estuarine coasts, bays, and tributaries (NOAA 2017). This type of shoreline restoration approach can provide multiple benefits, including minimizing coastal erosion and maintaining coastal processes to restore and enhance natural shoreline habitat. Living shorelines provide shallow water habitat and provide shoreline access for wildlife and recreation. Coastal storm risks are reduced through the absorption of wave energy, storm surge, and flood waters, and they can improve water quality by settling sediments and filtering pollutants (Maryland DNR 2011). This type of restoration activity was considered in the lower estuarine sections of the Choptank River watershed.

Streambank and shoreline stabilization involves the restoration of the banks of streams, lakes, and estuaries and excavated channels to mitigate scour and erosion by using vegetative plantings, soil bioengineering, and structural systems (USDA NRCS 1996). Shoreline stabilization can work to reduce the force of water against the streambank, or to increase the resilience of the streambank to erosive forces. Often, these types of measures can work in concert with each other (USDA NRCS 1996). Streambank stabilization was considered to address erosion in the upper riverine sections of the Choptank River watershed.

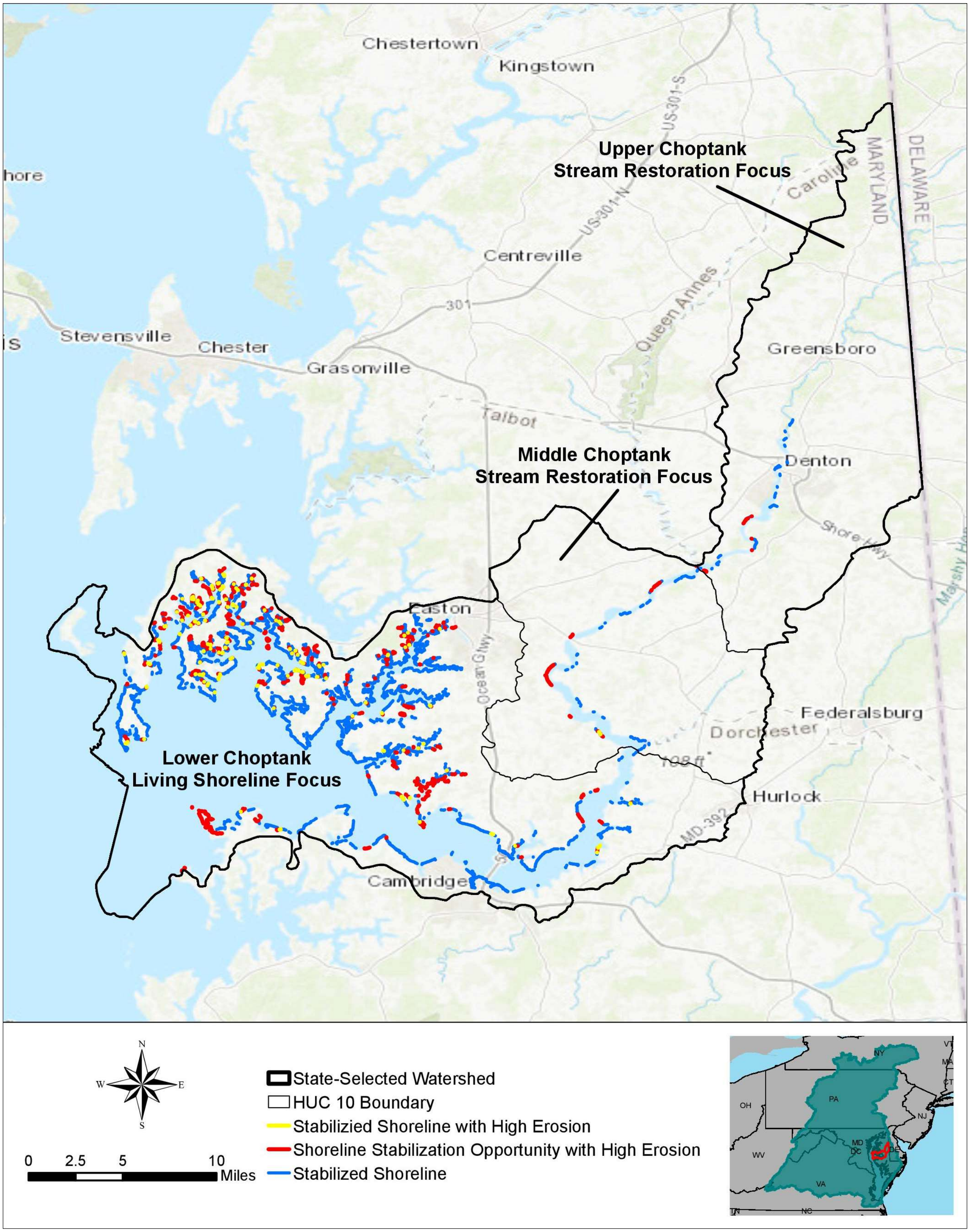

Figure 23. Areas of stabilized and unstabilized shorelines experiencing high erosion rates (Maryland GIS Data Catalog 2006c, 2006d).

3.2.2.2 Existing and Ongoing Streambank Stabilization and Living Shoreline Projects

Within the Choptank River watershed, a Maryland living shoreline project was developed to incorporate sea level into designs at the Gunston School, Ferry Point Park, Conquest Preserve, and Shingle Breach. Farther upstream within the mainstem of the Choptank shoreline, restoration is planned at Cambridge Beach, Howbrooks Beach, Hurst Creek, Franklin Point Park, and St. Catherine's Island. Projects have been completed to manage coastal flood risks along the waterfront.

These existing and planned projects are shown on **Figure 21.**

3.2.2.3 Streambank Stabilization and Living Shoreline Opportunities

Within the Choptank River watershed, 36 miles of shoreline with high erosion rates were identified, illustrated with the yellow and red shoreline segments on **Figure 23**. These areas of high erosion were further divided to distinguish areas of stabilized shorelines where the stabilization features may be failing and locations where no stabilization efforts have been expended. Areas of stabilized shorelines that are still experiencing erosion may be ideal locations to replace hardened infrastructure with living shorelines and vegetation to reduce erosion. Within the 4 miles of stabilized shoreline that are experiencing erosion, living shorelines or natural and nature-based features should be explored to manage erosion risks along the banks of the Choptank River. By minimizing the use of hardened structure, habitat opportunities are created for oysters, fish, and other wildlife. These systems may also help attenuate storm surge and wave activity, reducing coastal storm risks. Beyond the 4 miles of stabilized shoreline experiencing erosion, there may be additional opportunities to remove hardened shorelines from the remaining 165 miles of stabilized shoreline within the watershed and replace them with more natural and nature-based features.

Living shorelines were identified in the Choptank River watershed analysis as an appropriate measure to address high erosion rates in the 29.2 miles of the unstabilized portion of the Lower Choptank along the estuarine coast. Areas of unstabilized shoreline in the middle and upper reaches of the Choptank River watershed were considered opportunities for streambank stabilization.

This analysis identified 2.6 miles of high erosion area farther upstream in the Choptank River where streambank stabilization may be a viable mitigation measure and living shorelines may be less appropriate. Further investigation is recommended to confirm the most appropriate solutions in each of these areas. Streambank stabilization projects also help provide habitat for fish and other wildlife. Control of aggressive bank erosion within the Choptank River watershed can help improve water quality and may provide improved recreational space and opportunities.

3.2.2.4 Streambank Stabilization and Living Shoreline Creation Costs

Costs to develop living shorelines are estimated at $1,280 per linear foot. This cost estimate does not include land acquisition. Applying this estimate, the development of living shorelines to the 29.2 miles of unstabilized eroding shoreline in the Lower Choptank would cost approximately $200 million in U.S. 2017 dollars. The approximate cost to develop and implement living shorelines along the 4 miles of armored shoreline experiencing high erosion rates would be $27 million in U.S. 2017 dollars, with additional expenditures to remove the existing hardened shoreline structures.

Stream stabilization costs are estimated at approximately $600 per linear foot. This estimate does not include land acquisition costs. Using this estimate, stabilization of the 2.6 miles of shoreline would cost approximately $8 million in U.S. 2017 dollars.

3.2.2.5 Implementation Barriers to Streambank Stabilization and Living Shorelines

Funding is a major implementation barrier to implementing streambank stabilization and living shorelines. Land access and acquisition may be necessary in some instances to develop living shorelines and streambank stabilization projects, presenting a significant implementation barrier and requiring additional funding. Other states have been successful in obtaining access to floodplains and stream buffers through collaboration with other NGOs.

Additionally, wetland stressors may be an implementation barrier. In coastal areas, relative sea level change, coastal storms, and wave action may be implementation barriers to developing and maintaining successful living shorelines. Poor water quality also may be an implementation barrier to living shorelines.

For stream stabilization projects, upland land use and drainage patterns may be an implementation barrier to successful streambank stabilization. Additionally, climate change or varying streamflow patterns from upland development may be barriers to successful streambank stabilization efforts.

3.2.3 Riparian Buffers

3.2.3.1 Summary of the Riparian Buffer Need

Riparian buffers can provide water quality and habitat benefits throughout the watershed. Riparian buffers can help clean water by preventing pollutants, nutrients, and sediment loads from entering waterbodies and assist with stabilizing streambanks (USACE 2015). In addition to providing habitat restoration benefits, restored riparian buffers can also serve flood risk management benefits (USACE 2015). The 2014 Chesapeake Bay Watershed Agreement goals target restoration of 900 miles per year of riparian forest buffer and conservation of existing buffers in the Chesapeake Bay until 70 percent of the riparian areas in the watershed are forested (USACE 2015).

Based on the Maryland GIS Data Catalog Shoreline Inventory – Riparian Land Use dataset (2006b), evaluating the mainstem of the Choptank River, only 20 percent of the riparian shorelines are forested, as illustrated on **Figures 14 and 15**, with another 10 percent classified as scrub-shrub, leaving plenty of opportunity to restore forested riparian buffers. This dataset was only available for the mainstem of the Choptank River and was considered best available data for defining riparian land use.

Due to high agricultural land use, there are several areas of high nutrient loading in the Choptank River watershed as illustrated in **Figure 16**. Riparian buffers may help manage nutrient and other pollutant loadings to the receiving waters of the Choptank River. Riparian buffer restoration should be targeted along tributaries and the mainstem in areas with highest nutrient loading. Geospatial information was not available at the time of this study to identify those areas to prioritize riparian buffer restoration. However, if information was available, this dataset would have been used to identify riparian buffer opportunities.

