

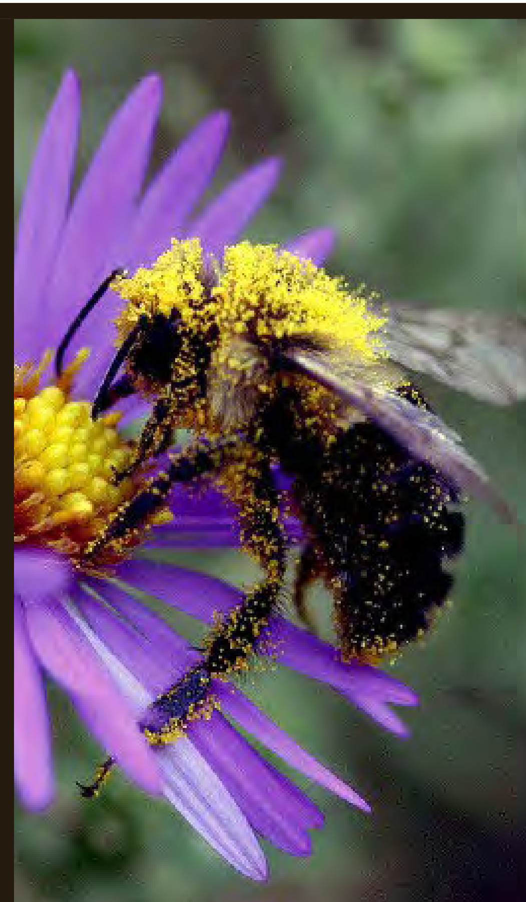

MARYLAND STATE WILDLIFE ACTION PLAN

2025-2035

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

MARYLAND
State Wildlife Action Plan

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Chapter 1

Introduction to Maryland's State Wildlife Action Plan

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Introduction

Under a 10-year mandated revision from the U.S. Fish and Wildlife Service (USFWS), the Maryland Department of Natural Resources (MD DNR) and its partners have updated Maryland's State Wildlife Action Plan (SWAP or Plan) for the 2025–2035 period. Required of all fifty states, the District of Columbia, and five U.S. territories, SWAPs outline strategic conservation approaches for species and habitats in greatest need of conservation. The overall goal of Maryland's SWAP is to keep common species common—in other words, to keep species from becoming listed as rare, threatened, or endangered, as well as work to recover already listed species so that they no longer require legal protection.

A SWAP serves two main purposes. First, it acts as a non-regulatory, guiding document for a state's conservation efforts for the next 10 years. Second, an updated SWAP is a condition to receive financial support (i.e., State Wildlife Grants) from the U.S. Department of the Interior, which funds wildlife management at the state level. These grants are one of the main sources of funding for nongame species management in Maryland and allow for the continuation and improvement of the protection and management of Species of Greatest Conservation Need (SGCN) and their habitats. The revision of the SWAP is also funded by this grant program.

While the revision effort for Maryland's SWAP was spearheaded by MD DNR, it is a *statewide* plan, meaning that it is intended to be used by all conservation agencies and organizations in the state. The Maryland SWAP represents a shared vision and a strategy that has been developed by working with state, federal, and local organizations that partner with MD DNR for wildlife conservation. Through this effort, MD DNR and partners identified SGCN, Key Wildlife Habitats (KWHs), conservation priorities, threats, and conservation actions for species and their associated habitats. SGCN include plants and animals, both aquatic and terrestrial, that are at risk or are already declining in Maryland; KWHs include the most critical habitats that support these species.

Although SWAPs are created at the state level, species, habitats, and the threats against them are rarely contained by state boundaries. Conservation agencies in the Northeast region have made an effort to coordinate their SWAPs in the interest of strengthening conservation work throughout the region. The driving force behind this effort has been the Northeast Association of Fish and Wildlife Agencies (NEAFWA) and its Fish and Wildlife Diversity Technical Committee (NEFWDTC). NEAFWA and NEFWDTC have worked to provide a shared framework, set of terminology, and regional perspective for various aspects of the SWAP. Therefore, in addition to Maryland-specific actions, this Plan contains a multitude of references to regional efforts and the guiding documents provided by NEAFWA.

The 2025 SWAP revision is the third version of this Plan. Maryland's first plan, the 2005 Wildlife Diversity Conservation Plan, was completed in 2005; its first major update, the 2015 Maryland State Wildlife Action Plan, was completed in 2016. Major differences from the previous version of the SWAP include the revision of the SGCN list and KWHs; the revision of associated threats and actions; the addition of the State Assessment Priority Species (SAPS) list, which functions as a supplementary list for data deficient species of concern; an increased focus on plants, including their new status as full SGCN; and a general consolidation of text and action items, meaning that this document is significantly shorter than the previous revision.

This introductory chapter serves as a primer for the rest of the SWAP. It begins with a brief history of wildlife conservation, both in Maryland and the United States as a whole, with a focus on the role of MD DNR and the SWAP. This chapter then provides an overview of what the SWAP must include by Congressional requirement as well as the supplementary elements that Maryland has chosen to include. Finally, it ends with a brief list of the contents of each chapter and appendix.

A Brief History of Wildlife Conservation

Modern funding of wildlife management in this country has greatly evolved over the last 100 years. Historically, such management programs were focused on game species. An overview of wildlife legislation of the twentieth century illustrates this.

The Pittman-Robertson Act of 1937 (Federal Aid in Wildlife Restoration Act) was designed to support selection, restoration, rehabilitation and improvement of wildlife habitat, research, and information distribution, with an emphasis on game species. A 1970 amendment added hunter training programs and maintenance and support of public target ranges. Because the funding is derived from excise taxes on the sale of sporting arms, hand guns, ammunition, and archery equipment, the focus on game species seemed logical.

The Dingell-Johnston Act of 1950 (Federal Aid in Sport Fish Restoration Act) intended a similar program as Pittman-Robertson for the management, conservation, and restoration of fishery resources. Similarly, funding is derived from the sale of fishing gear. An amendment adopted in 1990 to conserve wetlands reflected a modern shift in the understanding of the needs of nongame species protection.

Species not covered by the Pittman-Robertson and Dingell-Johnson Acts, and not listed in law as Threatened or Endangered, are addressed somewhat by the Forsythe-Chaffee Act (Fish and Wildlife Conservation Act). This Act, passed in 1980, called for comprehensive wildlife management plans that include nongame species. This was the first real step towards the integration of nongame and game species conservation. In other words, this act combined the goals of game species management, endangered species conservation, and keeping common species common. Unfortunately, though the legislation was passed, funding was never forthcoming.

To address this continued gap in funding for nongame species, in the 1990s, a coalition of state management agencies, private commercial ventures, and individuals known as Teaming with Wildlife amassed bipartisan support for the Conservation and Reinvestment Act (CARA). This act would have guaranteed a long-term (15-year) funding source to support efforts in state, federal, and local conservation programs. The goals of Title III of this Act were threefold: 1) to prevent species from becoming endangered, 2) to enhance outdoor recreation experiences, and 3) to foster a responsible stewardship ethic through conservation education. Although CARA passed a House vote in 2000 and 2001, it never made it to the Senate floor.

Instead, the Commerce, Justice, and State Appropriations Act provided a smaller, temporary funding source in 2000, called the Wildlife Conservation and Restoration Program (WCRP). These monies were transferred to the Department of the Interior and were meant to enhance fish and wildlife conservation and restoration efforts, including wildlife-related education and recreation projects.

The most recent major funding source for wildlife conservation is the State Wildlife Grant (SWG) program. These monies, derived from the Land and Water Conservation Fund, were first appropriated for the 2002 fiscal year in the Department of the Interior's appropriations budget. These funds have been continued annually, although funding for states has fallen by approximately 35% compared to 2002 levels (USFWS 2002, 2025). This program aims to fill the holes left by previous legislation. Until this point, conservation agencies lacked the means to plan and prioritize comprehensively for all wildlife due to limited funding and programs. The creation of the SWG program and related SWAP requirement allows MD DNR and its partners to undertake this comprehensive planning effort.

The Role of the Maryland Department of Natural Resources

MD DNR is the lead agency on the decision for use of these funds, though it works closely with its conservation partners to make decisions and distribute funds for the implementation of conservation actions. The unit within MD DNR that manages these efforts and funds is the Wildlife and Heritage Service (WHS)—more specifically, WHS's Natural Heritage Program (NHP or the Program). NHP is also the entity in charge of revising Maryland's SWAP. Since 1979, NHP has been the lead entity responsible for protecting and managing nongame, rare, threatened, and endangered species and their habitats. NHP seeks to sustain populations of rare plants and animals through the maintenance of healthy natural ecosystems. This is accomplished through a number of conservation actions, including field surveys, research on natural history requirements, restoration of degraded habitats, technical assistance and data distribution to conservation partners and landowners, and public education. Because of its responsibility for nongame and rare species, it is fitting that NHP would be the lead program within WHS on the SWAP.

The Program also works with other units within MD DNR and with private organizations for the purchase of properties and easements with habitats that support rare species and natural communities. Today, MD DNR owns over 507,000 acres of public land and protected open space (MD DNR 2025), with the Forest Service, Fisheries Service, Park Service, and WHS managing these lands for natural, historical, cultural, and recreational resources. WHS in particular oversees the management of 64 Wildlife Management Areas (MD DNR 2026). In addition to conservation of wildlife habitat through land ownership, MD DNR conserves land and wildlife habitat through a number of easement programs, such as the Conservation Reserve Enhancement Program, Rural Legacy Program, and Forest Legacy Program, and by working directly with landowners to provide technical guidance on managing fish and wildlife habitats.

Units of MD DNR also contribute to resource conservation in other ways. For example, the MD DNR's regional foresters provide technical assistance and incentive programs to urban communities and private landowners to better manage forest habitats. MD DNR's Maryland Biological Stream Survey program provides information to ensure the protection and restoration of Maryland's stream ecological resources. The Fisheries Service manages the state's fisheries and shellfish, including the use of fish hatcheries to stock many of the state's streams and lakes. WHS manages the health and recreational enjoyment of the state's wildlife, including the conservation of rare plants and animals under the coordination of the NHP, and the management of game species.

These examples constitute only a small fraction of the conservation efforts led by MD DNR. The multiple programs and services within MD DNR cooperate on these efforts, sharing their areas of expertise to apply the best available information and resources to the state's conservation needs. Through the MD DNR website, all of the programs and services within MD DNR contribute to ongoing public education and involvement to promote citizens' awareness of and participation in natural resource conservation.

The Contents of the SWAP

As prescribed by Congressional requirement, each SWAP must address the same eight elements (Table 1.1). The organization of Maryland's SWAP document reflects these elements.

Table 1.1 Eight required elements identified by Congress

Element 1: Species of Greatest Conservation Need (SGCN)	Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife.
Element 2: Key Wildlife Habitats (KWHs)	Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in the first element.
Element 3: Threats	Descriptions of problems which may adversely affect species identified in first element or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.
Element 4: Conservation Actions	Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions.
Element 5: Monitoring	Proposed plans for monitoring species identified in the first element and their habitats, for monitoring the effectiveness of the conservation actions proposed in the fourth element, and for adapting these conservation actions to respond appropriately to new information or changing conditions.
Element 6: Plan for Review and Revision	Descriptions of procedures to review the Strategy at intervals not to exceed 10 years.
Element 7: Partner Coordination	Plans for coordinating the development, implementation, review, and revision of the plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats.

<u>Element 8:</u> Public Involvement	Descriptions of the necessary public participation in the development, revision, and implementation of the Plan.

Along with these required elements, Maryland's SWAP includes three additional elements. The first is the State Assessment Priority Species or SAPS list, the inclusion of which was recommended by NEFWDTC in the 2022 Northeast Lexicon (Crisfield & NEFWDTC 2022). It is essentially a list for data deficient species for which more information is needed to fully understand their status, trends, and associated threats and actions. More details on this list, as well as why it was included, can be found in Chapter 3. The second is the addition of plant species to the SGCN list. Although plants do not qualify for SWG funding, MD DNR decided to include them in the 2025 SWAP in order to elevate their needs and emphasize how important plant species are to the success of wildlife and their habitats. The third is the inclusion of case studies that ground the content of the SWAP in reality and showcase past work done by MD DNR and its partners.

The Chapters and Appendices of the SWAP

Maryland's 2025 SWAP revision is divided into nine chapters and nine appendices. The following paragraphs describe the contents of each chapter or appendix (with the exception the current chapter) in order to aid in navigation.

Chapter 2 contains an overview of the landscapes, waterscapes, plant communities, and other physical characteristics of Maryland through the lens of its physiographic provinces. This provides context and lays the groundwork for the species and habitats described in later chapters. It also assists in the understanding of the four regions of Maryland (eastern, southern, central, and western) that are referred to throughout the SWAP.

Chapter 3 summarizes the full array of species found in Maryland and identifies Species of Greatest Conservation Need (SGCN) in each taxonomic group. It also describes the process used to select SGCN, the creation of the new State Assessment Priority Species (SAPS) list and its significance, the major threats facing each taxonomic group, and the actions that address those threats.

Appendix 3a contains the complete SGCN list.

Appendix 3b contains the complete SAPS list.

Appendix 3c contains the list of species that have been removed since the 2015 SWAP revision.

Chapter 4 introduces the concept of a Key Wildlife Habitat (KWH) and provides extensive descriptions for each KWH identified in the SWAP. Each description includes a habitat's physical characteristics, condition, distribution, and associated SGCN.

Appendix 4a contains the complete list of KWHs.

Chapter 5 reviews the threats facing Maryland's species and habitats. It provides an overview of the threat classification system and discusses priority threat areas identified by both Maryland and the larger Northeast region. This chapter supports the contents of **Appendices 6a** and **6b**.

Chapter 6 provides an overview of the conservation actions determined to be necessary to conserve the identified species and habitats. It also contains an explanation of these actions' prioritization schemes. It focuses on actions that address priority threat categories, are applicable statewide, or are considered regional priorities. This chapter also supports the contents of **Appendices 6a** and **6b**.

Appendix 6a lists all of the species-level threats and actions in the SWAP. It identifies individual threats and lists each threat's applicable action, relative priority, and associated species.

Appendix 6b lists all of the habitat-level threats and actions in the SWAP. It identifies individual threats and lists each threat's applicable action, associated habitat group(s), and any specific KWHs for which the action is particularly applicable.

Chapter 7 provides an overview of approaches and strategies for monitoring Maryland's SGCN, their habitats, and the effectiveness of implemented conservation actions. It also describes the use of monitoring data in an adaptive management framework to assess and improve the effectiveness of conservation actions.

Appendix 7a lists species-level monitoring programs in Maryland.

Appendix 7b lists habitat-level monitoring programs in Maryland.

Chapter 8 summarizes partner and public outreach, coordination, and participation throughout the SWAP process. It summarizes MD DNR's current conservation partners and details how these partners were involved in the development process. It also lists the ways in which the general public were made aware of the SWAP update and provided the opportunity to comment.

Appendix 8a lists all of the organizations that were involved in the SWAP revision process.

Chapter 9 describes the future of the SWAP, both in terms of implementation and the next revision process. It provides an overview of how MD DNR intends to work with its partners and the public to implement the SWAP's objectives. It ends with a plan for the next SWAP revision, including periodic reviews and updates before the next major revision in 2035.