3.2.3.2 Existing and Ongoing Riparian Buffer Projects

Although riparian buffer restoration may be taking place as part of stream restoration projects, there are no known independent riparian buffer restoration efforts in the Choptank River watershed.

3.2.3.3 Riparian Buffer Restoration Opportunities

With only 20 percent forested riparian buffer areas along the mainstem of the Choptank River and several stream impairments for nutrients, there are opportunities for restoring riparian forest buffers along the Choptank River and its tributaries.

Using the mainstem Choptank River shoreline land use classification data (Maryland GIS Data Catalog 2006b), areas that were considered grass and barren along the shoreline were identified for riparian buffer restoration. These two land use classifications covered 32.9 miles of shoreline, or approximately 392 acres of area, assuming a 30 meter buffer. Restoring riparian buffers in these categories of land use along the mainstem shorelines make up an additional 39 percent of the watershed. Executing riparian buffer restoration in residential and developed areas of the shoreline likely would be more challenging. Although conversion of these categories of land use would not achieve the 70 percent forested goal, it would be a significant improvement.

There are also inland riparian buffer opportunities that could be undertaken to reach the 70 percent goal. Along tributaries in the Choptank River watershed, areas for riparian buffer restoration were identified based on land cover classification and targeting areas of high value for contributing to the watershed water quality. Using the land use classification data within the watershed (Chesapeake Conservancy 2016), herbaceous and barren land cover areas were identified within 30 meters on either side of the tributaries within the watershed. Areas of herbaceous land cover classification generally include grassy, agricultural, and barren areas in the watershed. The Chesapeake Bay Program conducted a resource land assessment using geospatial data and expert knowledge to identify the most important remaining resource lands in the Chesapeake Bay Watershed (Chesapeake Bay Program n.d.-b). As part of this effort, they identified the most important areas of forests and wetlands that contribute to protecting water quality and sustaining watershed integrity. Those areas within 30 meters of tributaries within the watershed that were herbaceous or barren land cover intersect with the most valuable areas to watershed quality were identified for riparian buffer restoration opportunities. Using this approach, 641 acres of streambank along tributaries in the Choptank River watershed were identified as locations with opportunities for riparian buffer restoration. If data are available regarding the nutrient loading to each tributary in the Choptank River watershed, it is recommended that riparian buffer restoration be focused on areas of highest nutrient loading within the watershed.

Figure 24 highlights the identified riparian buffer restoration opportunities along the mainstem of the Choptank River and along tributaries within the Choptank River watershed. This analysis identified 96.5 miles of stream or river with riparian buffer restoration opportunities.

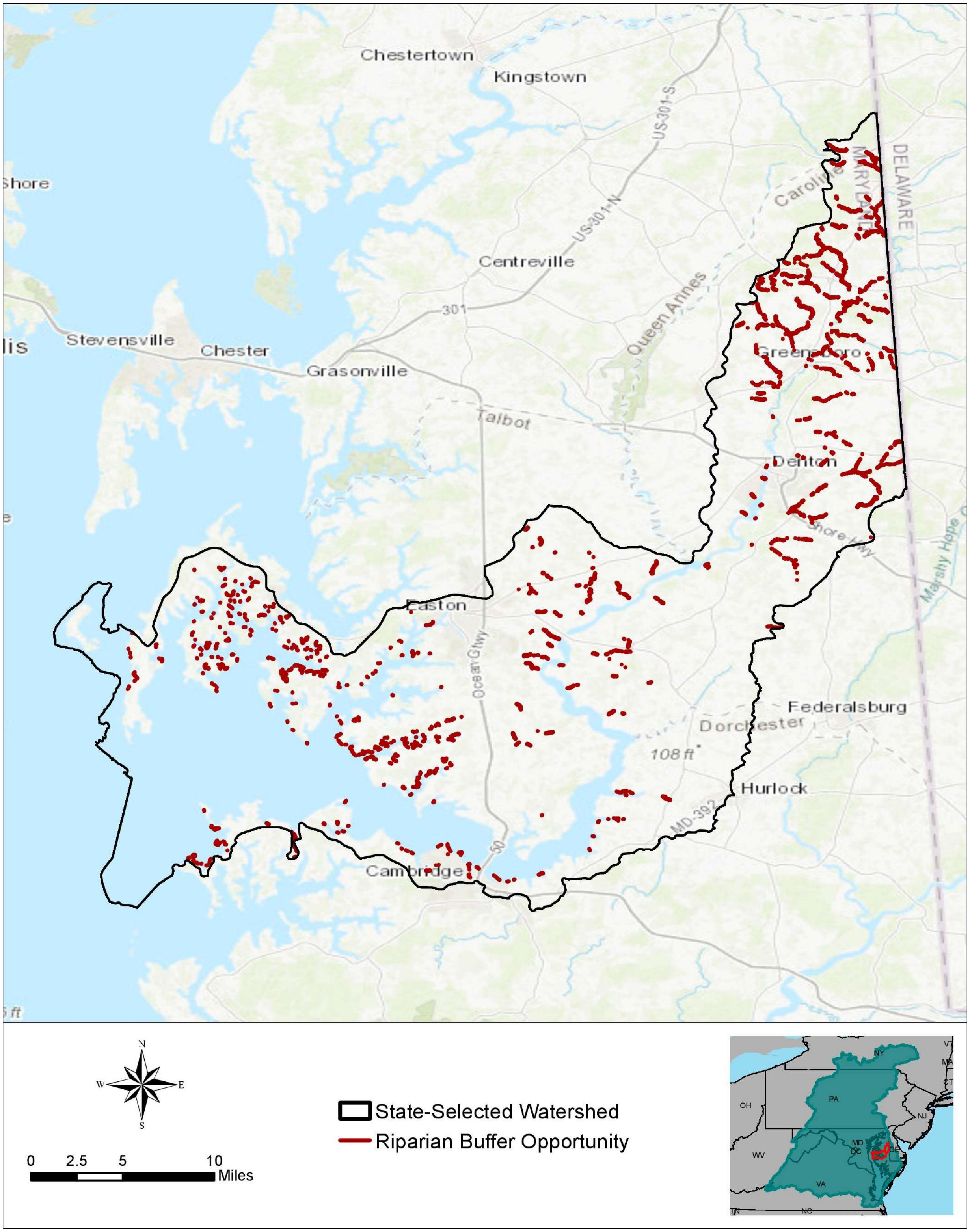

Figure 24. Riparian buffer restoration opportunities within the Choptank River watershed

3.2.3.4 Riparian Buffer Restoration Costs

There is a wide range of potential riparian buffer vegetation restoration costs. The U.S. Forest Service has revegetated riparian buffers for as low as $800 per acre (2017 U.S. dollars), whereas the *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers* (Palone and Todd 1997) cost estimates can be up to $6,200 per acre in 2017 U.S. dollars. This higher estimate includes site preparation, tree seedlings, maintenance and additional plantings, shelters, fencing, herbicide treatment, and mowing.

Assuming a 30 meter buffer along the mainstem Choptank River, the cost to restore riparian buffers in the areas currently designated as grass or barren land use along the mainstem of the Choptank River could cost between $315,000 and $2.5 million U.S. 2017 dollars. To restore 30 meter wide riparian buffers in herbaceous or barren land cover classification areas that intersect with the most valuable areas to watershed quality along tributaries to Choptank River could cost between $513,000 and $4 million U.S. 2017 dollars. It is recommended that those tributaries with the largest nutrient impairments be prioritized for riparian restoration.

3.2.3.5 Riparian Buffer Implementation Barriers

Land ownership is a significant implementation barrier to restoring riparian buffers. For cultivated land, getting acceptance from farmers to forest a 30 meter buffer around a river or stream may be a challenge. Installation of riparian buffers on public lands may be easier than on private land.

There also may be geomorphic limitations to the installation of riparian buffers. For very steep streambanks, additional streambank stabilization measures or stream restoration measures may be required to reconnect a stream or river to its floodplain and restore its banks to be able to support the added vegetation.

Funding can be a major implementation barrier to restoring riparian buffers, especially given the wide range of cost to restore areas. Federal assistance programs for these types of projects may be limited or inflexible.

3.2.4 Wetland Restoration and Marsh Migration

3.2.4.1 Summary of the Wetland Restoration Needs

Wetlands provide water quality and habitat benefits within a watershed (USACE 2015). The 2014 Bay Agreement goals highlight reestablishing 85,000 acres of tidal and nontidal wetlands and enhancing the function of an additional 150,000 acres of degraded wetlands by 2025 (USACE 2015). As part of the 2014 Bay Agreement goals, wetlands were also areas targeted for additional land conservation by 2025 (USACE 2015). Wetlands provide habitat to fish, birds, mammals and invertebrates. Wetlands also can provide flood risk reduction benefits and help with soil retention.

Within the Choptank River watershed, only 25 percent of the land cover is natural vegetation, with most of the land cover being cultivated agricultural land (see **Figures 12** and **13**). There has been a decline in tidal wetland areas in the Choptank River watershed because of increased nutrients, suspended sediments, sea level rise, subsidence, and coastal development, which have caused increased shoreline erosion (NOAA n.d.-a). Wetlands must build elevation to keep up with rising seas, which can be a challenge with accelerated sea level rise coupled with subsidence.

Wetland restoration can be achieved through several management techniques, including blocking ditches that have been dug in the past years to drain coastal lands and the application of thin soil layers to raise the surface elevations to keep up with rising sea levels and subsidence rates. Once the soil layers are applied, replanting and reseeding can occur. Often, restoration can be coupled with removal of invasive species, such as Phragmites, a perennial reed with tall stems.

3.2.4.2 Existing and Ongoing Wetland Restoration and SAV Opportunities

Within the Choptank River watershed, Ducks Unlimited and Maryland DNR have supported a wetland restoration effort on agricultural landscapes. Efforts to support wetland migration are also underway within the Choptank River watershed. In addition, beneficial reuse of dredged material is occurring within the Choptank River watershed on a large-scale at Poplar Islands and has also been undertaken on a smaller-scale at Barren Island.

Beyond the Choptank River watershed, in the nearby Blackwater watershed, a wetland restoration project was undertaken, using dredged material, to build up existing wetlands (The Conservation Fund et al. 2012). There were many lessons learned from this effort, particularly with the beneficial reuse of dredged material and the quality of material that could be used to implement similar efforts within the Choptank River watershed.

3.2.4.3 Wetland Migration and Restoration Opportunities

As illustrated on **Figure 25**, the Maryland Natural Filters – Wetland Opportunities (Maryland GIS Data Catalog 2014a) data layer was refined to identify wetland restoration opportunity areas within the Choptank River watershed. The Wetland Opportunities data layer was generated considering land use, hydrology, and soil characteristics to identify potential wetland restoration areas. The Chesapeake Conservancy High Resolution Land Cover dataset (2016) was used to refine the Wetland Opportunities data layer by removing any impervious area from consideration as an area for restoration. Areas of development were also eliminated from consideration as defined by the USDA National Cropland Dataset (USDA 2016). These areas were further refined by only considering those areas within 3 miles of USACE-dredged channel navigation projects (USACE n.d.) to maximize the beneficial reuse of dredged material. The ease of creating wetland was also considered by refining the proposed wetland migration and creation areas through a wetland cost-distance analysis conducted by TNC (2015). The TNC analysis (2015) considers land cover classification and elevation to evaluate the ease of wetland migration for protection and/or restoration consideration in terms of wetland "cost" as a unitless indicator. The areas proposed for wetland restoration and migration were further refined based on this cost-distance analysis by only considering those low-cost areas where the wetland migration "cost" was less than 2,000. The wetland migration cost is shown on **Figure 26** within the areas identified for wetland creation or restoration that were defined on **Figure 25**. Targeting those areas of wetland cost less than 2,000, this geospatial analysis resulted in an identified 26,504 acres of land within the Choptank River watershed recommended for wetland migration and creation. These areas should also be considered for conservation, to ensure that there are proper corridors for migration. Those areas around Crosiadore Creek, Holmes Creek, and Reeds Creek would be targeted for wetland migration based on this analysis.

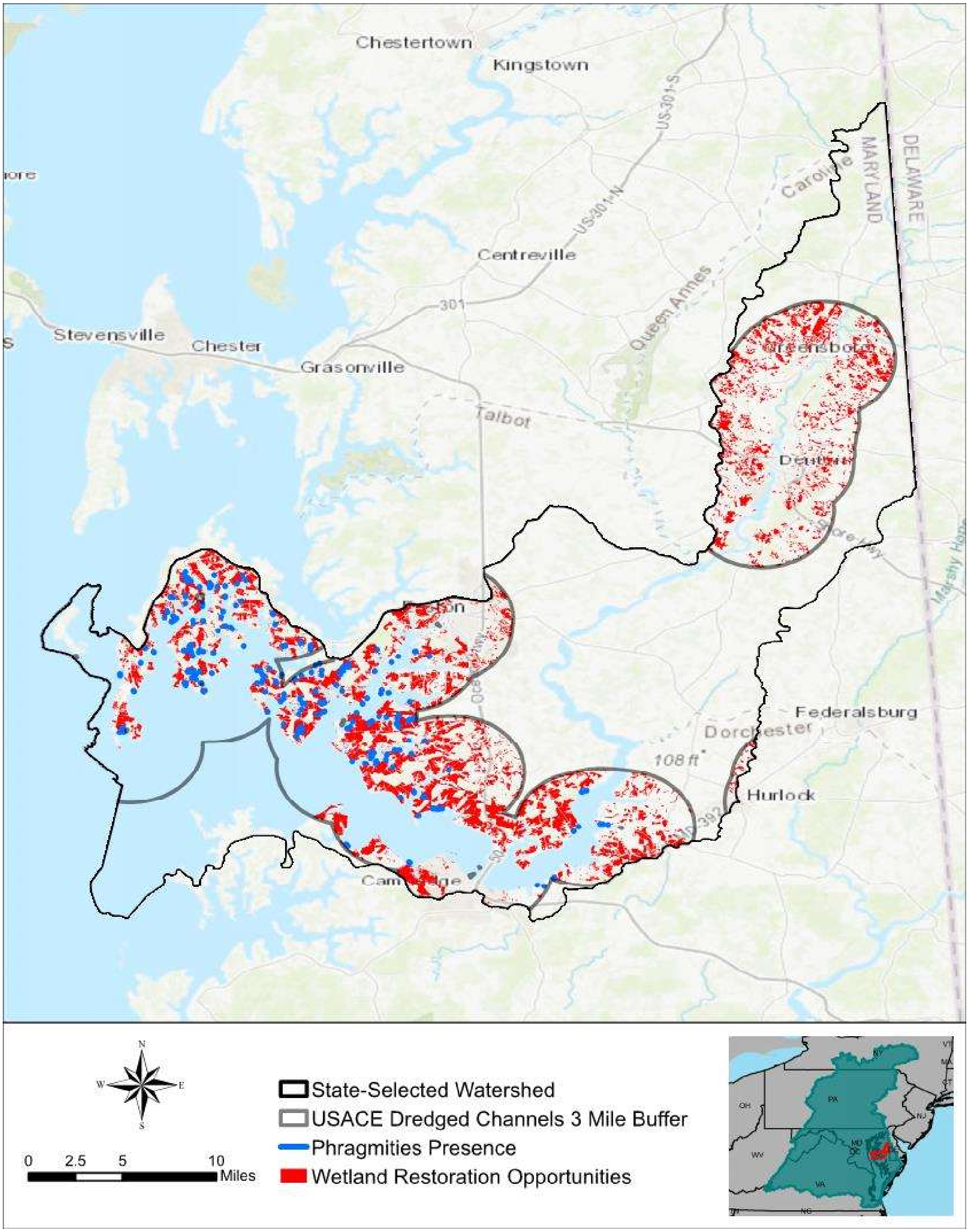

Figure 25. Wetland restoration opportunities and areas of Phragmites (Maryland GIS Data Catalog 2014a, 2006a; Chesapeake Conservancy 2016; USDA 2016)

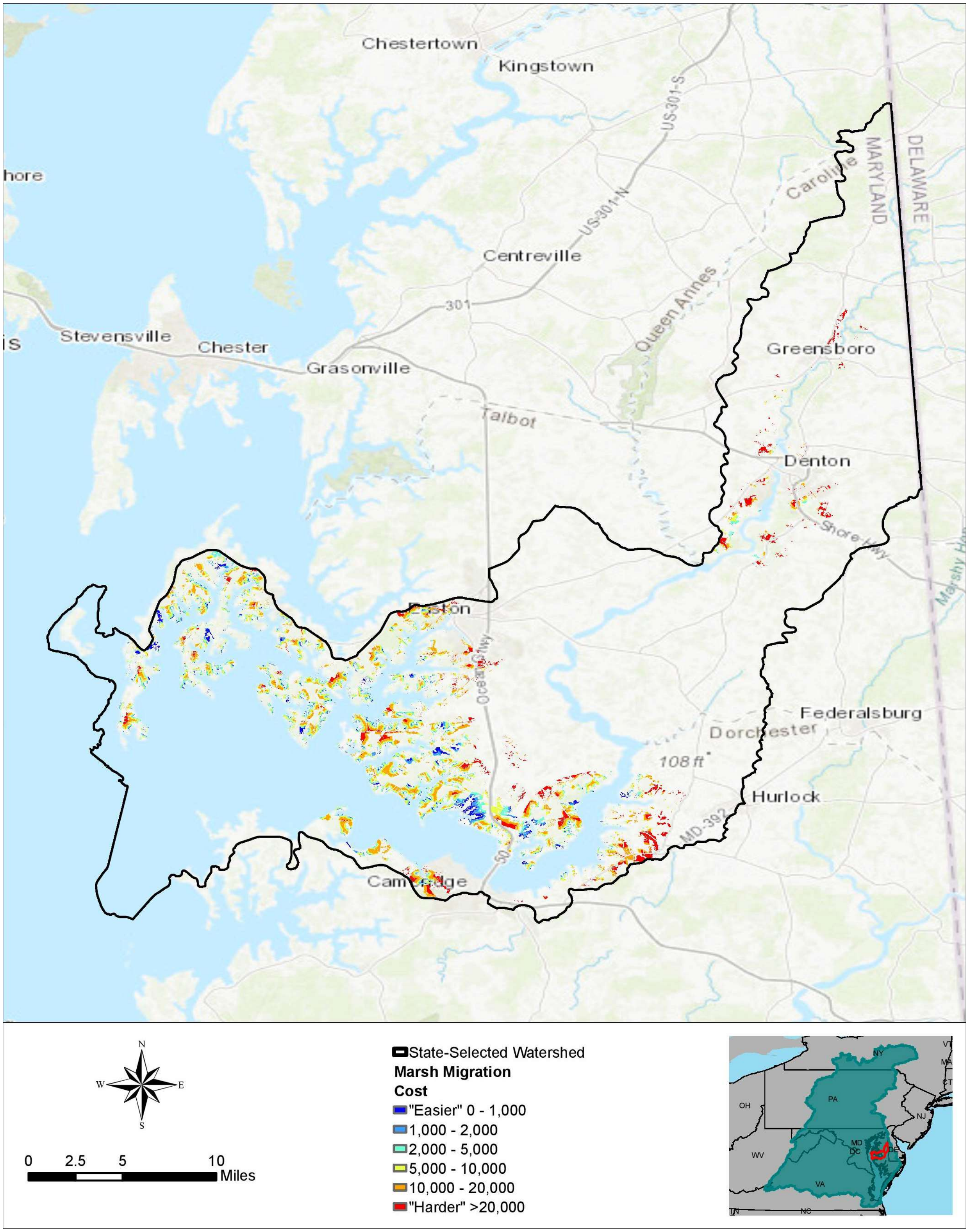

Figure 26. Marsh migration cost-distance (TNC 2015)

Additional restoration efforts may be required in areas where invasive species exist. To understand the added effort to remove invasive species, the Maryland Shoreline Inventory – Phragmites data layer was added to the map (Maryland GIS Data Catalog 2006a). This data layer highlights the presence of Phragmites in the immediate riparian zone and 3.5 miles of Phragmites presence in areas of potential wetland restoration.

3.2.4.4 Wetland Restoration Costs

There is a broad range of potential costs for wetland restoration. Tidal wetland restoration costs can range from approximately $16,000 to $178,000 per acre in U.S. 2017 dollars. Based on the total 26,504 acreage of potential restoration area identified, wetland restoration could cost between $424 million and $5 billion in U.S. 2017 dollars. Additional analysis and feasibility studies should be conducted to better define wetland restoration opportunities, considering implementation barriers.