This chapter laid the foundation for the following 2025 State Wildlife Action Plan revision. It summarized the SWAP's purpose, content, and organization. It also provided an overview of the history of wildlife conservation as well as the role of MD DNR in those efforts. The next chapter will provide information regarding Maryland's physical landscape, laying the groundwork for identifying the species and habitats that are the focus of the SWAP.

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Chapter 2

Maryland's Land and Waterscape

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Introduction

Maryland is a state of great geographic diversity. Often called “America in Miniature,” Maryland comprises a variety of habitats not often found in a single state. From the barrier islands, bald cypress swamps, and Delmarva Bays of the Eastern Shore to the mountain bogs, caves, and eastern hemlock forests of the Appalachian Plateau, Maryland encompasses a wide range of habitats that support an impressive number and variety of species.

Maryland’s wildlife distribution and abundance are intricately connected to and ultimately dependent on the ecological integrity and diversity of its habitats. The state’s varied physiographic features, geology and resulting soil types, topography, and climate support a range of plant communities and aquatic environments that provide diverse habitats for wildlife. These habitat characteristics directly influence the distribution of wildlife species in the state, especially for species at the northern or southern edges of their North American range and for endemic species with specific habitat requirements.

This chapter uses the framework of physiographic provinces to present an overview of this diversity, which lays the groundwork for identifying Maryland’s wildlife and Species of Greatest Conservation Need (SGCN), discussed in Chapter 3 (**Element #1**), and wildlife habitats essential to their conservation, discussed in Chapter 4 (**Element #2**). An understanding of why certain species and habitats exist in Maryland also leads to an understanding of threats and developing conservation actions that are addressed in the State Wildlife Action Plan (SWAP or Plan). This chapter therefore provides information on the physical layout, attributes, and plants of Maryland, providing a regional context for the elements of subsequent chapters.

Maryland’s Physiographic Provinces

Maryland’s diverse landscape flows through a wide range of topographic features from the mountains to the sea. The state’s landscape is divided into physiographic regions or provinces based primarily on soil types and the underlying regional geology. For the purposes of Maryland’s SWAP, Maryland has been divided into six distinct physiographic provinces: (1) Lower Coastal Plain, (2) Upper Coastal Plain, (3) Piedmont, (4) Blue Ridge, (5) Ridge and Valley, and (6) Appalachian Plateau (Figure 2.1).

These six provinces are slightly different from those more commonly recognized in Maryland. According to the Maryland Geological Survey (MGS), the Coastal Plain is a single province, and the Atlantic Continental Shelf is its own province (MGS 2026a). Maryland’s SWAP separates the Coastal Plain Province into the Lower and Upper Coastal Plains because of the important differences in physiography, habitat types, and therefore species found on either side of the Chesapeake Bay. As for the Atlantic Coastal Shelf Province, given that it is located exclusively offshore—and, furthermore, given that many aquatic species found in the Atlantic Ocean can also be found in the Coastal Bays or the Chesapeake Bay—it has been merged with the Lower Coastal Plain for the sake of simplicity.

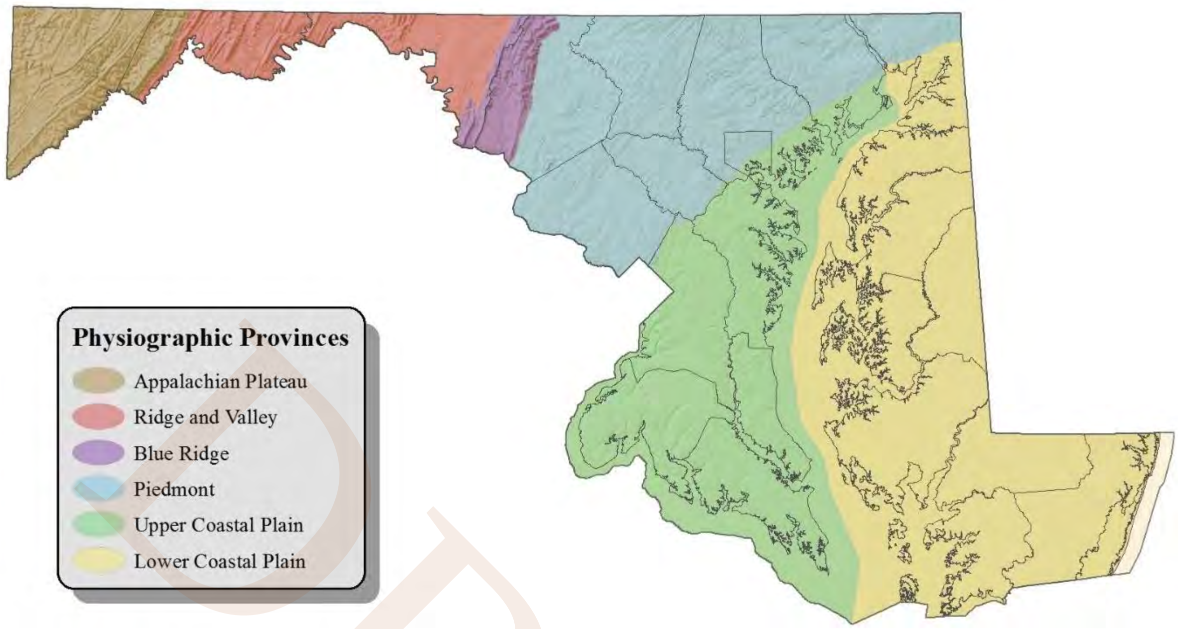


Figure 2.1 Physiographic Provinces of Maryland. Source: MD DNR.

All of these provinces have distinct characteristics that in turn support distinct sets of habitats and species. Given the importance of these provinces to Maryland's ecological diversity, the following sections detail the physical geography of and provide examples of plant species and communities that are found in each province. These plant communities in turn help form the basis for Maryland's Key Wildlife Habitats (KWHs), as discussed in Chapter 4. For a list of which KWHs can be found in which province(s), please see Table 4.1.

Furthermore, in order to more easily convey location information without becoming overly technical, later parts of the SWAP refer to regions of Maryland by their Maryland Department of Natural Resources (MD DNR) management region. There are four such regions: Eastern, Southern, Central, and Western. These are respectively referred to as eastern, southern, central, and western Maryland for the remainder of the SWAP. These regions are used much more widely than MD DNR and are more recognizable to the general public than the six physiographic regions. This section therefore includes references to which physiographic region corresponds to which management region of Maryland. They generally align with the physiographic provinces, so occasionally, terms may be used interchangeably. See Figure 2.2 for a visual of these management regions.

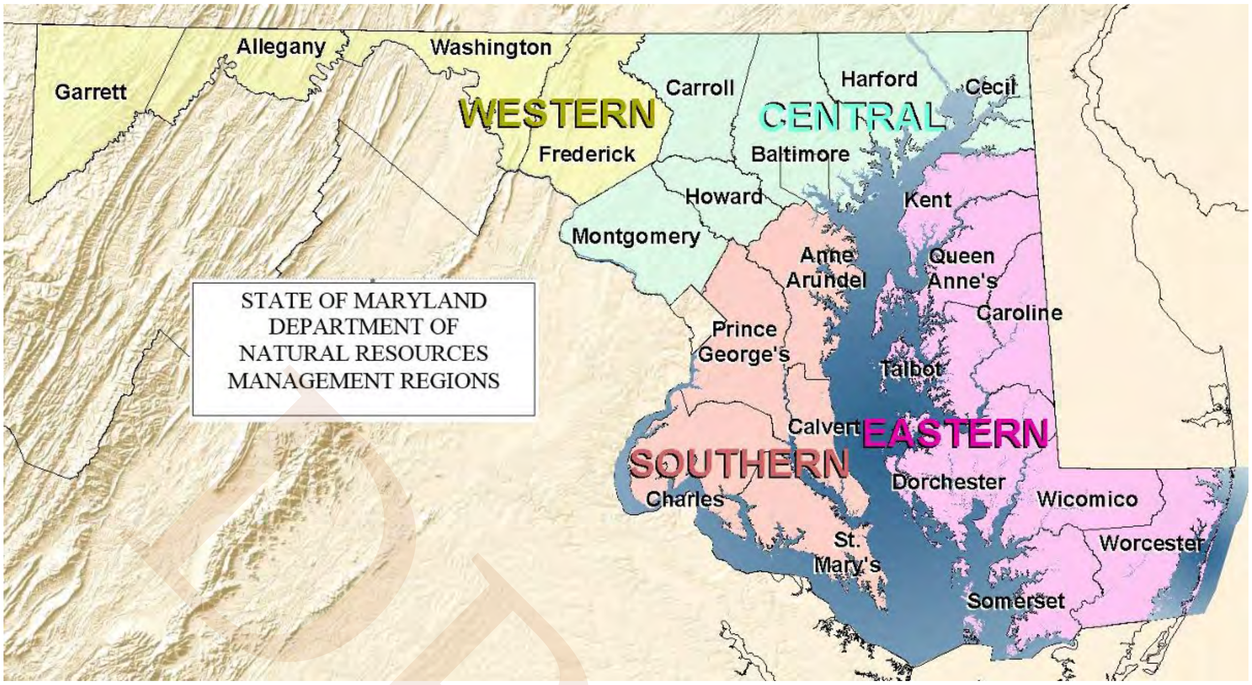


Figure 2.2 MD DNR Management Regions. Source: MD DNR.

Coastal Plain

The Coastal Plain contains approximately two-thirds of Maryland's land area, covering all or most of the area within 16 counties and Baltimore City that borders the Atlantic Ocean, Chesapeake Bay, and the Potomac River. It is bisected by the Chesapeake Bay, which divides it into two distinct regions: eastern Maryland, also known as the Eastern Shore, and southern Maryland. The Eastern Shore aligns with the Lower Coastal Plain; the Upper Coastal Plain roughly aligns with southern Maryland, though it includes small portions of central Maryland as well. The Upper Coastal Plain is also sometimes referred to as the Western Shore, but in order to avoid confusion with western Maryland, the 2025 SWAP revision does not use this term.

The Coastal Plain is characterized by low-lying landscapes with minor elevation change. Less than half of Maryland's Coastal Plain is above 10 feet in elevation; its highest point is below 450 feet (MGS 2008). It is bordered by the Piedmont Province to the west and the Atlantic Ocean and Delaware to the east. The geological boundary between the Coastal Plain and the Piedmont is marked by a transitional belt averaging approximately five miles in width, known as the Fall Zone or Fall Line. The Coastal Plain generally slopes gently downward from the Fall Zone as it approaches the Atlantic (UMBC 2003a), with higher elevations occurring mostly on the Upper Coastal Plain and lower elevations on the Lower Coastal Plain. These relative elevations are what give these provinces their names in the 2025 SWAP revision.

Mather Gorge, on Maryland's Fall Zone or Fall Line
(Chris Frye, MD DNR)

This region of Maryland is underlain by unconsolidated sediments of gravel, sand, silt and clay, and represents the youngest region of the state in geological terms (MGS 2026a). Sandier soils tend to be found closer to the Atlantic Ocean, and in some instances, these soils may be so sand-rich that they are economically valuable as sources of sand. Along shorelines, these loose sand soils can easily be seen in dunes and beaches. Where organic material is available, the Coastal Plain's sandy soils become loams, becoming highly acidic and retaining more moisture. In some shallow or exposed areas, soils may have silts or clays that further enhance their ability to retain moisture, host more diverse plant life, and support agriculture. Wetlands are found where silt, clay, and/or very fine sand create(s) wet, acidic soils, although these soils have been ditched and drained in many areas for use as farm fields. Tidal marsh and swamp soils are found along shorelines in the Coastal Plain and can either be sandy or rich in organic material, including peat. These wetlands in particular are less vulnerable to ditching and draining, as past research has shown that these soils may be highly toxic to crops due to sulfur that oxidizes when wetlands are drained (MDP 1973).

Wetland diversity in this region is exceptionally high and ranges from expansive freshwater to saline/estuarine marshes, tidal and palustrine swamps (e.g., bald cypress and Atlantic white cedar swamps), seasonally flooded depressions (e.g., Delmarva Bays and interdunal swales), and seepage swamps. This abundance of wetlands—and therefore favorable soil—is part of the reason why the Coastal Plain is heavily utilized for agriculture. Other contributing factors include its relative flatness, mild climate, and abundance of Chesapeake Bay tributaries scattered throughout the landscape (UMBC 2003a). These tributaries are warmer and lower in gradient than streams and rivers found elsewhere in Maryland. In fact, the Fall Line that divides the Piedmont from the Coastal Plain is defined as the area where streams tend to have falls as they pass from the rocky, higher-elevation Piedmont to the lower, flatter Coastal Plain. Coastal Plain streams and rivers also tend to have more woody debris (i.e., logs and fallen trees); some are even considered blackwater streams, with high tannin concentrations created by decomposing leaves (Boward et al. 1999).

Forest types on the Coastal Plain are shaped by this agriculture-favorable physiography and abundance of fresh water as well, as silviculture is also common. Much of the Coastal Plain's contemporary forest consists of successional or silvicultural stands of loblolly pine *(Pinus taeda).* These loblolly-dominated forests tend to be less biologically diverse and do not provide ideal habitat for most species native to the Coastal Plain. Prior to European settlement, the forests that covered the Coastal Plain consisted primarily of hardwoods, though they increasingly mixed with pine towards the south. These forests were likely combinations of oak-hickory, oak-gum, or oak-pine, and today exist in second-growth form as the result of repeated cutting or agricultural abandonment.

Loblolly pine-dominated forest
(Will Parson, Chesapeake Bay Program)

The Coastal Plain is also home to the Chesapeake Bay and Coastal Bays. The Chesapeake Bay, which is the largest estuary in the United States, has a drainage area that extends into Virginia, West Virginia, Pennsylvania, Delaware, and New York. The Coastal Bays are smaller, saltier estuaries that are narrowly separated from the Atlantic Ocean by Fenwick and Assateague Islands. Along with supporting a wide range of aquatic species themselves, these bays are the sites of dozens of islands. These range from large, forested islands (e.g., Poole's, Coaches, and Barren Islands) to sandy islands less than 10 square meters in size. These smaller islands, referred to as Small Coastal Plain Islands in later chapters of the SWAP, serve as critical breeding sites for many of Maryland's colonial nesting waterbirds.

This network of wetland, forested, sandy, and aquatic habitats supports a wide range of wildlife, from birds to fish to sand-dependent insect species. Agricultural activities can prove either boon or threat depending on management techniques, potentially adding another important habitat type to this network: working lands. Agricultural lands managed with biodiversity and conservation in mind can provide pseudo-grassland habitat for birds, pollinators, small mammals, and other species groups. On the other hand, overapplication of pesticides, herbicides, and fertilizers can increase runoff into the Coastal Plain's abundant wetland and aquatic habitats, negatively affecting both terrestrial and aquatic species. In recent years, it has also become more common for farmers to lease or sell their lands to solar companies, which takes away from the stock of important working land habitat unless carefully sited, designed, and managed.

Lower Coastal Plain

The largest of Maryland's provinces, the Lower Coastal Plain Province comprises the portion of the Coastal Plain east the Chesapeake Bay and Elk River. It is also referred to as eastern Maryland or the Eastern Shore. This province is easily identified by its flat, low-lying landscape with many tidal wetlands and tributaries that drain into the Chesapeake Bay and the Coastal Bays on the Atlantic coast. Elevations are usually less than 60 feet above sea level, with much of the Lower Coastal Plain being even lower in elevation.