3.2.4.5 Wetland Restoration Implementation Barriers

Due to the largely tidal nature of the Choptank River watershed, wetlands are subject to climate change threats and relative sea level rise threats, including wave activity and associated shoreline erosion (USACE 2015). In addition, development on the backside of wetlands and marshes can limit their availability to migrate over time. Future development in potential wetland migration areas can also put wetlands at risk.

Other implementation barriers include land ownership and accessibility. Accessibility becomes important for monitoring and maintenance as well as restoration implementation. When reusing dredged sediment, spray distances are also a limitation. This was a lesson learned from the Blackwater wetland restoration effort (The Conservation Fund et al. 2012). Similarly, the Blackwater wetland restoration effort highlighted limitations based on the quality of the dredged material and content of organic matter versus clays, silts, or sand. Water depths also may limit the locations where dredging and beneficial reuse of the material will be successful.

Invasive species can be an implementation barrier. Areas of Phragmites were identified on **Figure 25** and would require additional effort to remove invasive species as part of the wetland restoration activities.

Funding is another limitation for wetland restoration projects, with several agencies that may be available as potential partners.

3.2.5 Submerged Aquatic Vegetation Restoration

3.2.5.1 Summary of Submerged Aquatic Vegetation Needs

Historical trends in Chesapeake Bay have shown a decline in SAV habitats (USACE 2015). The 2014 Chesapeake Bay Watershed Agreement goals target sustaining 185,00 acres of SAV habitat in the Chesapeake Bay with 90,000 acres by 2017 and 130,000 acres by 2050 (USACE 2015). As illustrated on **Figure 19**, the extent of SAV habitat in the Choptank River watershed has been variable. SAV habitat is sensitive to a number of factors, including water quality and temperature. SAV occurs in shallow waters with good clarity and sandy bottoms. SAV provides critical habitat to species such as crab and bass, improves water quality, and is tied to scallop restoration in the southern portions of Chesapeake Bay (USACE 2015).

Figure 27 illustrates areas of SAV habitat loss (Virginia Institute of Marine Science [VIMS] 2015) when comparing the extent of habitat from 2015 to 1971. This information is overlaid on the same wetland restoration opportunity areas shown on **Figure 25.**

3.2.5.2 Existing and Ongoing Submerged Aquatic Vegetation Restoration

There are no known SAV restoration activities that are ongoing or existing in the Choptank River watershed. However, for SAV restoration to be successful, there must be good water quality. Many of the ongoing activities within the Choptank River watershed are working to improve water quality, which will provide habitat where SAV can thrive.

3.2.5.3 Submerged Aquatic Vegetation Restoration Opportunities

Figure 27 highlights the loss of 6,824 acres of SAV habitat between 1971 and 2015. Of the 6,824 acres, 5,837 are within 3 miles of a USACE navigation project where beneficial reuse of dredged material may occur to restore wetlands and benefit local water quality. These areas of SAV loss present opportunities to restore SAV habitat once conditions are established to support SAV. As stated previously, SAV restoration is sensitive to water quality; therefore, completion of other restoration efforts that improve water quality will be important prior to completion of these restoration projects. Beyond these 6,824 acres, other restoration opportunity areas could be identified in areas that are less than 6 feet deep (USACE 2015).

3.2.5.4 Submerged Aquatic Vegetation Restoration Costs

SAV habitat restorations can vary in cost between $41,000 to $314,000 per acre in 2017 U.S. dollars. To restore the full 6,824 acres of SAV habitat, costs may vary between $280 million to $2.1 billion. However, large scale SAV restoration is not recommended at this time.

3.2.5.5 Submerged Aquatic Vegetation Restoration Implementation Barriers

As previously mentioned, poor water quality is an implementation barrier to SAV restoration. Therefore, completion of other restoration activities to improve water quality will be an essential effort prior to expending effort on SAV restoration.

Securing funding to support these activities is another implementation barrier.

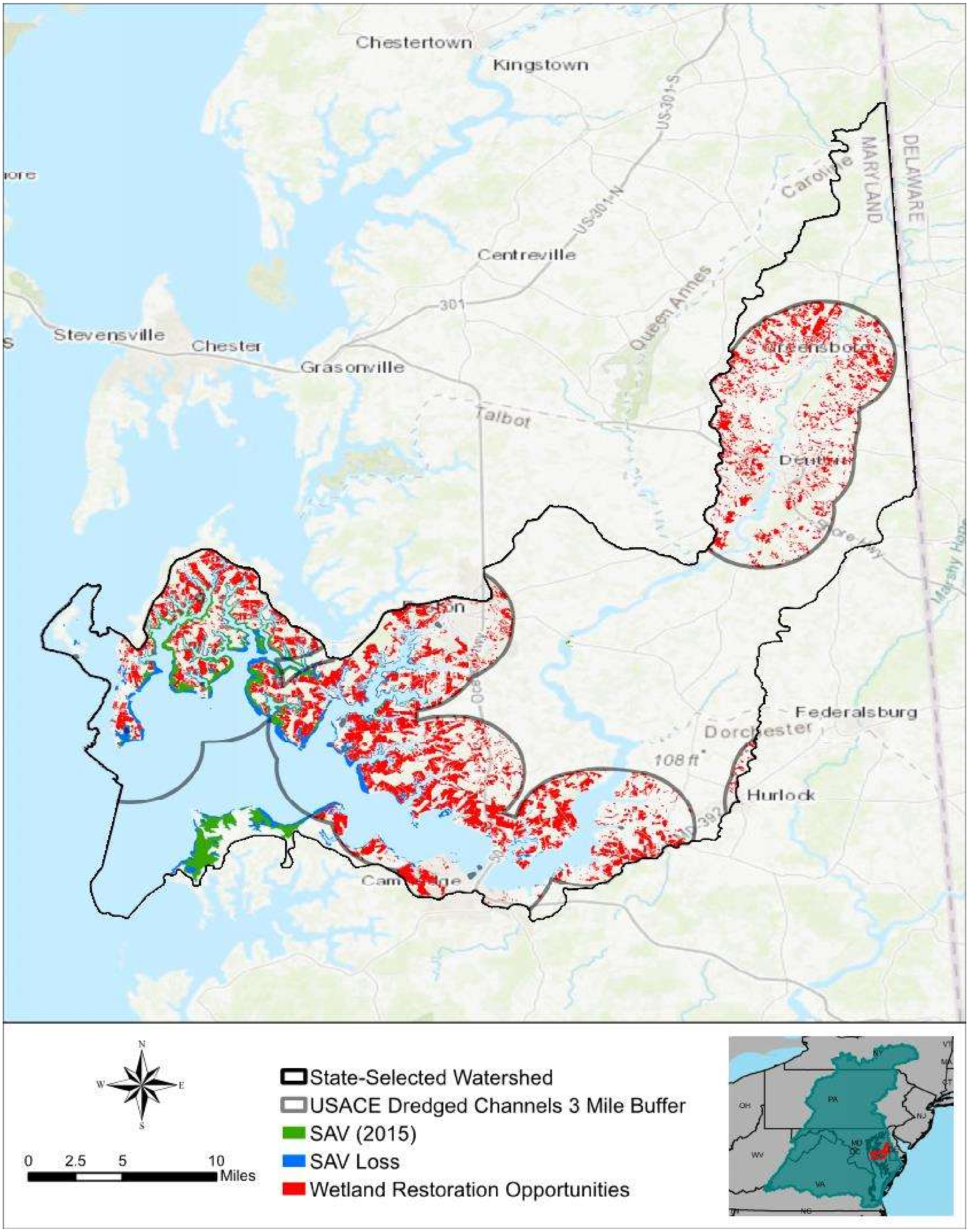

Figure 27. Areas of SAV habitat loss (VIMS 2015)

3.2.6 Stream Restoration and Fish Passages

3.2.6.1 Summary of the Stream Restoration and Fish Passages

The Choptank River watershed has been an epicenter for the Chesapeake Bay's most important fisheries (NOAA n.d.-a). The 2014 Chesapeake Bay Watershed Agreement goals highlight the continual increase of habitat to support migratory fish populations by opening 1,000 miles of stream by 2025 (USACE 2015). Success of this goal is to be measured by the presence of fish species.

Seven dam fish blockages were identified within the Choptank River watershed as shown on **Figure 20**. In addition to the dams, stream crossings were assessed to determine those stream crossings that may impact fish and aquatic habitats. Each of these blockages were prioritized to identify those blockages that will have the largest impact on fish species.

There are five Tier 1 (highest priority for removal) dams for anadromous fish within the Choptank River watershed. They are the Forge Branch Dam, Lake Bonnie Dam, Spring Branch Dam, Williston Mill Dam, and one dam with an unknown name.

3.2.6.2 Existing and Ongoing Stream Restoration and Fish Passage Projects

No fish passage restoration projects have been identified within the Choptank River watershed. However, efforts to evaluate the impact of stream crossings and culverts are a critical first step to making improvements in the watershed.

3.2.6.3 Stream Restoration and Fish Passage Opportunities

There are several opportunities for restoration of fish passages. There has been significant work to date to prioritize those dams and stream crossings for removal, which is reflected on **Figure 20**.

Figure 28 shows the Tier 1 and Tier 2 prioritized dams for removal and the severe and significant barrier stream crossings and culvert locations relative to stream heath indicators in the Choptank River watershed. Many of the barriers targeted for removal or replacement are located along segments of tributaries where stream health has not been assessed. Further assessment of these areas to assess the existing stream health and opportunity for habitat improvement is recommended prior to restoration. Stream restoration should consider restoration of areas beyond the streambanks. Restoration and reconnection of floodplains can be critical to restoring stream functionality and improving stream health.

3.2.6.4 Stream Restoration Fish Passage Costs

The cost of executing a fish passage restoration project is highly dependent on the size and length of the dam being modified or removed. Costs can range from $190 to $200,000 per linear foot in 2017 U.S. dollars. Additional feasibility studies would be required at each dam. Similarly, site-specific estimates for stream crossing restoration would need to be developed with a feasibility study.