Soils on the Lower Coastal Plain tend to be sandier than those on the Upper. These deep sand soils are very permeable and do not retain moisture well; in fact, when they are exposed at the surface without vegetation, they are easily eroded by wind and water (MDP 1973). This combination of exposed sandy soil, low elevation, and plentiful water features makes the Lower Coastal Plain especially vulnerable to water-based, climate change-related threats such as sea-level rise, saltwater intrusion, and increased storm intensity and frequency. Some soils on the Lower Coastal Plain have also been influenced by a long history of human activity. At several shoreline sites, extensive Native American shell-middens, formed from accumulations of discarded oyster shells over thousands of years, have created an altered soil composition that supports a unique and diverse plant community (McAvoy & Harrison 2012). These rare natural and cultural resources represent special contributions to soil and habitat diversity resulting from the rich Native American history of Maryland.

Native American oyster shell-midden
(Torben Rick, Smithsonian)

The Lower Coastal Plain is the only physiographic province in Maryland with direct access to the Atlantic Ocean. This means that ocean-dependent SGCN such as the North Atlantic right whale *(Eubalaena glacialis)*, Cory's shearwater *(Calonectris borealis)*, and white shark *(Carcharodon carcharias)* are exclusive to this region of Maryland. Other habitat types limited to the Lower Coastal Plain and generally related to this proximity to the Atlantic Ocean are dunes, maritime swamps, and Coastal Bays.

Additionally, the Eastern Shore of Maryland is part of the Delmarva Peninsula. This peninsula is shared by Delaware, Virginia, and Maryland, and is bound by the Chesapeake Bay, Delaware Bay, and Atlantic Ocean. This separation from the rest of the eastern seaboard means that certain habitats and species are found only on this peninsula. Seasonally flooded Delmarva Bays, for instance, are unique to this region, as is the state-listed Delmarva fox squirrel *(Sciurus niger cinereus)*.

Upper Coastal Plain

The Upper Coastal Plain is bounded by the Fall Line to the west and the Chesapeake Bay to the east. Though not an exact match, it is also a close approximation of what is considered southern Maryland. From its western edge, the Upper Coastal Plain generally grades downward to sea level at the waters of the Chesapeake Bay (UMBC 2003a). Though still relatively flat and low-lying, the Upper Coastal Plain is higher and more variable in elevation than the Lower; it features bluffs made of older, stiffer clays and marls with a more dramatic scarp and terrace topography. One example of this topography can be found at Calvert Cliffs, an area that encompasses a long stretch of tall, steep-to-vertical bluffs along the Chesapeake Bay. The Upper Coastal Plain also has higher freshwater input due to nearby Piedmont and Appalachian geology, leading to slightly different stream, river, and wetland conditions than the Lower Coastal Plain.

Though not necessarily restricted to Maryland's Upper Coastal Plain, the aforementioned coastal bluff habitat type is highly concentrated in this area. Calvert Cliffs is the best example of this

Calvert Cliffs (MD DNR)

habitat found in Maryland. The eroding cliff faces provide vital habitat to various species of tiger beetle, including the state- and federally listed Puritan tiger beetle *(Ellipsoptera puritana)*. Similar (if smaller and more scattered) habitats can be found at the mouth of the Sassafras River and elsewhere in the state.

Plants of the Coastal Plain

The flora of the Coastal Plain is diverse, with 148 of the 454 plant SGCN (see Chapter 3) restricted to this province spanning 16 KWHs (see Chapter 4). The previously mentioned Delmarva Bay is just one of these KWHs. These shallow, seasonally flooded freshwater wetlands are generally small (< 1 acre) but numerous, with several thousand bays present on the Delmarva Peninsula. The plants of these bays are adapted to a seasonal drawdown of the groundwater, with extreme variation in dominant species. Early in the spring, when the bays are full, they appear like any other pond with emergent and floating vegetation. The same bay may appear as grassland in late summer and fall with a completely different set of dominant species. The species composition is zonal and associated with hydrology and position within the bays, from open grassy swales dominated by herbaceous species near the lower, depressional center of the pond to forested wetlands around their perimeters. Delmarva Bays harbor 45 rare and uncommon plant species, eight globally rare plant species, and the federally endangered Canby's dropwort (*Tiedemannia canbyi*); the latter occurs in a single pond in Queen Anne's County. One of the more intriguing globally rare plants is the diminutive Harper's fimbristylis (*Fimbristylis perpusilla*). This is a tiny, inconspicuous grass-like plant which grows only a few inches tall that is restricted to the very center (i.e., the lowest elevation) of the ponds. It may grow in dense patches in the exposed muddy soil, but only in those years when the ponds are completely dry. The total habitat area in the state for this species may be less than a half-acre, with each pond contributing a few square feet. Delmarva Bays also provide habitat for narrow endemic species such as the Mid-Atlantic beakrush (*Rhynchospora mesoatlantica*), which occurs in a few ponds in Dorchester County.

Of the native plant communities endemic to Chesapeake Bay, the intertidal habitats (i.e., those occurring along the shorelines between low and high tides) along the Chesapeake Bay and its tidal tributaries comprise a distinctive set of globally rare and near-endemic species. Seaside alder (*Alnus maritima* ssp. *maritima*) is a wetland shrub restricted to tidal rivers on the Eastern Shore and Delaware, with two other subspecies having disjunct populations occurring in Georgia (ssp. *georgiensis*) and Oklahoma (ssp. *oklahomensis*). This odd distribution is thought to be the result of range retraction during a glacial epoch, leaving isolated populations in disparate locations that have now diverged genetically and ecologically. Another globally rare species is the regional endemic Maryland bur-marigold (*Bidens bidentoides*) that occurs in the upper Chesapeake Bay, Delaware Bay, and a few scattered populations in New Jersey and New York. Maryland has the lead responsibility for conservation of this species, as Maryland populations comprise the bulk of individuals within its narrow range. Intertidal habitats are also locations for federally threatened sensitive joint-vetch (*Aeschynomene virginica*) and the globally rare Parker's pipewort (*Eriocaulon parkeri*), a species exhibiting steep regional declines in fresh-tidal waters of the Chesapeake Bay.

Much of the lower Eastern Shore is covered by a surficial layer of well-drained sands of the Parsonburg Formation or Parsonburg Sand Sheet. Parsonburg sands extend from southern New Jersey across the Delmarva Peninsula and southern Maryland to eastern Virginia. They contain large areas of elliptical sand dunes where Coastal Plain Oak-Pine Forests are a common KWH. These forests are particularly fire-prone, and natural stands are often dominated by fire-tolerant species such as shortleaf pine (*Pinus echinata*), pond pine (*Pinus serotina*), pitch pine (*Pinus rigida*), blackjack oak (*Quercus marilandica*), and post oak (*Quercus stellata*). Although many of these inland dune systems have been converted to plantations, as mentioned above, excellent representatives of these fire-prone communities remain in Pocomoke State Forest. These sandy woodlands and shrublands provide habitat for plants that thrive in full sun and in harsh, nutrient-poor growing conditions, such as sundial lupine (*Lupinus perennis*), which is one of Maryland's most showy wildflowers. Due to the nutrient-poor status of the sands, many of the plant SGCN of the Parsonburg sands are nitrogen-fixing legumes, some of the rarest including Fernald's tick-trefoil (*Desmodium fernaldii*), Pineland tick-trefoil (*Desmodium strictum*), hairy snoutbean (*Rhynchosia tomentosa*), and spiked hoary-pea (*Tephrosia spicata*). Shade-intolerant and fire-dependent species of wildflowers such as late goldenrod (*Solidago tarda*) and threadleaf gerardia (*Agalinis setacea*) are also present. Shade-intolerant grasses may thrive in the dry open sands, including woolly three-awn (*Aristida lanosa*), rough dropseed (*Sporobolus clandestinus*), and few-flowered witchgrass (*Dichanthelium oligosanthes* var. *oligosanthes*).

Sundial lupine (Lupinus perennis)
(Chris Frye, MD DNR)

On the Upper Coastal Plain, Coastal Plain Pine-Oak Forests are of a slightly different character. The rare natural communities there are remnants of once widespread natural communities that occurred along the Fall Line. There are also fire-prone forests, sandy barrens, and woodlands that support single-population species such as scaly gayfeather (*Liatris squarrosa*) and golden heather (*Hudsonia ericoides*). The Upper Coastal Plain also contains natural communities that occur nowhere else in Maryland, including the globally rare Fall-Line Gravel Terrace Bogs. Located between Washington, DC and Baltimore, these irreplaceable habitats are small but highly diverse wetlands that support numerous rare species of plants and animals. Rare species such as ten-angled pipewort *(Eriocaulon decangulare*) that occupy this habitat require an open canopy and are not present when woody plants dominate. The combination of the development pressure in the Baltimore–Washington corridor and suppression of the natural fire regime means that many of these habitats and the species associated with them are at risk, with some that have already been lost entirely.

Instances of the Coastal Plain Seepage Acidic Fen KWH occur across the Coastal Plain province and contain some of Maryland's rarest plants, including the northern pitcherplant (*Sarracenia purpurea*) and red milkweed (*Asclepias rubra*). These fens dot the Coastal Plain and are generally small, isolated wetlands surrounded by swamp forests or other mesic forest types. Other carnivorous plants such as sundews (*Drosera* spp.), bladderworts (*Utricularia* spp.), and several species of rare orchids including tuberous grass-pink (*Calopogon tuberosus*) and white fringed orchid (*Platanthera blephariglottis* var. *blephariglottis*) are restricted to this KWH. In southern Maryland, these fens contain a population of kidneyleaf grass-of-parnassus (*Parnassia asarifolia*), one of the most intricately beautiful flowers in the flora. Maryland populations are disjunct from the Appalachian/Ozarkian core and are the northernmost (and likely easternmost) populations in the United States.

Case Study: Conservation of Red Milkweed (Asclepias rubra) *in Maryland*

Red milkweed is a species occurring in acidic wetlands in the southeastern United States. Maryland sits at the northeastern edge of its range, which extends from Texas to Florida and north to New York (where it is now presumed extirpated). In Maryland, red milkweed is in critical decline across all known sites. Current census data indicates only about 86 plants remain statewide. These populations are small, isolated, and highly vulnerable, with many individuals remaining in a non-flowering state for years.

Red milkweed (Asclepias rubra) (Jim Brighton, Maryland Biodiversity Project)

Key Threats to Recovery

Reproductive Barriers: Like most milkweeds, this species is self-incompatible, meaning it requires pollen from genetically different individuals to produce seeds. In small populations, a lack of compatible mates or low pollinator activity often leads to reproductive failure. For instance, a small population in Wicomico County aborted its flowers for three consecutive years despite being protected from deer.

Habitat Management: Without natural fire cycles, woody plants and aggressive species—such as the invasive Phragmites australis and the native Smilax rotundifolia—quickly overgrow the milkweed's habitat.

Human Impact: Many surviving plants are located under utility lines or along roadsides, making them highly susceptible to herbicide applications. This is the likely cause of the species' disappearance from a site in Worcester County.

Climate Change: Populations on fringe freshwater wetlands have been lost due to sea-level rise and salt intrusion.

Conservation and Monitoring

MD DNR's Wildlife and Heritage Service has implemented several strategies to halt this decline:

Deer Exclusion: Wire cages have successfully protected large populations in Worcester County, leading to robust fruit sets with hundreds of seeds per pod. However, caging alone is ineffective for smaller populations that lack compatible pollen.

Population Augmentation: To combat genetic isolation, the Service is expanding its program to include hand-pollination (using pollen from different sites) and the outplanting of greenhouse-raised seedlings.

As most forested areas on the Coastal Plain have experienced hundreds of years of logging and conversion into loblolly pine plantations, large, intact upland forests are rare. The areas of Mesic Mixed Hardwood Forest KWH that remain contain habitat for globally rare species such as Virginia least trillium (*Trillium pusillum* var. *virginianum*), a species endemic to Maryland and Virginia that is restricted to ancient shorelines of the Atlantic Ocean on the lower Delmarva Peninsula. One old growth parcel of Mesic Mixed Hardwood Forest on the Coastal Plain also contains a large population of the rare nodding pogonia (*Triphora trianthophoros*).

An intriguing herbaceous species-dominated community exists on the Coastal Plain that has yet to be thoroughly described or named, as we do not have ecological knowledge of these communities prior to settlement by Europeans. These were undoubtedly grasslands or savannas that were maintained by frequent episodes of fire—as with Coastal Plain Oak-Pine Forests—but they occur on more level ground adjacent to wetland communities like Delmarva Bays. As this habitat type is both scattered throughout the Coastal Plain and little-understood, some plant SGCN of the Coastal Plain are therefore assigned to the Roadside and Utility Right-of-Way KWH. These open meadows contain a diverse array of rare plants that are most commonly associated with southern pine barrens or midwestern prairies, including the globally rare pale false foxglove (*Agalinis skinneriana*), wand-like three-awn grass (*Aristida virgata*), slender plume grass (*Erianthus strictus*), low showy aster (*Eurybia spectabilis*), shortleaf beardgrass (*Gymnopogon brevifolius*), and dwarf iris (*Iris verna* var. *verna*).

Piedmont

The second largest province in Maryland, the Piedmont Province—a close approximation of central Maryland—extends from Catoctin Mountain in the west to the Coastal Plain in the east. This divide between the two provinces, the Fall Line or Fall Zone, is occasionally visible to the naked eye due to the presence of rapids and falls where it is crossed by rivers and streams, such as at Great Falls along the Potomac River. This irregular line also runs roughly along Interstate 95 (Pyzik et al. 2004). Elevations in the Piedmont Province range from approximately 100 to over 1,200 feet above sea level, with its highest point being Sugarloaf Mountain (1,282 feet) in Frederick County (MGS 2008).

The soils of the Piedmont tend to have a high proportion of clay. A band of red clay extends through northern Prince George's County, northwestern Anne Arundel County, and eastern Washington, DC, covered by a few inches to several feet of surface soil. In other areas, the bedrock of the Piedmont creates an acidic, thin soil that contains a high percentage of shale or other rock fragments. Broad ridges or upland depressions often have moderately well-drained, thin (< 2 feet), silty or loamy soils that are perched on top of an underlying clay or hardpan layer, which also seasonally traps the shallow water table and creates strongly acidic wetlands (MDP 1973). This is reflected in the number of groundwater-fed wetland habitats unique to the Piedmont Region, including the Piedmont Seepage Wetland and Piedmont Upland Depression Swamp KWHs (see Chapter 4). Floodplain and rocky soils are similar to those found in the mountains, which results in multiple floodplain habitat types being shared across these regions.

As the different types of hard igneous and metamorphic rocks found underlying the Piedmont weather and erode at different rates, they form the distinct topography of the Piedmont: rolling hills with deeply incised stream valleys, which mark where less resistant rock has eroded more quickly. In general, habitat diversity in the Piedmont is high but very localized due to the numerous bedrock formations (i.e., calcareous, mafic, felsic) and high-gradient rivers along the Fall Line. Historically, the forests of Maryland's Piedmont could have been characterized as oak-chestnut, but since the near eradication of the American chestnut by chestnut blight, they have now been replaced by oak-hickory and oak-pine forests with scattered pockets of mixed mesophytic (i.e., moderate moisture level) forests. In addition, the thousands of acres of grasslands that once existed in northern Maryland (Mayre 1920) have been reduced to small pockets where soils are poorly developed and bedrock is exposed. These are partially contained in the Piedmont-specific Serpentine Barren KWH, which develops in the shallow soils over serpentine bedrock. Most take the form of graminoid-dominated oak savannas, open grasslands, or a mix of the two, with patches of exposed bedrock common due to the shallowness of the soil.

Streams and rivers of the Piedmont tend to be steeper in gradient and therefore more swiftly moving than those of the Coastal Plain. Substrates are rockier as well. This tumbling of water over rocks tends to result in streams and rivers with higher levels of dissolved oxygen; water temperatures are also cooler than those of the Coastal Plain (Boward et al. 1999), though warmer than waters further west.

The Piedmont is the connecting region between the flat Coastal Plain to the east and the more mountainous areas of Maryland to the west. As such, it functions as a sort of transition zone, sharing certain characteristics, habitats, and species with both extremes of the state. This results in a very biodiverse region, given that both upland and lowland species and habitats can be found in the Piedmont. Piedmont streams and rivers in particular serve as vital connectors between the upstream aquatic habitats of western Maryland and the downstream aquatic habitats of southern and eastern Maryland, including the Chesapeake Bay. This means that threats to Piedmont streams and rivers affect all of Maryland's freshwater habitats. In terms of upstream effects, impoundments for drinking water reservoirs and hydroelectric power generation have reduced upstream access to spawning grounds for many migratory fishes. In terms of downstream effects, water quality degradation—from runoff, dumping, and combined sewer overflows—reduces quality of both Piedmont rivers and streams and those downstream in the Coastal Plain.

These kinds of issues are only exacerbated by the fact that central Maryland (i.e., the Piedmont Province, along with parts of the Upper Coastal Plain) contains some of the most urbanized areas in the state. More development pressure and population density means more pollution, habitat loss/fragmentation, and other human-related threats. This negatively affects terrestrial habitats as well as aquatic ones. Undeveloped areas are increasingly fragmented due to the continued conversion of forest and agricultural lands to residential use—and associated roads, power lines, and other infrastructure—as the urban centers of Baltimore and the District of Columbia continue to expand.

Plants of the Piedmont

The Maryland Piedmont is home to over forty plant SGCN that occur nowhere else in Maryland. Many of these plants are associated with Glade, Barren and Cliff habitat types, including the Acidic Glade and Barren, Cliff and Outcrop, and aforementioned Serpentine Barren KWHs. While Serpentine Barrens occur over surficial outcroppings of serpentinite that contain heavy metals toxic to most plant life, they also support a suite of plant SGCN that occur nowhere else in the state. These include the globally rare serpentine aster (*Symphyotrichum depauperatum*), the endemic Octoraro Creek chickweed (*Cerastium velutinum* var. *villosissimum*), and Endangered grasses such as northern dropseed (*Sporobolus heterolepis*) and tufted hairgrass (*Deschampsia cespitosa*). Small streams that cut through Serpentine Barrens provide the only known habitat for the Endangered fringed gentian (*Gentianopsis crinita*).

Nantucket shadbush (Amelanchier nantucketensis) (Chris Frye, MD DNR)

Large river systems in the Piedmont have cut deep into the surrounding geological formations as they approach the Coastal Plain, forming a variety of cliff, outcrop, and river scour-bar habitats. The Potomac River at Great Falls (i.e., the Potomac Gorge), for example, has an outsized contribution to species diversity in Maryland despite its limited geographic area. Some of the more unique plant communities in Maryland occur at Great Falls. The Potomac Gorge sustains populations of rare species such as McDowell's sunflower (*Helianthus occidentalis*), which is more commonly associated with Midwestern prairies; the globally rare Nantucket shadbush (*Amelanchier nantucketensis*), a shrub more commonly associated with previously glaciated regions of New England; and the globally rare racemose goldenrod (*Solidago racemosa*), which is restricted to riverscour habitat throughout its narrow range. Historical components of the flora of Great Falls that highlight its unique phytogeography—though not SGCN themselves—include running buffalo clover (*Trifolium stoloniferum*) and curly heads (*Clematis ochroleuca*).

Several unique habitats occur along Montane-Piedmont Floodplains at the meeting point between the metamorphic and igneous rocks of the Piedmont and the unconsolidated sediments of the Coastal Plain in the Fall Zone. The Montane-Piedmont Floodplain KWH is home to the globally rare rock grape (*Vitis rupestris*), which occurs along the Potomac River, and

Open barren habitat at Soldiers Delight
(Chris Frye, MD DNR)

Susquehanna doll's-daisy (*Boltonia asteroides* var. *asteroides*), which is endemic to the Susquehanna River in Maryland and adjacent Pennsylvania. Piedmont Seepage Wetland and Montane-Piedmont Acidic Seepage Swamps provide wetland habitat for the federally threatened swamp pink (*Helonias bullata*), the Endangered death-camas (*Stenanthium leimanthoides*), and the Threatened Canada burnet (*Sanguisorba canadensis*).

The unifying characteristics of most of these habitats are that they are frequently disturbed by flood or fire and have sparse tree cover. Many of the plant SGCN in the Piedmont are obligate heliophytes, meaning that they require sunny locations where forests give way to open, frequently disturbed habitats. Natural disturbances such as fire are vital to the health of these plant communities. In the absence of natural disturbances, artificial stand-ins such as prescribed fire can serve the same function(s).

Blue Ridge, Ridge and Valley, & Appalachian Plateau

To the west of the Piedmont lies the mountainous region of the state, often referred to as western Maryland. Though the match between these mountainous physiographic regions and western Maryland counties is not exact, with the eastern half of Frederick County in fact on the Piedmont Plateau (see Figures 2.1 and 2.2), this is the colloquial understanding of western Maryland. This mountainous region of Maryland—which comprises the Blue Ridge, Ridge and Valley, and Appalachian Plateau Provinces—will therefore be referred to as western Maryland for much of the SWAP.

This region of Maryland is characterized by sub-ranges of the Appalachian Mountains and the valleys between them. During its formation hundreds of millions of years ago, folding and faulting (i.e., tectonic forces) wore the area nearly flat and then raised it up once more, creating a series of ridges and valleys: ridges where more resistant rock was raised and resisted erosion, valleys where less resistant rock has been eroded by flowing water, even though much of it was once raised to the same level as the ridges (UMBC 2003b).

Soils in the more mountainous areas of Maryland are often thin, with loose rocks or bare bedrock exposed on the surface. Even in places where bedrock is not exposed, it can be nearly so, with less than 20 inches of soil between the surface and the bedrock below. This is because the dramatic relief of the mountains creates steep slopes where soils may be easily eroded, especially if the land has been cleared. The mountain soils frequently contain gravel or rock fragments as the underlying rock is weathered to produce the soil; some of the gravel concentrations are even high enough to be economically valuable for road fill and other uses. Soils may be strongly acidic depending on the area's rock type (e.g., acid shale, sandstone). Ridges and hillsides composed of limey shales, limestones, and clays have created clay-rich soils interspersed with rock outcrops (MDP 1973).

The lower-lying portions of western Maryland, the valleys, have much more fertile soils. This is due in part to the abundance of rivers that flow through western Maryland; river floodplains have deeper, well-drained soils of loamy alluvium that were deposited by their rivers or streams during floods. This process has created fertile soils excellent for farming. However, floodplain soils located farther from the river or stream tend to have higher concentrations of finer sediments and are poorly to very poorly drained (MDP 1973).

Winders Cave (Dennis Slifer, MGS)

The geology of western Maryland is an important factor in determining the abundance, distribution, and integrity of several wildlife habitats. Not only does it influence the topography of the mountains and valleys, but several valuable habitats occur only on certain geologic features. For example, there are over 50 caves in western Maryland (MGS 2026b), many of which provide habitat for numerous specialized, subterranean species. The distribution of limestone rocks creates karst—a landscape of caves, springs, and seeps—and limestone cliff habitats for other specialized species. Shale Barrens and other bare rock habitats are also present in this region due to the occurrence of those particular geological layers. These habitat types, found nowhere else in Maryland, contribute greatly to Maryland's biodiversity and are responsible for a significant portion of the species on the SGCN list.

Other terrestrial habitats in western Maryland include forests and wetlands. Forested habitats in this region are a mix of natural forests and human-made conifer stands akin to the loblolly pine plantations of the Coastal Plain. The majority of northern hardwood forests in Maryland are found in the Appalachian Plateau and Ridge and Valley physiographic provinces, where higher elevations and a cooler climate provide favorable growing conditions for northern tree species. Oak, oak-pine, and oak-hickory forests are also common. Managed conifer forests can still be found where they were established in the 1930s by Civilian Conservation Corps work crews. Though not necessarily ideal habitat for the native flora and fauna of western Maryland, these human-created stands serve as stand-in habitat for the natural conifer forests that were depleted by logging in the nineteenth and early twentieth centuries. Wetland habitats are somewhat rarer, though a mix of floodplain and groundwater wetlands still occurs throughout these three physiographic provinces. They are less common in the Blue Ridge and Ridge and Valley Provinces, occurring only in topographic slopes and depressions; however, wetlands of the Appalachian Plateau are more diverse, manifesting in the form of wet thickets, shrub bogs, seasonally flooded wet meadows, and marshes (LaBranche et al. 2003). Springs are also more common in western Maryland than any other part of the state.

Given its relative distance from the Chesapeake Bay and Atlantic Ocean, aquatic habitats in these three provinces are solely freshwater. On the whole, water temperatures are cooler, gradients are steeper, and waters are faster-flowing than the rest of the state, though rivers and streams of the Ridge and Valley and Appalachian Plateau Provinces calm where they pass through valleys and meander on wide floodplains (Roth et al. 1999). Western Maryland is also home to some of the rarer stream and river types in Maryland, including the biologically unique Limestone Stream KWH, which is found only in the Blue Ridge and Ridge and Valley Provinces. Headwaters of many rivers that feed the Chesapeake Bay are found in these provinces as well, including the Potomac River Basin.

The Ridge and Valley and Appalachian Plateau provinces have traditionally been areas for coal extraction, in the form of both deep and strip mines. Though active and/or poorly managed mining operations can present threats to species and habitats of western Maryland, old mines can also serve as pseudo-cave habitat for subterranean and cave-dwelling species, and capped strip mines can create much-needed grassland habitat. Other forms of energy have been increasing in more recent decades, especially wind energy, which can interrupt important bird migration corridors if not carefully sited. Though banned in Maryland at the time of writing, shale gas extraction (i.e., hydraulic fracturing) also has the potential to impact western Maryland more than any other region.

Human populations are relatively sparse throughout the montane provinces and are mostly confined to the larger valleys, where land is more easily built upon and soils are more fertile. Suburban and second-home development from large urban centers (e.g., Baltimore, Washington, D.C., Pittsburgh), however, is rapidly encroaching on the mountain areas, leading to habitat loss and fragmentation. This increase in development also means an increase in impervious surfaces. Combined with increased storm volatility as a result of climate change, this means that—even though sea-level rise and saltwater intrusion is not an issue in this region of the state—western Maryland is facing an increase in flash flooding. Historic floods like those in 2025 are likely to become more common in western Maryland as both development and climate change continue.

Blue Ridge

The Blue Ridge Province lies just to the west of the Piedmont. Measuring 10 miles wide and accounting for just 3% of Maryland's land area, it is the smallest of Maryland's physiographic provinces. Most of its land area is given over to the Blue Ridge Mountains, one of the sub-ranges of the Appalachians. These mountains are formed from quartzite and gneiss anticlines (i.e., upward rock folds), which are very resistant to weathering and erosion, forming distinct ridges representing Catoctin and South Mountains. A small valley region lies between these two ridges as well. (MGS 2026a). At 2,140 feet above sea level, Quirauk Mountain on the South Mountain ridge is the highest point in the Blue Ridge Province, and the eighth highest in Maryland (MGS 2026c). The lowest elevation in this physiographic province is 250 feet along the Potomac River in Washington County near Harper's Ferry (MGS 2008).

Although no habitat type is necessarily limited to this physiographic region, certain habitats—and therefore species—are more highly concentrated in this area of Maryland than any other. The Montane-Piedmont Oak-Pine Forest KWH, for example, is quite common on the relatively low slopes of the Blue Ridge Mountains. Other habitats found in this physiographic region include other forest types, glades and barrens, cliffs and rock outcrops, caves, rivers and streams, and the occasional floodplain or groundwater-fed wetland.

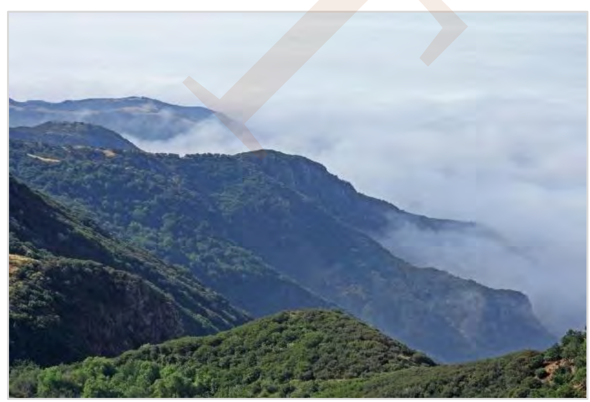
Ridge and Valley

Continuing eastward, the Ridge and Valley Province comprises about 7% of Maryland's land area and is characterized by southwest to northeast-oriented mountain ridges, deeply dissected trellis stream drainage patterns, and a high degree of topographic relief between parallel mountain ridges and river valleys (Roth et al. 1999). It lies between South Mountain to the east and Dans Mountain to the west. Elevation ranges from 200 to 2,000 feet, with Warrior Mountain in Allegany County representing the highest point at 2,185 feet above sea level (MGS 2026c). The Great Valley, located in the eastern part of the Ridge and Valley, forms a broad lowland at about 500 to 600 feet in elevation and is dominated by karst topography (Roth et al. 1999). Also called the Hagerstown Valley, this area of Maryland is one of the most important agricultural areas in the state (UMBC 2003b).

The Ridge and Valley is also the driest part of the state, receiving less than 40 inches of rain annually (MDSCO 2026). This is because of the rain shadow effect created by the mountain ranges on either end of the province; the Allegheny Mountain range blocks most of the precipitation from the west, and the Blue Ridge Mountains blocks precipitation moving in from the east. This results in warmer, drier summers than much of the rest of western Maryland (UMBC 2003b). A combination of the region's climate and geology means that the Ridge and Valley Province is the sole region of Maryland where the Shale Barren KWH can be found. This habitat type develops on steep, dry slopes, where only species adapted to drought stresses can thrive. Aside from this unique habitat type, the Ridge and Valley shares many habitats with the Blue Ridge province, though differences in climate mean that slightly different species are found in each region.