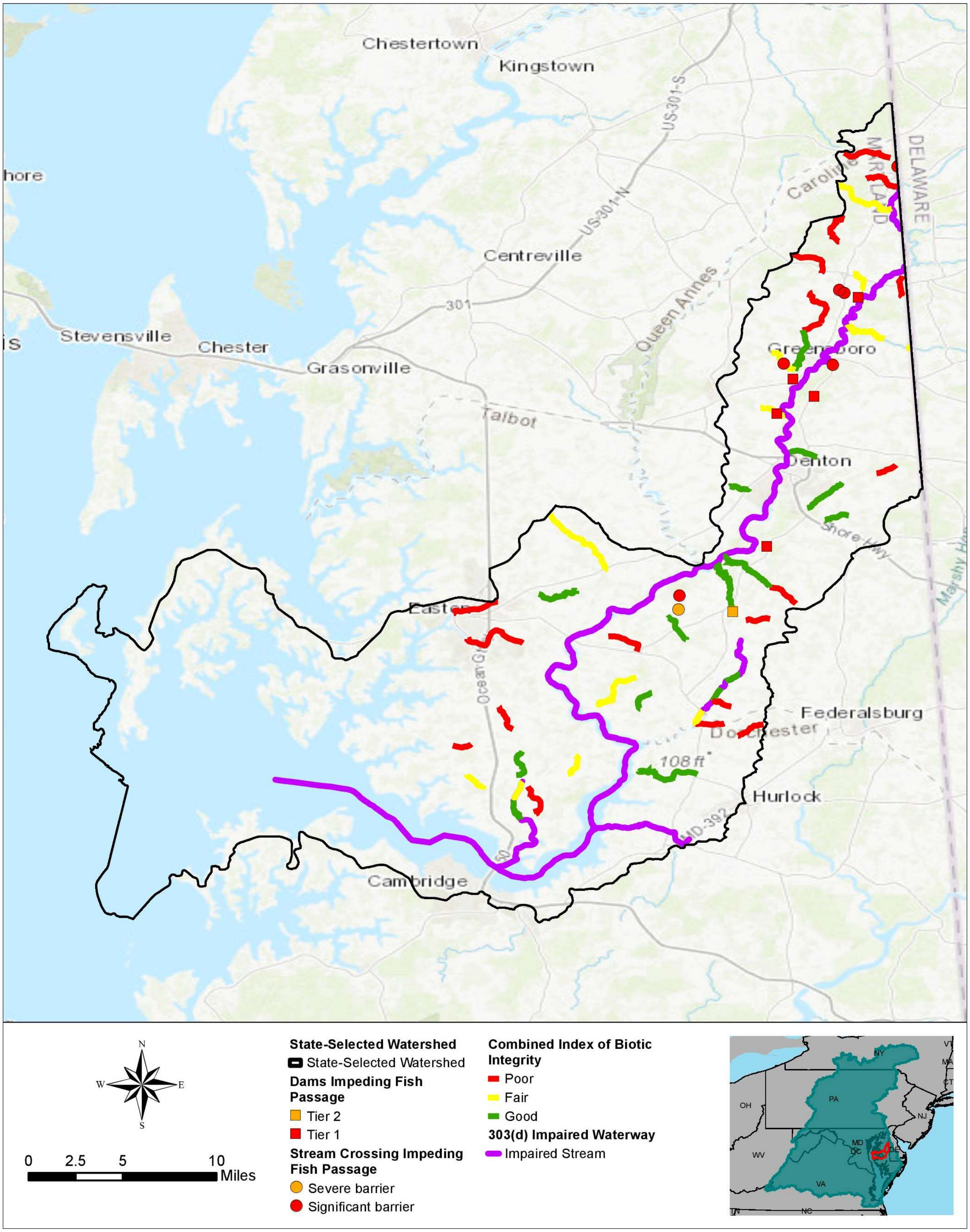

Figure 28. Fish passage dam and culvert locations with stream health (TNC 2013; NAACC 2015; Maryland GIS Data Catalog 2017b; EPA 2015)

3.2.6.5 Fish Passage Implementation Barriers

There are several implementation barriers to removing dam blockages, including willingness of the dam or blockage owner, funding, transportation and infrastructure limitations, potential for contaminated sediments, climate change risks, flood risk management impacts, and potential downstream impacts. However, there are opportunities to partner with state and local jurisdictions to remove fish blockages within the Choptank River watershed.

For improving stream crossings, there are similar implementation barriers, such as funding, disruption to traffic patterns, flood risk impacts, and potential downstream impacts. Similarly, there are opportunities to partner with other organizations to help receive funding and support restoration of streams through improvements of stream crossings and blockages.

3.2.7 Conservation Opportunities

Maryland DNR has identified Targeted Ecological Areas (TEAs), or areas of high ecological value, that have been identified as conservation priorities. These areas are preferred for conservation funding through the Maryland Stateside Program Open Space. The Maryland Stateside Program Open Space, established under DNR in 1969, provides financial and technical assistance toward the planning, acquisition, and/or development of recreation land or open space areas. Over 6,000 parks and conservation areas have been assisted through the program to date (Maryland DNR n.d.-b). **Figure 29** illustrates the existing protected areas and 61,520 acres of TEAs prioritized for conservation in the Choptank River watershed. The existing protected areas include environmentally important lands owned by Maryland DNR. **Figure 30** refines these areas to highlight 17,931 acres of unprotected TEAs that overlap with areas of sensitive species based on the Maryland GIS Data Catalog Sensitive Species Project Review Areas (2010a) data layer. To provide benefit for sensitive species, these areas are recommended to be prioritized for conservation.

The Maryland Conservation Reserve Enhancement Program (CREP) has helped landowners plant streamside buffers, establish buffers, protect eroding lands, and create wildlife habitat. This program would be a source of support for future conservation opportunities. CREP, administered through Maryland DNR, authorizes the state to purchase easements in which an interest to install or maintain conservation exists to protect water quality and natural resources (Maryland DNR n.d.-b).

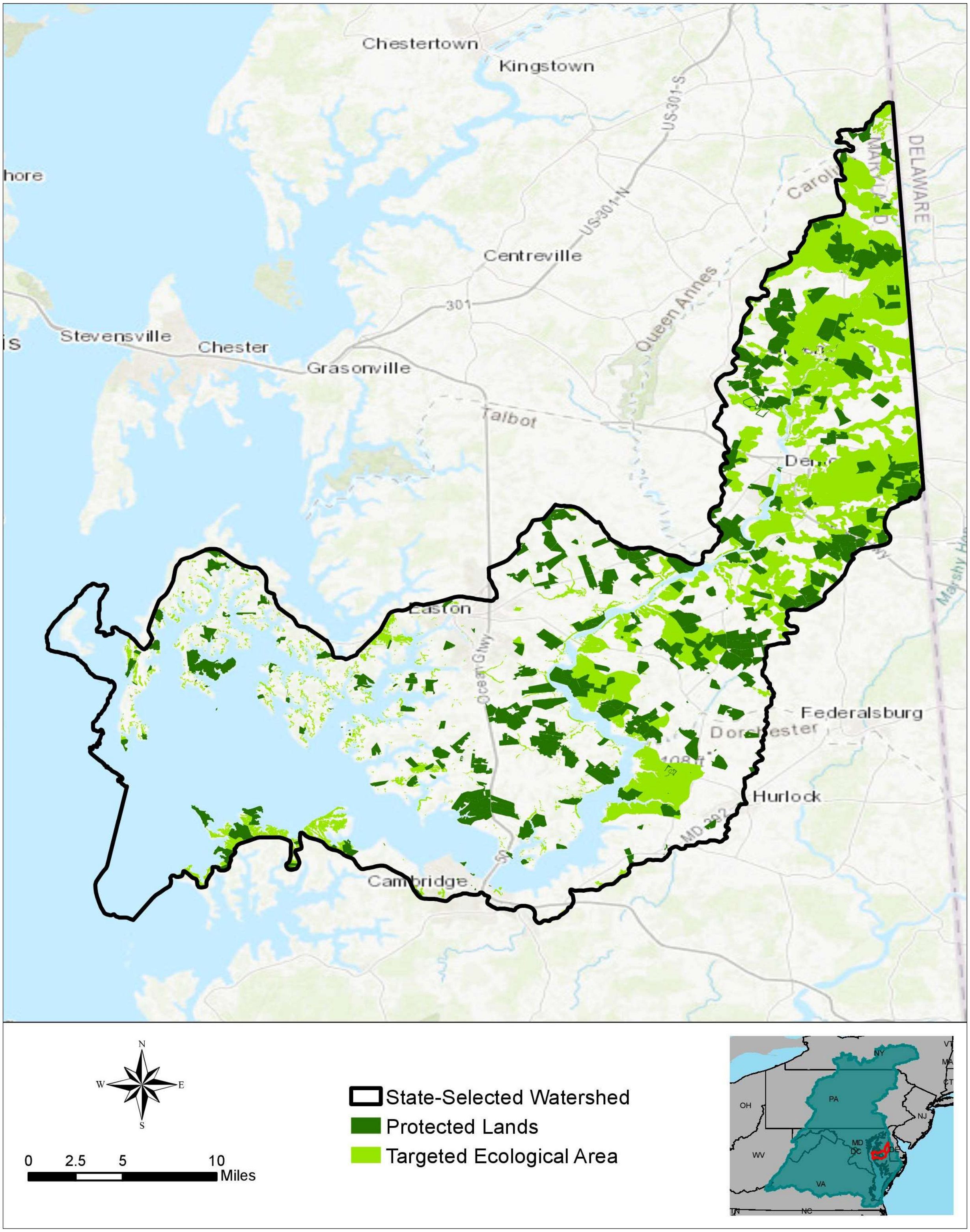

Figure 29. Choptank River watershed TEAs for conservation and existing protected lands (Maryland GIS Data Catalog 2016, 2017a)