Appalachian Plateau

The Appalachian Plateau Province, representing 8% of Maryland's landscape, has the state's highest elevations (generally 2,000 to over 3,000 feet), with parallel mountain ridges sometimes separated by dramatic gorges and whitewater rivers (Roth et al. 1999). This region of Maryland is also home to the largest range in elevation: Garrett County, the westernmost county in the state, shows 2,400 feet in relief, with the lowest elevation at 960 feet along the Potomac River at Bloomington and Backbone Mountain—the state's highest point—at an elevation of 3,360 feet above sea level (MGS 2008). The region is demarcated by Dans Mountain to the east and the Maryland–West Virginia border to the west.



Backbone Mountain (Jim Belsey, NPS)

Unlike the sharp ridges of the neighboring Ridge and Valley, this region features broad, horizontal layers of sedimentary rock that have been eroded into flat-topped ridges and deep river valleys. The Appalachian Plateau is well-known for its cold subarctic swamps formed after the last Ice Age, such as those found at Finzel and Cranesville. These wetland complexes are glacial relics with cold, dense air sinking into bowl-shaped valleys, creating a climate much colder than the surrounding Appalachian Mountains. Combined with the already colder climate expected of higher elevations, this means that the Appalachian Plateau is significantly cooler than the rest of Maryland, with the entire region experiencing the lowest maximum, minimum, and average temperatures of the entire state (MDSCO 2026). It is also wetter than the rest of the state, with much of the region accumulating an average of 50 or more inches of precipitation each year (MDSCO 2026).

This combination of high elevations, cool temperatures, and wet conditions is only found in this region of Maryland, meaning that it plays an outsized role in the state's habitat and species diversity, considering its small geographical area. Multiple habitat types are found only in this part of the state. For example, the High Elevation Ridge Forest KWH only occurs along Maryland's highest mountain ridges. This forest type occupies some of the most inhospitable habitats in Maryland, situated on exposed sites that are frequently subjected to high winds throughout the year and ice storms during the winter months. Montane Acidic Fens are also only found in this part of Maryland. This KWH exemplifies the aforementioned subarctic swamps of western Maryland and supports multiple species that are only or nearly only found in this habitat. Additional habitat types common to the other provinces of western Maryland can also be found on the Appalachian Plateau, though in somewhat colder and wetter iterations.

Plants of Blue Ridge, Ridge and Valley

Thirty plant SGCN are restricted to the Ridge and Valley and five are restricted to the Blue Ridge. Some habitats and plant communities are found in both regions, including the Montane-Piedmont Oak-Pine KWH. This forest type forms the forested matrix in which all the other KWHs of these regions are embedded. Species such as mountain-ricegrass (*Patis racemosa*) occur within the forested matrix but do not often flower until stimulated by an opening in the closed canopy forest, which can follow timber harvest or wildfire.

Though many of these rare species are found in the mountains of these regions, some are found in the valleys, due in large part to their underlying geologies. In the eastern part of the Ridge and Valley, for example, Hagerstown Valley formed over several geological formations of limestone and dolomite-producing calcareous soils (i.e., high pH soils containing calcium and other plant nutrients). These calcium-rich habitats contain some of the most floristically diverse communities in Maryland, including the Basic Glade and Barren and Mesic Mixed Hardwood Forest KWHs. These KWHs are also found scattered throughout the Blue Ridge Province.

Occurrences of the Basic Glade and Barren KWH can be found over limestone formations, chiefly in the Hagerstown Valley on steep-to-moderately-steep slopes along the Potomac River and its major tributaries. The globally rare tall larkspur (*Delphinium exaltatum*) occurs on exposures of limestone, as do the early buttercup (*Ranunculus fascicularis*) and prairie goldenrod (*Solidago rigida*). In the more mesic limestone forests that are included within the Mesic Mixed Hardwood Forest KWH, one of Maryland's most beautiful wildflower species, snow trillium

(*Trillium nivale*), can be found on steep slopes over limestone. The presence of this species in particular is a novelty because most populations occur within the boundaries of previously glaciated territory, of which this area is not.

Further west, shale and sandstone bedrock forms the rugged terrain of the Ridge and Valley in Allegany County, with much of the area contained in Green Ridge State Forest. The forest is defined by several prominent parallel ridges that run generally northeast to southwest, separated by narrow valleys following small streams. Green Ridge State Forest is one of the driest regions in Maryland, receiving an average of only 36 inches of precipitation annually (MD DNR 2025). These chronic dry conditions favor a drought-resistant flora. Many smaller streams within the forest dry up completely during the summer months and all streams exhibit a significant summer drawdown. One species that has adapted well to these conditions is the federally endangered harperella (*Harperella nodosa*), which can withstand the seasonal drawdown events where it occurs on exposed scour bars and stream banks.

The Shale Barren KWH is also a frequent component of the landscape in the Ridge and Valley. Shale Barrens have a unique flora, including Central Appalachian endemics such as Kate's Mountain clover (*Trifolium virginicum*). Other rare species include stiff-hair sunflower (*Helianthus hirsutus*); characteristic but rare shrubs such as Allegheny plum (*Prunus alleghaniensis*) and common snowberry (*Symphoricarpos albus*); low herbs such as mountain parsley (*Taenidia montana*) and rusty woodsia (*Woodsia ilvensis*), a tiny fern of crevices in exposed seams of shale.

The Acidic Glade and Barren KWH is present primarily in the form of ecological communities known as Sandstone Glades in Allegany County. Sandstone Glades occupy mid-slope positions on several mountain ridges in Allegany County, including Wills Mountain, Haystack Mountain, Warrior Mountain, Martin Mountain, and Collier Mountain, which run parallel to each other and are separated by small streams in flat valleys. Sandstone Glades are characterized by open expanses of pavement-like sandstone slabs dominated by species that are tolerant of the harsh growing conditions. Characteristic species of Sandstone Glades include running serviceberry (*Amelanchier spicata*), which grows in thin soil of crevices in sandstone, and wild bleedinghearts (*Dicentra eximia*), which grows abundantly in the outcrops and boulderfields over Tuscarora Sandstone.

Rock outcrop habitat in the Blue Ridge region (Chris Frye, MD DNR)

Instances of the Cliff and Outcrop KWH occur throughout the Blue Ridge and Ridge and Valley both. These include generally small (<1 ha), exposed outcrops of shales, sandstones, mudstones, and limestones. They occupy positions where streams undercut the rocks, on erosion-resistant rocks exposed on steep slopes, or on the tops of ridges. The flora of these communities varies according to the underlying geology and soil chemistry. One species, running shadbush (*Amelanchier humilis*), occupies one extreme of soil chemistry restricted to outcrops of limestone. At the other extreme, Appalachian sandwort (*Geocarpon glabrum*) occupies an exposure of resistant quartzite at a single location in the Blue Ridge. The occurrence of this species is an example of a plant that is disjunct (i.e., geographically distant) from its core range in the Southern Appalachian Mountains well to the south. Similarly, Canby's mountain-lover (*Paxistima canbyi*) and bearberry (*Arctostaphylos uva-ursi*) occur as single populations that are wide disjuncts from the nearest locations in the southeast and northeast, respectively. Other species are relics of past climates, including the highland rush (*Oreojuncus trifidus*) and Houghton's umbrella-sedge (*Cyperus houghtonii*), both of which occur on exposed cliffs of Tuscarora Sandstone in the Ridge and Valley. Small outcrops of more calcareous shale may hold populations of American harebell (*Campanula rotundifolia*), ebony sedge (*Carex eburnea*), and Michaux's stitchwort (*Sabulina michauxii*).

Appalachian sandwort (Geocarpon glabrum) (Chris Frye, MD DNR)

Wild calla (Calla palustris) (Richard Wiegand, MD DNR)

Plants of the Appalachian Plateau

The Appalachian Plateau is the westernmost province in Maryland, spanning Garrett County and far western Allegany County. It is defined by a unique, boreal-influenced ecosystem with plant species that are often found in colder, historically glaciated, and high-elevation environments. Due to this boreal influence, the flora of Maryland's Appalachian Plateau contrasts sharply with other physiographic provinces. Forty-nine plant SGCN are restricted to this province, and many of them occur in the Montane Acidic Fen KWH that is well-represented in Garrett County. Species such Fernald's mannagrass (*Torreyochloa pallida* var. *fernaldii*), Canada yew (*Taxus canadensis*), wild calla (*Calla palustris*), Tuckerman's sedge (*Carex tuckermanii*), slender cottongrass (*Eriophorum gracile*), lesser panicled sedge (*Carex diandra*), slender sedge (*Carex lasiocarpa*), creeping snowberry (*Gaultheria hispidula*), small cranberry (*Vaccinium oxycoccos*), and American larch (*Larix laricina*) are more commonly associated with previously glaciated territory in the northeastern U.S. and Canada.

The High Elevation Ridge Forest KWH is also restricted to this province. Species that occur here are adapted to extreme weather such as icing events, high winds, and deep snow that may exceed 100 inches annually (MSA 2026). Species more typical of the high-elevation spruce and fir forests of the Southern Appalachian Mountains also occur here, including mountain woodfern (*Dryopteris campyloptera*) and beaked dodder (*Cuscuta rostrata*). The Hemlock-Northern Hardwood Forest KWH also occurs as a primary forest type in this region. It is home to some of the rarest plant species in Maryland, including bunchberry (*Chamaepericlymenum canadense*), Clinton lily (*Clintonia borealis*), and kidneyleaf twayblade (*Neottia smallii*).

In mid-to-lower elevations with deep valleys and ravines, the landscape provides shelter from the winds and accumulates deep nutrient-rich soil of the Cove Forest KWH. Unlike the sparser Northern Hardwood understory, the Cove Forest KWH features a lush carpet of ferns and rare endemics like Fraser's sedge (*Carex fraseriana*). In the valleys, high-gradient coldwater streams and rivers such as the Youghiogheny River and Casselman River contain representatives of the Montane-Piedmont Floodplain KWH that possess a very different flora than the adjacent Ridge and Valley. Two species that occur only in Garrett County along rocky streambanks and cobble bars are fowl bluegrass (*Poa palustris*) and blue monkshood (*Aconitum uncinatum*). The North Branch of the Potomac River contains Maryland's only viable populations of pipevine (*Isotrema macrophyllum*), an endemic to the Appalachian Mountains that is found in Maryland near its northern range limits. Together, these diverse habitats and rare botanical relics establish the Appalachian Plateau as a critical sanctuary for biodiversity, preserving a distinct northern landscape found nowhere else in Maryland.

This chapter summarized the landscapes, waterscapes, plant communities, and other physical characteristics of Maryland through the lens of its physiographic provinces. This lays the groundwork for describing the Key Wildlife Habitats (KWHs) found in the state (addressing **Element #2**) and their associated species. The next chapter will provide information on the full array of wildlife found in Maryland and will identify Maryland's Species in Greatest Conservation Need (SGCN) (addressing **Element #1**).

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Chapter 3

Maryland's Species of Greatest Conservation Need

MARYLAND

MARYLAND DEPARTMENT OF NATURAL RESOURCES

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Introduction

The State Wildlife Action Plan (SWAP or Plan) compiles, evaluates, and presents summary status information for Species of Greatest Conservation Need (SGCN) (**Element #1**). This chapter describes the process used to select SCGN and summarizes the best available information regarding the conservation status, distribution, and abundance of all major taxonomic groups that occur in Maryland. It also addresses regional SGCN (RSGCN), as they were considered in the selection of Maryland's SGCN, and introduces the new State Assessment Priority Species (SAPS) list.

Numerous experts and sources of information (e.g., scientific literature, databases, agency reports) on Maryland's wildlife abundance and distribution were consulted during the planning process and are listed throughout the Plan. More detailed information regarding the status and relative abundance of Maryland's SGCN is provided in Appendices 3a and 3b, which includes each species' state and global conservation ranks as well as state and federal legal status. Distributions of species are included by association with one or more Key Wildlife Habitats (KWHs), which are discussed in detail and mapped in Chapter 4.

To provide easier distinction between SGCN and non-SGCN, in-text scientific names are included for SGCN the first time they are referenced per chapter; non-SGCN are referred to only by their common name. Exceptions are made for plants, which can be difficult to reference without using scientific names. A full list of scientific names for SGCN and SAPS can be found in Appendices 3a and 3b, respectively.

Distribution of Maryland's Wildlife

Despite its small size, Maryland's wildlife is remarkably diverse. This is due in large part to the wide range of habitats that are found in the state, from the Atlantic Ocean in the east to the Allegheny Mountains in the west. Native fauna documented in the state include 97 mammals, 463 birds, 89 reptiles and amphibians, at least several hundred freshwater and marine fishes, and over 20,000 species of invertebrates. Additionally, Maryland has recognized over 3,000 distinct native plant species.

Carpenter frog (Lithobates virgatipes)
(Peter Jayne, MD DNR)

The state's physiographic provinces and their associated habitats and climates have a profound influence on the distribution of wildlife species. While many wildlife species occur throughout the state—such as the eastern box turtle *(Terrapene carolina)* and black-and-white warbler *(Mniotilta varia)*—others are restricted to a particular region, watershed, or habitat. For example, species like the seal salamander *(Desmognathus monticola)* and nesting Canada warbler *(Cardellina canadensis)* are limited to high-elevation habitats in the far western part of the state, in the Appalachian Plateau physiographic region. Maryland populations of fish such as the Allegheny pearl dace *(Margariscus margarita)* and checkered sculpin *(Cottus sp. 7)* are confined to spring-fed coldwater streams in the Blue Ridge physiographic province. Other species, including the carpenter frog *(Lithobates virgatipes)* and nesting saltmarsh sparrow *(Ammospiza caudacuta)*, occur only on Maryland's Eastern Shore. For more information on these regions of Maryland and their characteristics, please see Chapter 2.

Some of the state's most imperiled species are confined to just a handful of sites and, in some cases, single locations. For example, the only remaining breeding areas in Maryland for the beach-nesting piping plover *(Charadrius melodus)* are on Assateague Island, while several subterranean crustaceans are single-site endemics, whose only known populations in the world are restricted to a single cave or spring. Details on the associated habitat distributions of SGCN can be found in Chapter 4 and Appendix 3a.

Conservation Status of Maryland’s Wildlife

The Maryland Department of Natural Resource’s (MD DNR) Natural Heritage Program (NHP), part of the Wildlife and Heritage Service (WHS), is one of the state’s lead programs for biodiversity conservation. NHP identifies, ranks, conserves, and conducts status assessments of all rare and endangered species and natural communities throughout the state. It currently monitors the status of over 1,250 native plants and animals. Species status assessments play a critical role in conservation work: they help set NHP and partner conservation priorities, support state and federal species listing decisions and related regulatory processes, and help inform the public of key conservation issues. These status assessments, along with other data provided by NHP and various partners, helped shape the revised SGCN list for the 2025 SWAP revision.

The criteria used to select Maryland’s SGCN are described in the following sections. First, a summary of species that are currently either extinct or extirpated is presented, followed by an overview of state-listed species and non-listed but declining species. Conservation status rank (i.e., global [G1, G2, etc.] and state ranks [S1, S2, etc.]), legal protection status (Endangered, Threatened, In Need of Conservation), and other criteria used to select SGCN are then reviewed.

Maryland’s Extinct and Extirpated Species

Congress recognized human impacts on wildlife over 40 years ago in its preamble to the Endangered Species Act: “The Congress finds and declares that various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation” (USFWS 1973). Since European settlement, nearly 100 species of plants and animals have become extinct or extirpated from the state (i.e., no longer in Maryland but still present elsewhere) (COMAR 08.03.08.06). Those species now gone entirely include the Carolina parakeet, passenger pigeon, and greater prairie chicken. Habitat loss and overhunting were largely responsible for their demise and eventual extinction during the first half of the twentieth century (Cornell Lab of Ornithology 2008).

Today, 62 plants and 32 animals (10 birds, 6 mammals, 1 amphibian, 4 fishes, and 11 invertebrates [5 butterflies, 1 beetle, 3 dragonflies, 1 snail, and 1 crustacean] [COMAR 08.03.08.06], Table 3.1) are state-listed as Endangered Extirpated. This legal status indicates that these species were once viable components of the state's flora and fauna but no longer occur in Maryland and, if rediscovered, would be afforded the legal status of Endangered. Six of the 32 animals listed as Endangered Extirpated are mammals. These include gray wolves, which historically occurred throughout the state but were eliminated by the late 1800s as a result of indiscriminate hunting and trapping, habitat loss, and increasingly scarce prey populations.

American bison (National Park Service)

American bison and elk ranged throughout central and western Maryland when Europeans colonized the state. Maryland's last American bison was shot in 1775 in Garrett County (Paradiso 1969) and the last elk, also eliminated by overhunting, vanished around 1850 (Lee 1984). The American pine marten's range included western Maryland until the early 1900s. The snowshoe hare also historically occurred in high-elevation red spruce-dominated forests of western Maryland; there have been no reliable Maryland records in over 50 years (Paradiso 1969).

As with some of the mammals mentioned above, habitat loss was the primary cause for the extirpation of many bird species that once nested in Maryland. The Endangered Extirpated Swainson's thrush *(Catharus ustulatus)* historically nested in high-elevation red-spruce dominated forest (Robbins & Blom 1996) but was eliminated following extensive logging and the nearly complete loss of red spruce in the nineteenth and early twentieth centuries. The red-cockaded woodpecker *(Leuconotopicus borealis)*—also Endangered Extirpated in Maryland—disappeared due in large part to the loss of expansive tracts of old growth forest containing large pine trees that provided nest cavities (Robbins & Blom 1996; USFWS 2003). Bachman's sparrow, a species that formerly nested in some of Maryland's open pine woodlands, is also extirpated in Maryland due in part to habitat loss. Habitat loss may also have been the main factor leading to the extirpation of several other species listed as Endangered Extirpated.

However, even after a species has become extirpated in Maryland, there may be a chance of its reestablishment. For example, the once-extirpated fisher was eventually able to return to Maryland due to the release of 23 animals in West Virginia near the Maryland border in the winter of 1969. Certain species listed as Endangered Extirpated in Maryland, including two of the three bird species discussed above, remain SGCN because there is still hope for their reintroduction.

Endangered, Threatened, and In Need of Conservation Species

Currently, 476 species and subspecies are listed in state regulations as Endangered, Threatened, or In Need of Conservation in Maryland (COMAR 08.03.08). Most of the species that are state-listed as Endangered are plants (241) and 98 are animals. An additional 83 plants and 18 animals are recognized as Threatened in the state. Thirty-six animal species are listed as In Need of Conservation in Maryland. A fraction of these plant and animal species (40) are also federally listed as Endangered or Threatened, including two plant and seven animal species considered to be extirpated in Maryland.

A broad overview of these numbers can be found below in Table 3.1. For additional details on state-listed species, please refer to later subsections of this chapter. Appendices 3a, 3b, and 3c also list each species' state and federal legal status.

Table 3.1 Summary of all listed species in Maryland. Source: NatureServe and COMAR 08.03.08.

Federally Listed Species		
Category	**Plants**	**Animals**
Endangered	5	22
Threatened	4	9
Total	**9**	**31**

State-listed Species*		
Category	**Plants**	**Animals**
Endangered	241	98
Threatened	83	18
In Need of Conservation	n/a	36
Endangered Extirpated	62	32
Total	**386**	**184**

*Summary of state-listed species only includes species listed in COMAR 08.03.08.

Additional Declining Species

Although the state officially recognizes 184 animal species in its protected species regulations, many other species are declining and may warrant listing in the future. This holds true for nearly every taxonomic group represented in Maryland.

Amphibians, for example, are exhibiting alarming rates of decline, with more than 40% of species globally threatened (Luedtke et. al. 2023). Reptiles are also exhibiting dramatic declines similar to that of amphibians, with 21% of the world's reptiles estimated to be threatened with extinction (Cox et al. 2022). Habitat loss and degradation, environmental pollution, unsustainable use, diseases, introduced invasive species, and global climate change are the leading causes for these declining populations (Gibbons et al. 2000).

Numerous bird species are also showing population declines nationally, regionally, and locally. A recent assessment of U.S. bird populations has noted that, since 1980, overall grassland bird populations have declined by 43%, shorebird populations have declined by 33%, and eastern forest birds have declined by 27% (North American Bird Conservation Initiative 2025). While this report documented an increase of 24% in dabbling and diving duck populations and an increase of 18% in waterbird populations, progress is hindered by continuing loss and degradation of wetlands, especially for southern species such as the king rail *(Rallus elegans)*. In addition to these more general trends, Partners in Flight (PIF) keeps track of priority bird species for conservation based on region. Maryland falls within two of these regions: the Appalachian Mountains and Atlantic Coast. For the Appalachian Mountains region, PIF ranked 9 forest birds, 5 grassland birds, and 2 habitat generalist birds as priority species; for the Atlantic Coast region, 3 coastal saltmarsh birds, 16 forest birds, 5 grassland birds, and 2 habitat generalist birds were ranked (Rosenberg et al., 2016). Declining population trends remain a concern for most of these species today.

Nearly every taxonomic group represented in Maryland is facing issues that are negatively affecting populations. Pollinating insects are threatened by pesticide use, invasive plant species, and overly frequent mowing; bats are threatened by white-nose syndrome, hibernacula disturbance, and obtrusive recreational activities; and aquatic species are threatened by invasive animals, rising temperatures, and water pollution. The SWAP represents an opportunity to reverse these declining population trends for numerous species in greatest need of conservation. By incorporating existing conservation ranks, population assessments, and conservation plans into the development of the Maryland SWAP, MD DNR and its conservation partners have the opportunity to implement conservation actions that will have positive effects on species that truly have the greatest conservation need, even for those that do not yet have regulatory protections.

Species of Greatest Conservation Need (SGCN)

Maryland wildlife species vary in their need and urgency for conservation. Some more obviously warrant conservation attention than others. State- and federally listed species are clearly high priorities, but the Plan also provides the opportunity to consider species that, while not currently listed, are declining or at risk of decline. In determining which species warrant SGCN status, Congress allows states to consider the "distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife" (**Element #1**). By considering all species and their requisite habitats in this assessment, the broader interrelationships of wildlife conservation can be addressed.

The criteria that were used during the assessment process and to ultimately identify these species were very similar to that of the previous SWAP revision, which were adopted from national and regional guidelines developed by the Association of Fish and Wildlife Agencies and found in the *Best Practices for State Wildlife Action Plans* (AFWA 2012). Additional guidelines provided by the Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) were organized into the Northeast Lexicon document (Crisfield & NEFWDTC 2022), which is a set of common metrics and terminology developed by the Northeast states to facilitate interstate collaboration.

Fundamental considerations for assessing a species' conservation need and inclusion or exclusion from the SGCN list include species abundance and trend; threats (e.g., number, immediacy, extent, reversibility); state responsibility (i.e., relative importance of the state to conservation of the species); and habitat trend (i.e., changes in the extent or condition of habitat, which may be closely related to threats). In addition to these considerations and existing Maryland conservation status ranks, numerous state, regional, national, and global ranking systems that prioritize or rank species for each wildlife taxa group were used during this evaluation process. The criteria from all of these sources are included in Table 3.2.

Table 3.2 Categories considered for inclusion on Maryland's SGCN list

Special Conservation Status
Federally listed Threatened and Endangered species
State-listed Threatened and Endangered species

Wildlife species listed as In Need of Conservation
Globally rare species ranked by NatureServe
MD DNR Natural Heritage Program tracked and watchlist species
IUCN Red List species
Northeast Regional Species of Greatest Conservation Need (RSGCN)
Species recognized as endangered from international trade (CITES)
Recognized Bird Priority Status
Partners in Flight and all bird conservation plan priority species
U.S. Fish & Wildlife Service’s migratory birds of conservation and management concern
Colonial waterbirds
Forest interior breeding birds
Shrubland successional breeding birds at risk
Grassland breeding birds at risk
Shorebirds with significant migratory concentrations and declining populations
Marshland breeding birds (e.g., rails, bitterns, sedge wren) at risk
Marine birds in decline
Other Terrestrial Conservation Status Priorities
Reptiles and amphibians at risk
Bats at risk
Small mammals at risk
Terrestrial invertebrates at risk
Aquatic Conservation Status Priorities
Aquatic invertebrates at risk
Freshwater and marine fish at risk
American Fisheries Society’s species of concern
Depleted anadromous fish (e.g., shad spp., sturgeon)
Depleted marine invertebrates (e.g., horseshoe crab)
Additional Selection Criteria
Endemic species
Disjunct species
Vulnerable species (to a variety of threats, particularly impacts from climate change and invasive species impacting host plant species)
Species with limited dispersal
Species with fragmented or isolated populations
Focal species (e.g., keystone species, species with specific needs)
Indicator species of high quality habitat
“Responsibility” species (i.e., species that have their center of range within Maryland)
Species that aggregate in concentration areas (e.g., migratory stopover sites, bat roosts/maternity sites)

Identifying SGCN in Maryland began with reviewing the previous 2015 SGCN list. Review of these species, using the guidance criteria explained above, provided an introductory understanding of species population changes over the last ten years. Decisions about which species to include on the draft 2025 SGCN list relied heavily on a review of the species' current conservation status, based on both state and global conservation ranks. The best available quantitative and qualitative data regarding status, abundance, distribution, and population trends for many species in the state were considered to confirm conservation status and preliminary SGCN selection. Further justification for changes (i.e., additions and deletions) to the 2015 SGCN list, other than changes in conservation or legal status, included new discoveries and research findings since 2015; an increase (or decrease) of existing threats (e.g., illegal trade, habitat loss/fragmentation); and new, emerging threats (e.g., novel pathogens, energy sector changes, loss of host species due to non-native pests). In addition, species on the Northeast RSGCN list and priority species from taxa-specific groups, conservation partners, and regional conservation plans were evaluated for inclusion on Maryland's 2025 SGCN list. For further explanation of this review process, please refer to "The Process for Identifying SGCN for the 2025 SWAP" in Chapter 8.

State Assessment Priority Species (SAPS)

New to the 2025 SWAP is the State Assessment Priority Species (SAPS) list. The inclusion of this list was recommended by the 2022 Northeast Lexicon (Crisfield & NEFWDTC 2022). It is essentially a list for data deficient species for which more information is needed to fully understand their status, trends, and associated threats and actions. Unlike species on the SGCN list, species on the SAPS list do not have associated habitats, threats, or actions. The threat for these species is lack of information; the action is to obtain that information.

The SAPS list addresses a number of needs. First, it allows Maryland to refine its SGCN list, ensuring that it truly reflects the flora and fauna most in need of conservation in the state. Second, it allows the 2025 SWAP revision to elevate data deficient species to a category of their own, ensuring that species most in need of information (e.g., life history, population distribution, threat assessment, climate vulnerability) do not get overshadowed by the SGCN list. Third, it more closely mirrors the categorization of the RSGCN database, which includes a comparable "watchlist" category. Finally, it provides a way to include the pursuit, acquisition, and allocation of funding to address knowledge gaps for a variety of species that may otherwise not be included in the SWAP.

Part of the SGCN list review involved the selection of which data deficient species from the 2015 SWAP belonged on the SAPS list, as well as which new species should be added. Considerations for which species belonged on the SAPS versus SGCN list are articulated below in Table 3.3.

Table 3.3 Categories considered for inclusion on Maryland's SAPS list

Considerations for SAPS
Data deficient SGCN from Maryland's 2015 SWAP
Species with non-numeric state or global conservation ranks (e.g., SU, SNA, GNR)
Newly described species
Species with taxonomic uncertainty

Species with unclear habitat needs
Species with very few records in Maryland (i.e., unclear if vagrant)
Species with dubious or unconfirmed records in Maryland
Species found in adjacent states that are not yet confirmed in Maryland
Species expected to shift range to Maryland as a result of climate change (or other factors)
Potentially extirpated species that may be rediscovered in the near future
Species that are difficult to survey and/or identify, especially invertebrates
"Watchlist" RSGCN

Some species on the SGCN list may appear to belong on the SAPS list upon initial assessment. This is because each species was reviewed on an individual basis; for example, rather than simply moving all species with non-numeric state conservation ranks to the SAPS list (see the "SGCN Selection: Conservation Ranks" section of this chapter for additional details), species with some information needs were allowed to remain on the SGCN list if MD DNR and its partners could articulate specific threats, actions, and habitat associations for that species. If all three of these associations could not be made, a species was moved to the SAPS list.

Changes to the Species Lists Since 2015

Species from the 2015 SGCN list that fell outside the review guidelines were removed, and new species that met the guidelines were added. Additionally, data deficient species from the 2015 SWAP that met the criteria for the SAPS list were moved to this new list.

This process resulted in 365 more species in the 2025 SGCN list compared to 2015, due in large part to the elevation of plants to full SGCN status. An additional 821 species were assigned to the new SAPS list. Finally, of the 610 species reviewed from the 2015 SGCN list, 66 were removed from the SWAP. See Table 3.4 below for an overview of these numbers. For a species-by-species account of which species were kept from the 2015 SGCN list, which were moved to the SAPS list, which are new additions, and which were removed entirely, please refer to Appendices 3a, 3b, and 3c.

Table 3.4 Comparison of 2015 and 2025 species lists

Taxonomic Group[1]	2015 SGCN List	2025 SGCN List	2025 SAPS List	Removed Since 2015
Mammals	41	34	16	5
Birds	143	146	5	3
Reptiles	26	29	1	2
Amphibians	19	19	4	0
Fish	31	34	15	5
Plants	0	454	0	0
Insects				
Beetles	22	26	44	0
Bees, Wasps and Ants	36	48	225	6
Butterflies and Moths	101	70	294	22

Dragonflies and Damselflies	93	47	37	16
Stoneflies, Mayflies, and Caddisflies	14	8	66	1
Other Insects	6	9	78	2
Other Invertebrates				
Crustaceans and Allies	40	27	23	1
Snails	14	6	7	3
Freshwater Mussels	14	13	1	0
Flatworms	10	5	5	0
TOTALS	**610**	**975**	**821**	**66**

[1]As the 2025 SWAP uses slightly different species groupings than the 2015 SWAP, the 2025 categories have been crosswalked to the 2015 categories for the sake of comparison in this table.

The species on the final 2025 SGCN list are at risk of disappearing from Maryland in the foreseeable future if appropriate conservation actions (Chapter 6, Appendices 6a and 6b) are not implemented; species on the SAPS list must be further researched to determine the extent of this risk. All major taxonomic groups were considered for the SGCN and SAPS screening process: mammals, birds, reptiles, amphibians, fishes, insects, freshwater mussels, and other invertebrate groups, such as snails and flatworms. Complete SGCN lists with status ranking information can be found in this chapter under each taxonomic group. There are also separate appendices that list SGCN and SAPS alphabetically by scientific name (Appendices 3a and 3b).