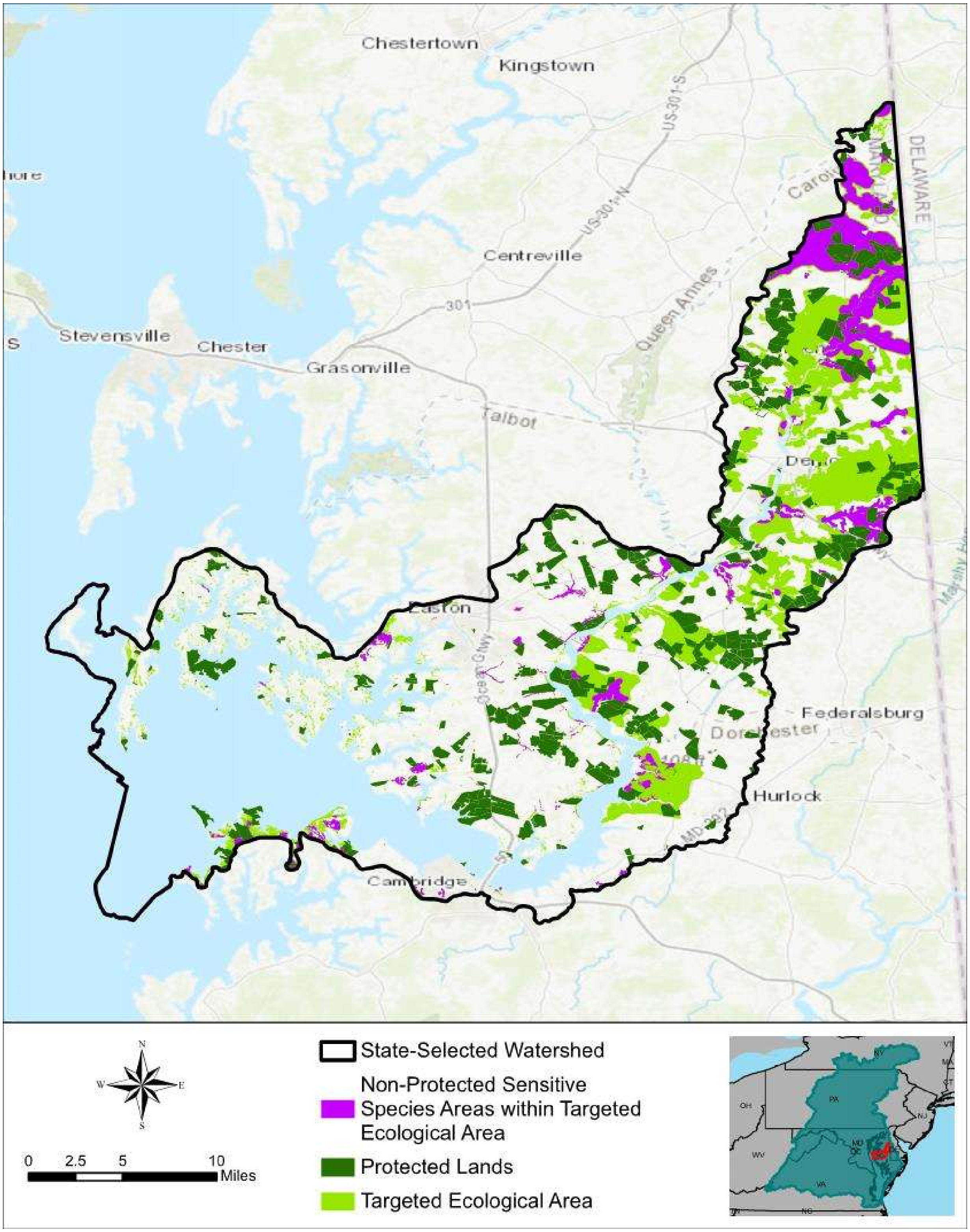

Figure 30. Choptank River watershed TEAs in areas of sensitive species outside of existing protected lands (Maryland GIS Data Catalog 2016, 2010a, 2017a)

3.2.8 Other Restoration Opportunities

Additional restoration opportunities include agricultural best management practices (BMPs) to help reduce nutrient loading to receiving waters. Some types of BMPs include cover crops, enhanced nutrient management, soil conservation, water control structures, manure transport, and waste management for the agricultural sector. With such a large portion of the Choptank River watershed's land use in the agricultural sector and the high loading of nutrients into the Choptank River, as illustrated on **Figures 12** and **13**, agricultural BMPs are important restoration activities for the Choptank River. As identified previously, there are vast opportunities to implement forest buffers to reduce nutrient loading to receiving waters.

Figure 31 highlights the agricultural BMPs implemented within the Choptank River watershed in 2016.

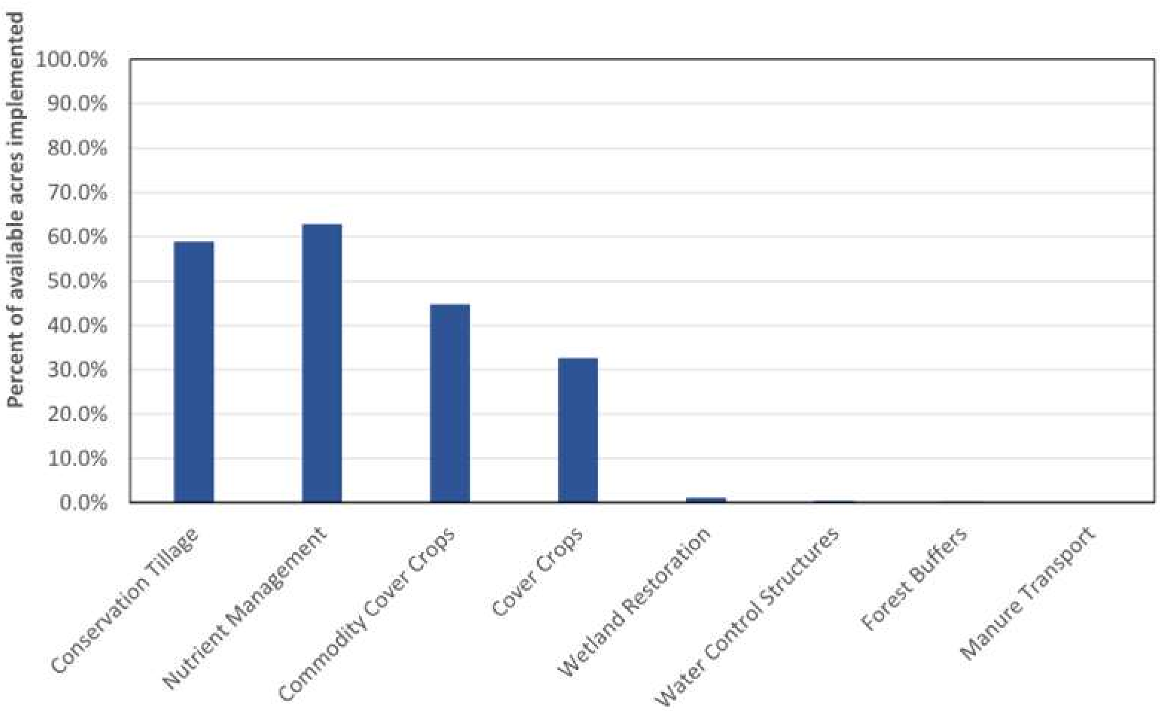

Figure 31. 2016 reported agricultural conservation practice implementation in the Choptank River watershed (Trentacoste 2017)

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Section 4

Summary

The Choptank River watershed, located on the Eastern Shore of Chesapeake Bay in Maryland, is considered an important ecological resource and has been an epicenter of the bay's most important fisheries (NOAA n.d.-a). The Choptank River watershed is largely agricultural in land use. This analysis and study focused on the portions of the Choptank River watershed within Maryland.

The Choptank River watershed has experienced ecosystem problems, including decline in SAV habitats, streams with poor biotic integrity, loss of wetland habitat, and a significantly decreased oyster population. The banks of the Choptank River also have experienced areas of high erosion. These problems stem from several sources, including high nutrient loading from runoff and groundwater sources, overfishing, land use patterns, stream impoundments and stream crossings that inhibit habitat movement, relative sea level rise, development, and increased water temperatures.

Several measures have been identified to help restore the Choptank River watershed, with many efforts currently underway. However, this list of measures is not exhaustive, and additional restoration and conservation opportunities may exist within the Choptank River watershed. **Figure 21** summarizes many of the restoration activities completed, planned, or ongoing within the watershed to restore ecosystems and improve ecological health within the Choptank River watershed.

Additional restoration opportunities that have been identified within the Choptank River watershed include streambank stabilization, re-establishment of riparian buffers, wetland restoration, oyster restoration, SAV habitat restoration, removal of stream barriers and fish passage blockages, and agricultural BMPs. In addition to these restoration activities, areas prioritized for conservation have been identified within the Choptank River watershed, with many local and state programs in place to help fund and support the conservation such as Maryland DNR's CREP. **Figure 32** summarizes the restoration and conservation opportunities identified within the Choptank River watershed including candidate projects identified by project stakeholders. **Table 1** lists the identified restoration and conservation activities and their recommended prioritization that are depicted in **Figure 32**, highlighting key limitations or conditions required to improve chances for success. **Table 2** shows the breakdown of these opportunities by subwatershed.

The sequencing of these restoration and conservation activities is important. Some of the wetland stressors may need to be addressed and mitigated prior to implementation of restoration activities. Further, SAV restoration can only be successful once adequate water quality is obtained in the watershed. Agricultural BMPs, conservation activities, and riparian buffer restoration will need to occur to improve water quality prior to SAV restoration.