SGCN Selection: Conservation Ranks

The species ranks assigned and maintained by MD DNR NHP are the most complete list and accounting of wildlife species conservation status in Maryland. Data maintained by NHP represents the best available summary of information on the abundance, distribution, threats, and conservation status of wildlife species for the state, and these data were reviewed as one of the initial steps to determine which species are of greatest conservation need.

Conservation status ranks (i.e., the global rank [G-rank] and state rank [S-rank]) are determined by state natural heritage programs and NatureServe in consultation with numerous biologists, taxonomic experts, and other members of the scientific community; other state, federal, and local agencies; and non-governmental organizations (NGOs). Definitions for these ranks can be found in Table 3.5. A variety of factors are considered when assessing a species' conservation status rank. These factors fall into three groups—rarity, threats, and trends—which together provide a composite assessment of a species' vulnerability to decline and extirpation (state ranks) or extinction (global ranks). These factors include:

- Total number and condition/viability of occurrences (e.g., populations)
- Population size
- Range extent and area of occupancy
- Short-term and long-term population trends
- Scope, severity, and immediacy of threats
- Intrinsic vulnerability
- Environmental specificity

Most conservation status ranks follow a simple numerical scale of 1–5. When a status assessment is completed, the most appropriate numeric rank is assigned from 1 (critically imperiled) to 5 (abundant, widespread, or demonstrably secure). Some additional non-numeric ranks may be most appropriate for a given species or subspecies, including “SH” for historically occurring species or “SX” for species thought to be extirpated with little, if any, hope of rediscovery within Maryland.

Table 3.5 Definitions of global (G) and state (S) conservation ranks and rank qualifiers

Rank	Definitions (Global / State)
GX or SX	**Presumed Extirpated**—Species believed to be extirpated from the jurisdiction (i.e. global, or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH or SH	**Historical (Possibly Extirpated)**—Known only from historical records, but with still some hope of rediscovery. There is evidence that the species may no longer be present in the jurisdiction, (i.e. global, or state/province) but not enough to state this with certainty.
G1 or S1	**Critically Imperiled/Highly State Rare**—At very high risk of extinction or extirpation due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors. Typically occurring in fewer than five populations.
G2 or S2	**Imperiled/State Rare**—At high risk of extinction or extirpation due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors. Typically occurring in 6–20 populations.
G3 or S3	**Vulnerable/Watchlist**—At moderate risk of extinction or extirpation due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors. Typically occurring in 21–80 populations.
G4 or S4	**Apparently Secure**—At fairly low risk of extinction or extirpation due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5 or S5	**Demonstrably Secure—**At very low risk of extinction or extirpation due to a very extensive range, abundant populations or occurrences, or little to no concern from declines or threats.
GU or SU	**Status Uncertain**—A numerical rank cannot be established with confidence for reasons including lack of historical records, low survey effort, cryptic nature of the species, or concerns that the species may not be native to the state. Uncertainty spans a range of 4–5 ranks as defined above.
GNR or SNR	**Not ranked—**Conservation status has not yet been fully assessed.
SNA	**Not a conservation target—**Species is not a suitable target for most conservation actions because of its transient occurrence or other factors.

Global Qualifiers	
Q	**Questionable—**Indicates that the taxon has questionable, controversial, or uncertain taxonomic standing (e.g., treated by some taxonomic authors as a species, whereas others treat it as a subspecies or variety or not at all).
T	**Taxon—**Indicates the rank of a subspecies or variety (i.e., an infraspecific taxon).
State Qualifiers	
?	**Questionable—**Indicating uncertainty that may span 2–3 numeric S-ranks, as defined above.
B	**Breeding**—Conservation status refers to Maryland's breeding population of a migratory animal.
N	**Non-breeding**—Conservation status refers to Maryland's non-breeding population of a migratory animal.
M	**Migrant**—Migrant animal that occurs regularly during migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating migrant population of the species in the state.

Both global and state conservation ranks were very valuable in the process of selecting SGCN, as the factors used to calculate the ranks address several aspects of the SGCN definition. Table 3.6 describes the guidelines related to state and global ranks that were used in the initial steps of determining the SGCN list for Maryland. Consideration of other factors in Table 3.2 and input from conservation partners and stakeholders, all in addition to this initial assessment, led to the final decisions as to what species are in greatest need of conservation in the state. More information on the SGCN selection process, especially relating to working with partners and stakeholders, can be found in Chapter 8.

Table 3.6 Cross-reference of conservation status ranks and their use in SGCN listing

Ranking	Explanation for SGCN Listing
G1 & G2 species that occur in Maryland	All confirmed present in Maryland are included because of their global imperilment and Maryland's responsibility in conserving the species.
G3 species that occur in Maryland	Many are included because of their global vulnerability and likelihood that they are of conservation value within the state due to their affinity with rare, declining, high quality or other significant habitats, or their importance as indicator species.
S1 and S2 species (either breeding or wintering for migrant species)	All confirmed present in Maryland are included because of their limited population size within Maryland and their elevated risk of loss from the state due to stochastic events or human-made habitat changes.

S3 species	Some are included based on limited or declining populations, or the threats they face are of sufficient scope, severity, or immediacy that their populations are likely to continue to decline without management or other intervention. Also, some S3 species may have been included due to their significance as indicator species within rare, high quality, or otherwise significant habitats even though they might not currently be facing severe or immediate threats.
S4 or S5 species	Some are included because of their importance as indicator or umbrella species of significant or high quality habitats, or because of known gradual, long-term population declines or shifting distribution even though they are still considered relatively common within Maryland.
SH (historical)	Some are included because of their potential for rediscovery, albeit sometimes rather low. Most of these species have had insufficient survey work and additional surveys are needed to confirm their loss from Maryland. Some may be candidates for reintroduction efforts, as identified.
SX (extirpated)	A few are included if they have some reasonable potential for successful reintroduction efforts.
SU (uncertain)	Some are included if they have restricted distributions within Maryland and/or live in rare, declining, high quality, or otherwise significant habitats, even though insufficient information currently exists related to threats, statewide population size, or other primary factors that are needed to determine an accurate conservation status rank. These species are often good candidates for additional research into biological attributes that would enable more accurate priority ranks to be assigned.
SNA	Because these are migrants or transitory species within Maryland, such that they could occur over a widespread area for relatively short periods during migration or the winter, the species are included primarily when there is regional or federal concern regarding their status.

Conservation Status Groups

As the factors and methods for determining species and natural community conservation status ranks have evolved over decades, the complexity of the ranking system has grown and the level of information contained within the ranks has increased. This is useful for conservation practitioners who understand the system's complexities, scientific rationale, and intended applications. However, for the more general public, a simplified system in the form of a small matrix is provided in Figure 3.1.

SGCN Categorization Matrix[1]

		STATE STATUS						
		S1	**S2**	**S3**	**S4**	**S5**	**SNR / SU / SNA**	**SH / SX**
GLOBAL STATUS	**G1**	A					D	E
	G2	A	A				D	E
	G3	A	A	B			D	E
	G4	A	B	C	C		D	E
	G5	A	B	C	C	C	D	E
	GNR / GU	A	B				D	E

Figure 3.1 Matrix used to categorize species into five conservation status categories. Global and state ranks are defined in Table 3.5. Conservation status categories are defined in Table 3.7.

[1]To apply the matrix, “range" status ranks were rounded upward in priority (e.g., S2S3 = S2); "range" ranks spanning 3 ranks were considered as the middle rank (e.g., S1S3 = S2); global status ranks for subspecies with T-ranks are treated as the "T" status (e.g., G5T3 = G3). Most "non-numeric" state status ranks are classified in Group D (e.g., SU, SNR, SP, SR), except for SH and SX.

Table 3.7 Definitions of the five conservation status categories from Figure 3.1 based on grouping global and state conservation status ranks.

Group	Definition
A	Highest conservation status
B	High conservation status
C	Moderate conservation status
D	Conservation status is uncertain; insufficient data to assign a state conservation status rank.
E	Historical status; ranked as “SH” or “SX” and may no longer occur in Maryland, but with some potential for rediscovery in the foreseeable future.

In this matrix, the assignment of conservation status groups to SGCN provides an overarching and less technical view of the state of Maryland’s wildlife species. Taking into account state and global ranks, this system especially highlights those species and taxonomic groups most in need of conservation (i.e., species in the A status group) and also those which are in danger due to lack of knowledge and research on these species (i.e., D status group). A number of species in the D status group remain on the SGCN list as opposed to the SAPS list. These are species for which—despite their relative data deficiency—specific threats, actions, and habitat associations could be articulated. If all three of these associations could not be made, a species was moved to the SAPS list. Each SGCN’s conservation status group is included in Appendix 3a; species on the SAPS list do not have conservation status groups because they are all assumed to be data deficient.

Regional Context for Species of Greatest Conservation Need:

An Additional Factor for SGCN Selection

The *Northeast Regional Conservation Synthesis for 2025 State Wildlife Action Plans* (TCI & NEFWDTC 2023) summarizes the status of Regional Species of Greatest Conservation Need, or RSGCN. These 806 species are indicative of the diversity and overall health of wildlife in the Northeast region. The RSGCN list, organized into 20 taxonomic groups, is updated every five years to include new information on the status of select species and taxonomic groups in the region. Certain portions of the 2023 synthesis have been included below in order to summarize how these RSGCN were selected and how the Northeast RSGCN list impacted the revision of Maryland's own SGCN and SAPS lists.

The states of the Northeast region and the District of Columbia have collaborated to prioritize Regional Species of Greatest Conservation Need (RSGCN) for shared conservation and management since 1999. This regional effort aims to maintain a non-regulatory list of RSGCN to provide focus, resources, and collaboration to conserve these species of mutual conservation concern (and their habitats) for current and future generations in the Northeast.

Northeast RSGCN are species for which the region has stewardship responsibility due to high conservation concerns or populations centralized within the Northeast Region. The list includes 20 vertebrate and invertebrate taxa groups of SGCN from SWAPs in the Northeast Association of Fish and Wildlife Agencies (NEAFWA) planning geography (Maine to Virginia, including the District of Columbia). The list promotes focused action on high-priority Northeast species by the Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) in developing SWAPs and conservation planning and implementation by state fish and wildlife agencies and their partners. NEFWDTC updates the RSGCN list every five years according to regional stewardship responsibility (i.e., proportion of the species range in the Northeast region) and conservation concern status.

The RSGCN list provides an effective, collaborative conservation focus, which facilitates regional watershed and landscape approaches for fish and wildlife diversity conservation in the Northeast. The current RSGCN list and supportive information on status updates demonstrate how the Northeast continues to lead the RSGCN concept nationally by implementing NEAFWA's conservation planning model through its Regional Conservation Needs (RCN) program and committee charges. This effort informs all Northeast state fish and wildlife agencies, their SWAPs, and partners about these priority species, habitats, threats, and actions. NEFWDTC then develops and implements research, surveys, and monitoring, as well as conservation on the ground through the RCN program to fund conservation at the regional scale.

The goal of the RSGCN list is to secure and restore RSGCN and their habitats across the region's lands and waters through strategic, collaborative action. It creates a recognizable regional stewardship responsibility, implements proactive measures to prevent further declines of common species with conservation concerns, and prioritizes imperiled species. The RCN program spotlights species with population or habitat declines or emerging issues for collective conservation actions, fills data gaps, and enhances knowledge of a species' range-wide distribution, imperilment status, threats, and needed actions.

The newest version of the RSGCN list includes subcategories of RSGCN that allow for more accuracy regarding each species' needs and current status. These categories are RSGCN, Proposed RSGCN, Watchlist [Assessment Priority], Watchlist [Interdependent Species], Watchlist [Defer], and Proposed Watchlist [Assessment Priority]. The four Watchlist categories are essentially the regional version of the SAPS list. Between all these categories, 806 species were listed as RSGCN in some capacity (Table 3.8).

Table 3.8 RSGCN by major taxonomic group

Taxonomic Group[1]	Number of RSGCN Species
Mammals	49
Birds	70
Reptiles	25
Amphibians	30
Fish	152
Insects	337
Other Invertebrates	143
Total	806

[1]As NEAFWA uses different invertebrate categories for RSGCN than Maryland does for its SGCN, the 'Insects' and 'Other Invertebrates' categories have been combined in the above table.

It is important to note that, being at the southern end of the Northeast region, many Northeast RSCGN are not actually found in Maryland, and therefore were not included on Maryland's SGCN or SAPS list. The RSGCN list also does not include plants. Because of this, while the RSGCN list was certainly a factor in determining whether some species were included in Maryland's SWAP, they account for a comparatively small portion of the total species. 222 of Maryland's 975 SGCN (23%) are on the RSGCN list; 73 of 821 of Maryland's SAPS (9%) are on the RSGCN list. The full list of Northeast RSGCN can be found at the online database. For a list of which Maryland SGCN and SAPS are also RSGCN, please refer to Appendices 3a and 3b.

Mammals of Maryland

A total of 97 native mammal species have been documented in the state, including 29 marine mammals. The 68 land mammals are represented by 12 shrews and moles, 12 bats, 3 rabbits and hares, 21 rodents, 16 carnivores, 3 ungulates, and one marsupial, the Virginia opossum. Most of Maryland's native extant mammals have a statewide distribution. However, the Appalachian Plateau physiographic region supports the highest diversity and the majority of the state's most imperiled mammals, followed by the Ridge and Valley. Eight non-native mammal species have also been introduced in Maryland and are now established, including Norway rat, black rat, house mouse, sika deer, fallow deer, nutria, domestic horse, and domestic cat. Though nutria has been considered eradicated from Maryland since 2022 (Eisenhauer 2022), recolonization of the Delmarva Peninsula remains a possibility due to its continued presence in Virginia.

Twenty-one mammals in Maryland are game species with regulated hunting or trapping seasons. MD DNR's WHS maintains several programs that monitor the status of game mammal species, including the deer, bear, small game, and furbearer projects. The white-tailed deer management program monitors abundance and distribution in the state and regulates deer hunting seasons to maintain healthy deer populations within biological and cultural carrying capacities. A deer management plan (MD DNR 2020) was first developed by DNR in 1998 and is revised on a roughly 10-year basis, with the current plan guiding management through 2034. Before implementation of this plan, which included creating one of the first ever urban/suburban deer management programs in the U.S., deer populations had dramatically rebounded from historic lows. Populations doubled or more in most counties, increasing as much as five to seven times (MD DNR 2020). Deer populations have been on a declining trend since the deer population peaked in 2002 at nearly 295,000 deer. The 2020–2021 white-tailed deer population was estimated at 232,000 (MD DNR 2021).

Having reached historical lows in the mid-twentieth century, Maryland's black bear population has increased dramatically in western Maryland over the past few decades. The first black bear management plan went into effect in 1992 and was followed by another 10-year management plan in 2004; at the time of writing, the plan is being updated once more and will be available to the public once completed. The bear population in western Maryland has continued to expand, with breeding now documented in Garrett, Allegany, Washington, and Frederick counties, and occasional sightings in neighboring counties. The population has likely grown to around 2,000 individuals; exact numbers will soon be available due to ongoing research efforts at the University of Maryland.