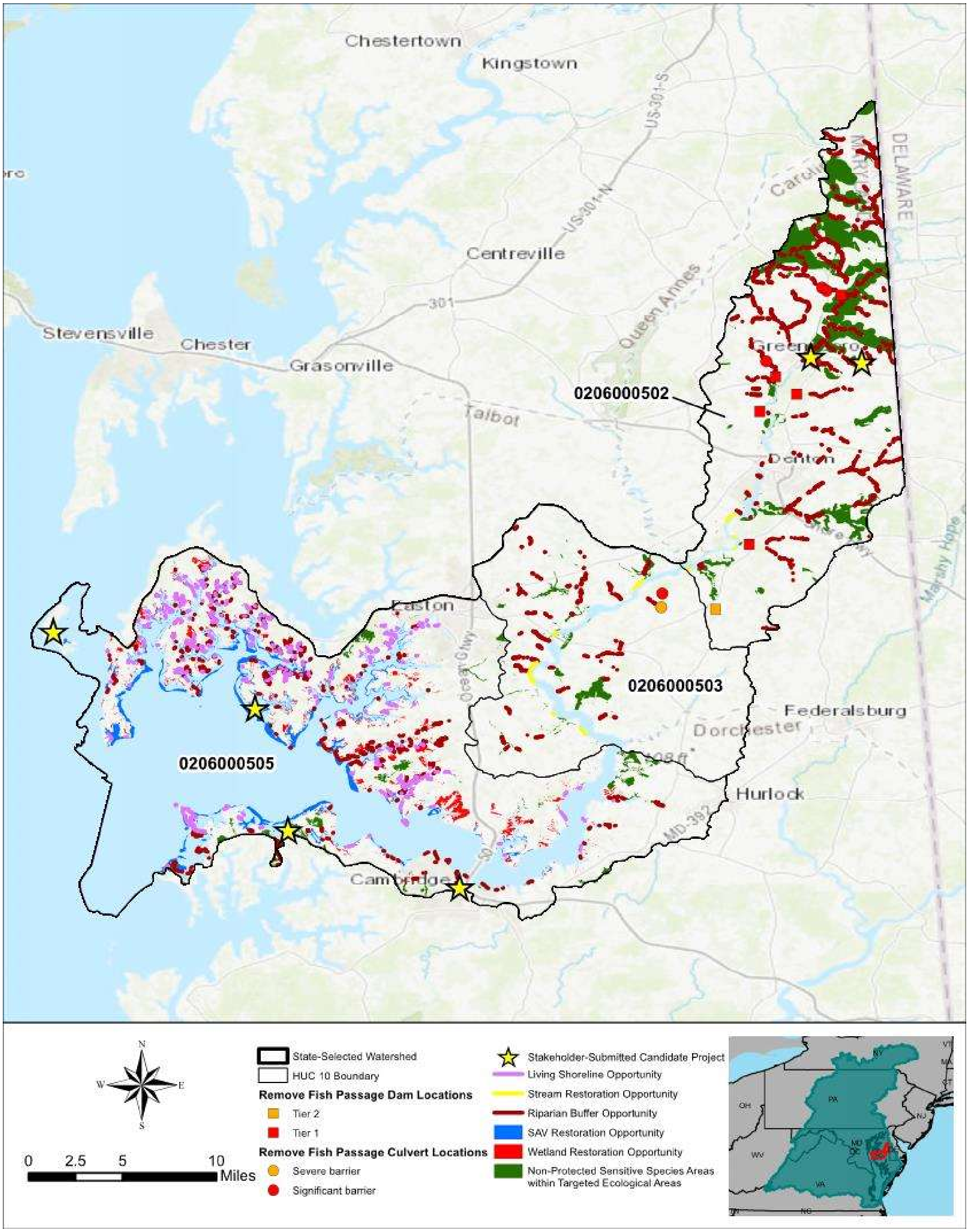

Figure 32. Restoration and conservation opportunities in the Choptank River watershed

US Army Corps of Engineers

Table 1. Summary of Choptank River watershed restoration and conservation activities

Suggested Prioritization	Activity	Quantity	Details
1	Agricultural BMPs	Not computed	Implementation of agricultural BMPs will help realize improvements in ecosystem health throughout the watershed, which will aid in restoration of vegetation and habitat throughout the watershed. Agricultural nutrients contribute to stressors in the watershed; addressing these stressors will be critical prior to initiating other restoration opportunities.
2	Oyster Restoration and Monitoring	1424 acres (504 acres in Tred Avon and Harris Creek, 920 acres additional areas of restoration from 2000 – 2014 and activity in seven tributaries within the Choptank River through the Maryland Grow Oysters Program)	Oysters provide multiple benefits to the ecosystems in which they exist. They filter water, improving water quality; can provide shoreline stabilization, wave attenuation, and flood risk management benefits; and provide habitat and food for other plants and animals such as crabs, fish, and birds. Oyster restoration efforts are currently underway in Harris Creek and Tred Avon River. Monitoring and support of these efforts should continue to help improve other ecosystems within the watershed and promote clean water.
3	Conservation	17,931 acres	Several areas have been identified within the Choptank River watershed as being priority areas for conservation because of their high ecological value. Programs like the Maryland DNR CREP exist to support the conservation of these areas.
4	Riparian Buffer Restoration	1,033 acres	Riparian buffers provide multiple benefits in the watershed, including shoreline stabilization and habitat creation, and provide water quality benefits to adjacent streams by preventing pollution from entering the waterways. Several riparian buffer opportunities were identified within the Choptank River watershed, on the mainstem, and along tributaries.
5	Priority Fish Passage	11 priority blockages	The dams and culverts within the Choptank River watershed have been prioritized for removal based on their impact to ecosystems and habitat. Removal or replacement of the five high priority dams and six high priority stream crossings will improve ecosystem connectivity, expand available aquatic habitat, and may improve stream functionality and stream health.
6	Stream Restoration	2.6 miles	Areas of high erosion along the mainstem of the Choptank River were targeted for streambank stabilization and restoration. Restoration efforts would help retain soil and restore functionality of the stream for habitat and wildlife.
7	Living Shorelines	29.2 miles	Armored and natural areas of high erosion along the mainstem of the lower portions of the Choptank River were identified as priority sites for living shorelines, which provide natural habitat and additional flood risk mitigation benefits.
8	Wetland Restoration and Migration	26,504 acres	Several areas were identified for wetland restoration or migration. Those areas with the lowest cost-distance for implementation, such as Crosiadore Creek, Holmes Creek, and Reeds Creek, were targeted areas for wetland migration. Wetlands trap polluted rainfall runoff, improve receiving water quality, and provide fish habitat.
9	SAV Restoration	6,824 acres	Once water quality is improved within the Choptank River watershed, SAV habitat can be restored. Areas of historic SAV habitat are prioritized for this restoration.

Table 2. Summary of Choptank River watershed restoration and conservation activities by subwatershed

Subwatershed	Oyster Restoration and Monitoring (acres)	Conservation (acres)	Riparian Buffer Restoration (acres)	Priority Fish Passage (# of blockages for removal)	Stream Restoration (miles)	Living Shorelines (miles)	Wetland Restoration and Migration (acres)	SAV Restoration (acres)
0206000505	1,424	10,691	424	0	0	29.2	24,977	6,824
0206000503	0	8,485	135	1	2.0	0	96	0
0206000502	0	42,342	476	10	0.6	0	1,431	0

Many of these conservation and restoration efforts complement NOAA's work in the Choptank River watershed, as summarized in the Choptank River Complex Habitat Focus Area Implementation Plan (NOAA n.d.-a). The Choptank River Complex Habitat Focus Area Implementation Plan identifies the following outcomes as opportunities:

- Oyster reef restoration in Harris Creek and Tred Avon River to cover at least 50 percent of the restorable bottom in the tributary.
- Identify and implement priority wetland restoration projects in the watershed.
- Improve fish habitat quality through collaboration with state and federal agencies on coastal development and land use activities and conduct Essential Fish Habitat (EFH) consultations to improve and conserve fish habitat and develop a monitoring guideline for living shoreline projects.
- Determine the feasibility and priority of pursuing fish blockage removals in collaboration with partners and landowners.

Execution of many of the restoration and conservation opportunities identified in this plan will help achieve these the goals of the Choptank River Complex Habitat Focus Area Implementation Plan.

To reduce the stressors in the Choptank River watershed, ongoing work to conserve targeted ecological areas and implement agricultural BMPs should continue throughout the Choptank River watershed. Within the Upper Choptank subwatershed, riparian buffer restoration also would aid in reducing pollutant loadings to receiving tributaries and the mainstem Choptank River, helping to improve overall water quality within the Choptank River watershed. If additional information on nutrient loading is available, riparian buffer restoration efforts should be targeted in those areas of highest nutrient loading and contribute to obtaining the maximum ecological benefit from the restoration efforts. This area also contains sensitive species which would benefit from these restoration efforts. These riparian buffer restoration opportunities could be coupled with removal of stream crossings, culverts, and dams that were identified as being a significant barrier to aquatic habitat to promote increased habitat connectivity in the upper sections of the watershed. Watershed stressors BMPs as well as conservation areas could be targeted for implementation based on restoration projects identified within the Choptank River subwatersheds, which could maximize synergistic benefits between water quality improvements and restoration of downstream aquatic habitat.

In addition to the Choptank River Complex Habitat Focus Area Implementation Plan, the CBCP Choptank River watershed analyses identified restoration opportunities that may also complement this ongoing work in other portions of the watershed. By disaggregating the Choptank River watershed further into subwatersheds, finer-scale actions are identified to guide the implementation projects.

There are several co-benefit restoration opportunities that can be undertaken across the watershed. Focus areas were identified that contain concentrations of co-located opportunities where co-benefits could be achieved. These focus areas were identified to assist with identifying a project to pursue for implementation and are bounded by the colored polygons in **Figures 33**.

Table 3 summarizes the activities proposed in the focus areas. Following public input, at least one project will be developed further for presentation in the final report.

Table 3. Summary of activities in proposed focus areas for project identification in the Choptank River watershed

Choptank River Watershed Project Focus Areas									
Activity	A	B	C	D	E	F	G	H	I
Conservation	X	X	X	X	X	X	X	X	X
Oyster Restoration	X	X							
Stream Restoration				X	X		X		
Riparian Buffer Restoration	X	X	X	X	X	X	X	X	X
SAV Restoration	X	X							
Wetland Restoration	X	X	X				X		X
Living Shoreline	X	X	X						
Removal of Fish Blockages					X	X		X	X
Stakeholder-Submitted Candidate Project		X							X

In the downstream Lower Choptank subwatershed 0206000505, the focus for restoration projects would be living shorelines, SAV, and wetland restoration within the Tred Avon and Harris Creek tributaries in conjunction with conservation and riparian buffers targeted for those upstream tributaries draining into those areas where oyster restoration projects are underway. In concert with the conservation and restoration efforts to reduce watershed stressors in the upper portion of the Choptank River watershed, there are several co-benefit restoration opportunities that can be undertaken in the Lower Choptank subwatershed as highlighted by the purple polygons on the lower portion of the watershed in **Figure 33**. Several restoration opportunities were identified in this area through geospatial analysis and based on candidate projects identified by project stakeholders. The shorelines of these areas have been identified as unstable, and opportunities exist to evaluate the feasibility of living shorelines in these areas to stabilize the shoreline and create additional habitat. Living shorelines in these areas may also reduce coastal flood risks to vulnerable populations. Restoring wetlands, preparing for wetland migration, and restoring riparian buffers in these areas will help promote improved water quality, provide additional habitat, and in turn, promote more favorable aquatic conditions. Once water quality improvements are realized within the watershed, SAV habitat can be restored in these areas, particularly in those areas of loss. These areas of suggested focus in the Lower Choptank subwatershed, as indicated by the purple polygons in **Figure 33**, contain several co-located opportunities for beneficial reuse of dredged material for wetland restoration, living shoreline creation to address shoreline erosion issues and provide additional habitat, oyster habitat restoration and associated monitoring, and eventually, SAV restoration, once water stressors are removed.

For the Middle Choptank subwatershed 0206000503, the focus for restoration projects would be those areas that would generally provide buffer areas or connectivity with the sensitive species areas within targeted ecological areas, including riparian buffers and wetland restoration. There are minor stream restoration opportunities as well as noted in **Table 2**. **Figure 33** presents the location of areas that would focus restoration opportunities in the Middle Choptank subwatershed, as indicated by the yellow polygons.

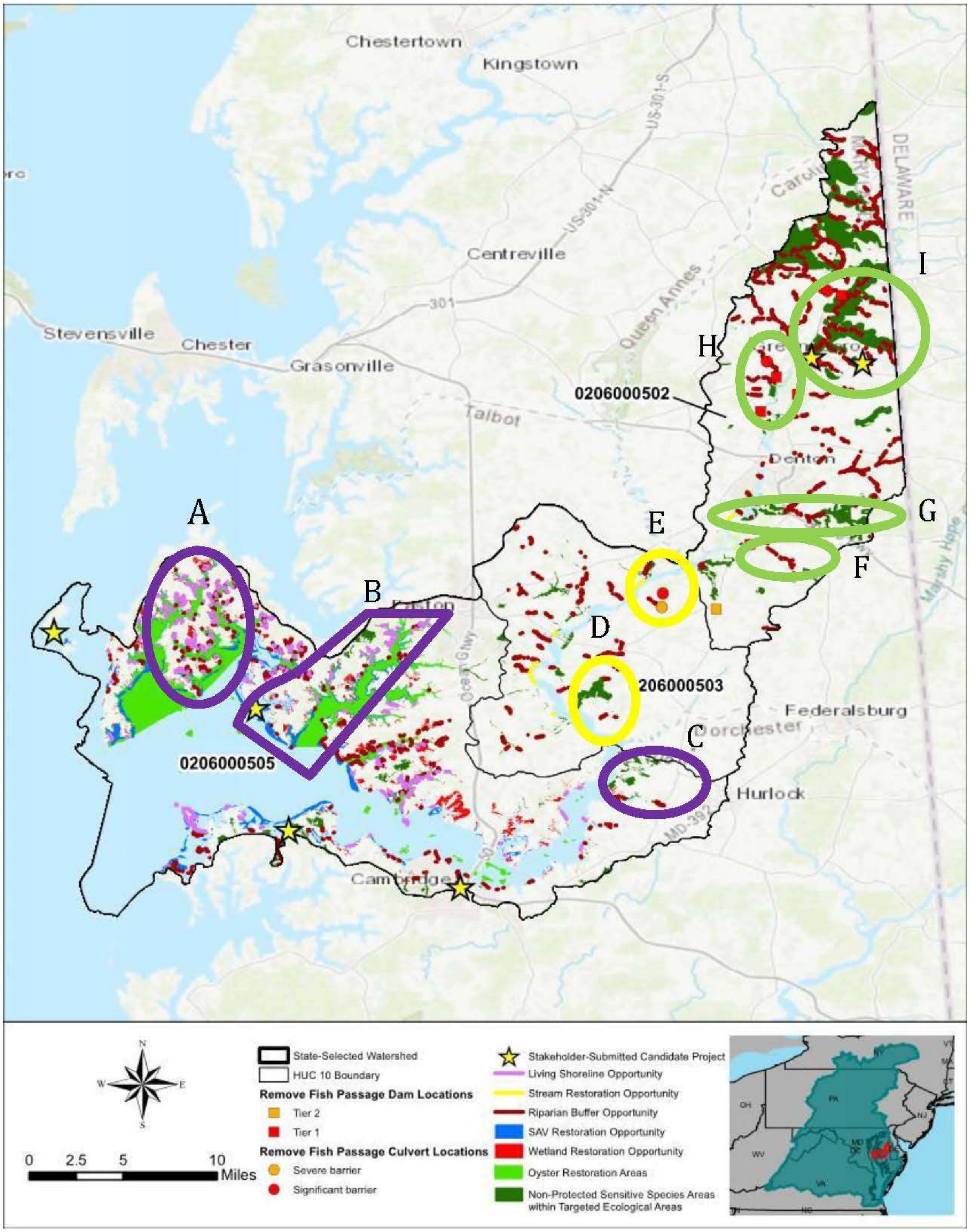

Figure 33. Proposed focus areas for project identification in the Choptank River watershed

In the upstream Upper Choptank subwatershed 0206000502, the focus is amelioration of fish barriers, which could be combined with other restorative project features, such as stream restoration and riparian buffers within the tributary opened to fish passage. The prioritization would be focused on downstream and higher order streams associated with fish passage amelioration. **Figure 33** presents several opportunities for riparian buffer restoration, conservation, and removal of dams and stream crossing impeding fish passage, as indicated by the green polygons.

To continue progress toward a restored Choptank River watershed, further analysis and collaboration (including collaboration with the State of Delaware, where the headwaters of the Choptank River watershed reside) should be conducted to understand applicability of these restoration measures at a project-level scale. Once confirmed, these projects should be implemented. The sequencing of these measures should be carefully considered to ensure their success. Watershed stressors will need to be addressed before restoration can take place.

USACE has several authorities to support the implementation of these projects. **Table 4** provides a summary of some of the USACE authorities that could support implementation of these identified project opportunities.

Table 4. Summary of USACE Program Support

Program Support	Brief Description
Continuing Authorities Program (CAP)	Under this authority, USACE can plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. CAP authorities cover a range of mission areas from ecosystem restoration to navigation to improvements to past USACE projects. A feasibility study must be performed prior to implementation. Implementation is conducted with a 50/50 cost share between USACE and non-federal sponsor. The Continuing Authorities Programs are: • Section 14: Flood Control Act of 1946 amended for emergency streambank and shoreline erosion protection for public facilities and services • Section 103: River and Harbor Act of 1962 authorizes participation in the cost of protecting the shores of publicly owned property from hurricane and storm damage • Section 107: River and Harbor Act of 1960 amended for navigation • Section 111: River and Harbor Act of 1968 amended for mitigation of shoreline erosion damage caused by Federal navigation projects • Section 145: Water Resources Development Act of 1976 amended for placement of dredged material on beaches • Section 204: Water Resources Development Act of 1992 amended for Beneficial Uses of Dredged Material • Section 205: Flood Control Act of 1948 amended for flood control • Section 206: Water Resources Development Act of 1996 amended for Aquatic Ecosystem Restoration • Section 208: Flood Control Act of 1954 amended for snagging and clearing for flood control • Section 1135: Water Resources Development Act of 1986 amended for project modifications for Improvement of the Environment.
General Investigation Studies	Projects under this authority address flood risk management, navigation, water supply, recreation, and other needs and opportunities, which, as authorized by Congress, anticipate a greater federal commitment than CAP studies. These

Program Support	Brief Description
	projects must be in federal interest and of major need to be economically justified and must be environmentally acceptable.
Section 510	This program provides design and/or construction assistance to non-federal interests for environmental projects that support the restoration and protection of the Chesapeake Bay estuary. Design and construction costs are cost-shared at 75 percent federal and 25 percent non-federal. Implementation of projects under this authority is dependent only on the extent that funds are separately budgeted or specifically appropriated for such work.
USACE Technical Services	This is the primary authorization and technical services program that USACE has available to states and local communities. It contains both the Planning Assistance for States Program (PAS) and the Floodplain Management Services (FPMS). • PAS – gives USACE authorization to use technical expertise in water and related land resources management to provide states, public entities within states, and Native American tribes planning assistance with water resources problems and needs. Types of projects may include all flood-related studies, GIS mapping, stormwater assessments, sanitary sewer studies, water supply and demand, water system vulnerability assessments, surface and groundwater quality, environmental restoration, wetland delineations, and watershed planning. There are two types of Planning Assistance offered through PAS: o Comprehensive Plans – including planning for the development, utilization, and conservation of the water and related resources of drainage basins, watersheds, or ecosystems located within the boundaries of the state or across states if both agree. Typical water resource problems included in a comprehensive water resource plan include flood risk management, water supply, water conservation, environmental restoration, water quality, hydropower, erosion, navigation, fish and wildlife, cultural resources, and environmental resources. However, design and implementation are not covered under this authority. o Technical Assistance Supporting State Water Resources Management Plans – support of planning efforts to manage state water resources including provision and analysis of hydrologic, economic, or environmental data and analysis for water resource management and land resource development plans. This authority may not be used for design or construction. • Floodplain Management Services (FPMS) authorizes USACE to conduct technical studies using either all federal funding or in combination with a voluntary contribution from a non-federal sponsor. The FPMS authority provides for technical assistance and does not have a provision for construction. Detailed plans, specifications, and construction would have to be accomplished under other civil works authorities or by non-federal sponsors.
Section 729	This is a watershed planning authority to assess the water resource needs of river basis and watersheds within the U.S. relating to: • Ecosystem protection and restoration • Navigation and ports • Flood risk management • Watershed protection • Water supply • Drought Preparedness. These studies require an initial federally funded (<$100,000) watershed assessment (reconnaissance phase). These projects must be implemented with a 75% federal and 25% non-federal cost share agreement.

Within the area highlighted in **Figure 33** in the Lower Choptank subwatershed, opportunities may exist for partnership with USACE and non-federal sponsors to utilize the CAP Authority to implement beneficial reuse of dredged material to support wetland restoration, and development of living shorelines to mitigate erosion damages and provide flood risk management. Section 510 funding may be available to support design and construction of living shorelines.

Within the upper reaches of the watershed where co-benefit project opportunities were identified as shown in **Figure 33**, riparian buffer restoration and removal of fish passage blockages were identified with conservation activities. The CAP Authority Section 206 may be appropriate for supporting the modification of removal of barriers to fish passage. Additional studies may be conducted to refine the location of riparian buffer opportunities as well, utilizing the Planning Assistance for States Authority.

These opportunities were identified based on the information available at the time of study. It is not an exhaustive identification of potential projects or opportunities. Additional opportunities will likely present themselves as more studies are conducted, data are collected, and collaboration continues. These additional opportunities should be considered in the support of a restored Choptank River watershed and Chesapeake Bay.

Section 5

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Attachment A – Choptank Watershed Stakeholders

The following stakeholders were engaged in the development of the Choptank watershed analysis:

- Matthew Fleming – Chesapeake and Coastal Service Director, Maryland Department of Natural Resources
- Joanna Ogburn – Program Director, Chesapeake Conservancy
- Jake Reilly – Chesapeake Bay Program Director, National Fish and Wildlife Federation
- Lauren Taneyhill – Partnerships Program Analyst, National Oceanic and Atmospheric Administration Chesapeake Bay Office
- Emily Trentacoste – Environmental Scientist, United States Environmental Protection Agency
- John Wolf – GIS Team Leader, U.S. Geological Survey
- Kristin Saunders – Cross Program Coordinator, University of Maryland Center for Environmental Science Chesapeake Bay Program Office

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