The furbearer management program monitors and collects biological information on 14 mammal species that are legally harvested for their fur, either currently or historically. These species include gray fox *(Urocyon cinereoargenteus)*, red fox, muskrat, beaver, and raccoon. Additionally, three carnivore species that had been extirpated from either portions of their historic range or all of Maryland prior to 1970 are now present due to natural range expansion or translocation efforts. Fishers were translocated to West Virginia in 1969 and rapidly expanded their range into Maryland, while river otter were reintroduced into the upper Potomac and Youghiogheny watersheds beginning in 1989. Eastern coyotes naturally expanded their range in the Mid-Atlantic and arrived in Maryland in 1972; they are now ubiquitous throughout the state and considered to be a naturalized species.

Exotic species of mammals have become established in Maryland either through intentional or unintentional introductions. The house mouse and Norway rat arrived in Maryland with the earliest waves of Europeans to the Americas. Native to East Asia, sika deer were released in Maryland on James Island in 1916 and on Assateague Island around 1930. They have expanded their range in Maryland, now occupying five counties on Maryland's Eastern Shore (MD DNR 2021). Nutria, a rodent species of South American origin, displaced the smaller native muskrat in many coastal marsh regions and degraded the marshes themselves through their destructive feeding habits. Their ability to breed throughout the year enabled their rapid expansion. An aggressive nutria eradication program achieved success in 2022, when they were declared to be eradicated from Maryland (Eisenhauer 2022). Current efforts to limit nutria expansion in Virginia are underway and are needed to prevent recolonization of the Delmarva peninsula.

Mammal SGCN of Maryland

Thirty-four of the state's 97 native mammal species were identified as SGCN in the 2025 SWAP revision (Table 3.10). Eighteen of these are state-listed, of which eight are also federally listed. The group also comprises 27 species of regional conservation concern in the northeastern U.S. (TCI & NEFWDTC 2023) and 14 globally rare species. In addition to these SGCN, 16 mammal species are listed as SAPS. While species on the SAPS list are not listed in this section, a full list of mammal SAPS can be found in Appendix 3b.

Delmarva fox squirrel (Sciurus niger cinereus) (John White)

The vast majority of mammal SGCN are represented by three broad groups: bats, marine mammals, and species that are restricted—or mostly so—to montane habitats in western Maryland. These groups are described below. In addition, several small mammals occur in a wider variety of forested and open habitats, such as American mink *(Neogale vison)* and least weasel *(Mustela nivalis)*. On Maryland's Eastern Shore, the Delmarva fox squirrel *(Sciurus niger cinereus)* depends on forested habitats with at least some larger mast-producing trees, and least shrew *(Cryptotis parva)* can be found in coastal marshes and other habitats.

Montane Mammal SGCN

The state's greatest mammal diversity lies in the mountainous western region, which encompasses the Blue Ridge, Ridge and Valley, and Appalachian Plateau physiographic provinces. Roughly 57 mammal species have been documented there, although seven are either extirpated from the state (snowshoe hare, gray wolf, American marten, elk, American bison), extinct (eastern cougar), or their current presence remains in question (eastern spotted skunk *[Spilogale putorius]*). Of those still extant, approximately half are SGCN, including eight bat species (see subsequent section on SGCN bats) and nearly all of the state's most critically imperiled mammals. Eight of these species occur only or nearly only in the western region, with Garrett County supporting the greatest number of land mammal SGCN.

Many of western Maryland's mammal SGCN are associated with rare or uncommon montane habitats within large forested landscapes. Among the most specialized mammals is the eastern water shrew *(Sorex albibarbis)*, a globally rare species listed as Endangered in Maryland. Feeding primarily on aquatic insect larvae (e.g., mayflies, caddisflies, stoneflies), this small (~15 cm), uniquely adapted, semi-aquatic mammal is restricted to pristine, high-elevation headwater streams in the central and southern Appalachians. The streams are typically bordered by bog wetlands and mature cool, moist forests dominated by northern hardwoods, hemlock, and/or red spruce, often with dense rhododendron thickets. In Maryland, small populations remain along just six or seven streams, all in Garrett County. Another globally rare species, the southern rock vole (*Microtus chrotorrhinus carolinensis*), is endemic to the Appalachian Mountains, with stringent habitat requirements. Known from just three Maryland sites, this state-Endangered mammal occurs in mesic, mature-to-old-growth northern hardwood-hemlock forest with extensive, moss-covered boulderfields that often lay over springs.

Including bats, at least 14 mammal SGCN are associated with rock outcroppings and talus in western Maryland. These unique montane habitats are used seasonally or year-round as den sites, young-rearing areas, refuges, escape cover, and for foraging or hunting. Mammal SGCN that use or have historically used one or both of these habitats include eastern spotted skunk, bobcat *(Lynx rufus)*, and eastern small-footed bat *(Myotis leibii).* Perhaps best exemplifying this habitat association is the state-Endangered Allegheny woodrat *(Neotoma magister).* An agile climber, it occurs almost exclusively in extensive rock outcroppings and talus slopes (and occasionally caves) surrounded by mast-bearing, mature-to-old-growth forest (Thompson 1984, Ford et al. 2006, Mengak et al. 2008). Although historically occurring as far east as the western edge of Washington, DC, today its Maryland range is limited to a handful of widely scattered sites in the three westernmost counties, mostly along or near mountain ridge crests. Like many SGCN, the Allegheny woodrat is sensitive to forest fragmentation, and maintaining adequate connectivity between sites to allow for dispersal and gene flow is key to the species' survival.

Another species that requires montane talus habitat is the long-tailed shrew *(Sorex dispar).* It is limited to mesic forest containing large areas of loose talus where it preys primarily on small invertebrates such as spiders, beetles, and centipedes. Although found throughout the Appalachians, it occurs in highly localized, widely scattered locations and is rare to uncommon in parts of its range—including Maryland, where it is state-listed as In Need of Conservation. Yet another montane habitat specialist is the Appalachian cottontail *(Sylvilagus obscurus).* It is partially restricted to heavily forested, high-elevation areas with extensive dense ericaceous vegetation (i.e., plants of the heather family, including mountain laurel [*Kalmia latifolia*] and great rhododendron [*Rhododendron maximum*]), especially along mountain ridgetops and slopes with extensive outcroppings and talus that provide thermal refugia and escape cover. It also occurs in natural shrubland and semi-open woodland habitats, such as shale barrens and sandstone glades. Appalachian cottontail is state-listed as In Need of Conservation and is a species of regional concern because of known and potential declines due to habitat loss, fragmentation, and competition with the ubiquitous eastern cottontail.

Bat SGCN

Of the 12 species of bats known to occur and three others potentially occurring in Maryland, eight are considered to be SGCN and six are SAPS. Unlike other mammals such as rabbits and mice, bats have a low reproduction rate. They make up for this low reproduction rate by living long lives, provided they survive the many stressors and hazards in their environment. As a result of these stressors and hazards, the Indiana bat *(Myotis sodalist)* and northern long-eared bat *(Myotis septentrionalis)* are federally listed as Endangered, The tricolored bat (*Perimyotis subflavus*) is proposed to be listed as federally Endangered and the little brown bat (*Myotis lucifugus*) is under review for federal listing. Additionally, the eastern small-footed bat is state-listed as Endangered. Two more bat species are under review for possible state listing because of

Indiana bat (Myotis sodalist)
(Adam Mann, USFWS)

white-nose syndrome, a fungus that has killed millions of bats in the eastern United States (USGS 2015).

All bats in Maryland are insectivorous and use a highly sophisticated system of echolocation to find and catch insects in mid-air or glean from foliage. Bats are the primary predators of night-flying insects and can almost eat their own weight in insects every night. Many of the insects eaten by bats are pests of gardens and farm crops (Webster et al. 1985).

Although bats in Maryland can be divided into groups based on life history strategies, in general they tend to select roosts near permanent water such as streams, rivers, ponds, and lakes. Since insects are generally not active during winter, some of Maryland’s bats migrate south and others fly to overwinter in hibernacula such as caves and abandoned sub-surface mines. Recent research (Johnson et al. 2024) and acoustic data indicates that some bats also hibernate in less “traditional” hibernacula such as cliffs, talus, and rock outcrops.

Migratory bats include eastern red bats *(Lasiurus borealis)*, hoary bats *(Lasiurus cinereus)*, and silver-haired bats *(Lasionycteris noctivagans)*. Eastern red bats have been documented as occurring year-round in Maryland, although it is unknown if the bats that are present in the summer are the same as the individuals that overwinter. Red bats prefer mature deciduous trees to roost in during the summer (Limpert et al. 2010) and will overwinter under leaf litter in the fall and winter, while hoary bats prefer evergreen trees as summer roosts. Hoary bats are the largest bats in Maryland and occur throughout the state with a similar pattern to red bats. They prefer to roost in coniferous trees in clumps of foliage (Webster et al. 1985). Silver-haired bats have not yet been documented as breeding in Maryland, although they have been documented during spring and fall migration periods. Silver-haired bats like to roost under bark crevices and in woodpecker holes, and occasionally are found in wood piles, open sheds, and rock crevices. Biologists think that silver-haired and hoary bats migrate south in the fall to areas where insects are active all year; however, much is still unknown about these species because they tend to roost singly or in family groups, are small in size, and are secretive in nature (Webster et al. 1985).

The remaining bat SGCN hibernate during the winter months when food is not available (little brown bat, northern long-eared bat, tricolored bat, eastern small-footed bat, and Indiana bat). These species winter in caves, mines, and abandoned railroad tunnels in Maryland, although recent research indicates that coastal bat populations may not fully hibernate; instead, they undergo short bouts of torpor during periods of colder weather when insects are not flying (Jordan 2020; De la Cruz et al. 2024). Very little is currently understood about these coastal populations and whether Maryland’s bats undertake a similar strategy. Tricolored bats were once the most abundant wintering species in Maryland’s caves, mines, and tunnels, but populations of this species—as well as little brown and northern long-eared bats—have been decimated by white-nose syndrome in addition to suffering other threats and stressors (M. Zagorski, unpublished data; MD DNR 2026a). During the summer breeding season, most of these species form loose colonies of females and pups (i.e., maternity colonies) in snags and hollow trees, under loose bark, in buildings, and in bat roosting boxes. Eastern small-footed bats differ in that they select rock outcrops for maternity sites. Males of these species tend to roost alone or in small bachelor colonies in similar habitats during the summer months.

Marine Mammal SGCN

Marine mammals encountered to date or likely to occur in Maryland waters (including the Atlantic Ocean) include 29 species: 24 cetaceans (whales, dolphins, porpoises), four pinnipeds (seals), and the West Indian manatee *(Trichechus manatus)* (MBP 2026). Of these 29 species, 10 have been selected as SGCN and four as SAPS.

Cetaceans are divided into two groups: the baleen whales and the toothed whales. Baleen whales have large strips of whalebone or baleen instead of teeth that are used to filter water and food. Baleen whales do not echolocate, though they do use sound to communicate. Baleen whale SGCN include the sei *(Balaenoptera borealis)*, blue *(Balaenoptera musculus)*, fin *(Balaenoptera physalus)*, minke *(Balaenoptera acutorostrata)*, humpback *(Megaptera novaeangliae)*, and North Atlantic right *(Eubalaena glacialis)* whales. All of these species (with the exception of minke and humpback whales) are federally listed as Endangered and population stocks are classified as depleted by the Marine Mammal Protection Act (MMPA). The federal status of the humpback whale was under review for delisting in April 2015, which resulted in subdividing the global population into 14 distinct population segments. The population segment that encompasses Maryland was downlisted to “not at risk” status (NOAA 2026a). Most baleen whales are state-listed as Endangered.

Baleen whales in general spend the summer much further north of Maryland waters and migrate through to calving grounds much further south. Most sightings of baleen whales off the coast of Maryland occur in the fall, winter, and spring. The primary diet of these species includes krill, copepods, small schooling fish, and squid, which they can consume in vast quantities. Sei whales can be found in subtropical to subpolar oceans on the continental shelf edge and slope, often singly or in small groups of two to five individuals. Blue whales tend to be further offshore than other baleen whales (NOAA 2026b) and in general their movements are correlated with krill concentrations. Fin whales form social groups of two to seven individuals, though they may also feed with humpback whales, minke whales, and Atlantic white-sided dolphins (NOAA 2026c). Humpbacks engage in hunting techniques involving the creation of air bubbles to herd and trap fish. This technique, called bubble netting, is unique to humpbacks and is a hunting strategy where individuals cooperate together to trap fish (NOAA 2026a). Right whales got their name because they have a layer of fat that floats them to the surface when dead; early whalers therefore referred to them as the “right” whales to hunt. Right whales are the rarest of baleen whales and among the rarest of marine mammals overall, with only 380 individuals estimated in the North Atlantic, of which as few as 70 are reproductively active females (NOAA 2026d). Their diet is primarily zooplankton but, unlike other baleen whales, they skim the water through a concentration of zooplankton with their mouths open. North Atlantic right whales occur in coastal or shelf waters.

Species of toothed whales on Maryland's SGCN list include the sperm whale *(Physeter macrocephalus)*, bottlenose dolphin *(Tursiops truncatus)*, and harbor porpoise *(Phocoena phocoena)*. The sperm whale is the only species federally and/or state-listed as Endangered, with stocks listed as depleted by the MMPA. Sperm whales can dive to 3,000 feet for an hour to feed on prey including large squid, sharks, skates, and fishes. Females form social bonds with other females and their young and tend to stay in the same unit all their lives in tropical waters, whereas young males form bachelor groups. As the young males age, they move polewards and become more solitary over time (NOAA 2026e).

Bottlenose dolphin (Tursiops truncatus)
(George Jett)

Bottlenose dolphins in the Mid-Atlantic are of two types: a coastal type (Tamanend's bottlenose dolphin), which is the one designated as "depleted" by the MMPA, and the offshore type (common bottlenose dolphin). The coastal type is the one most likely to be found along the coast of Maryland and in the Chesapeake Bay. Similarly, Williams et al. (2015) found the coastal type most prevalent in the nearshore part of the study area in summer and remaining until fall, returning in the spring. Bottlenose dolphins were also the most abundant delphinid observed in that study. Their diet consists of invertebrates, squids, and fish, and they use echolocation to find food. Sometimes these dolphins employ a strategy known as "fish whacking" where they use their flukes to smack fish out of the water (NOAA 2026f). Harbor porpoises, while not as abundant in Maryland as bottlenose dolphins, are found along the coast and in Chesapeake Bay (MBP 2026). They usually occur in small groups of two or three individuals, although groups of up to 200 have been reported. They feed on schooling fish and squid and often move seasonally inshore–offshore depending on prey availability. Population estimates and trends for the species in the Mid-Atlantic are unknown (NOAA 2026g); however, passive acoustic monitoring detected harbor porpoises regularly during the period January–May offshore of Maryland (Wingfield et al. 2017).

Threats to Mammal SGCN

Threats to mammal SGCN are varied, reflecting the unique life histories and habitat requirements of this diverse group of species. Extensive forested, mountain ridgetop areas containing rock outcrops, talus slopes, and mature-to-old-growth forest are among the most important habitats in Maryland for mammal SGCN. These areas are threatened by energy development (e.g., wind power development, coal strip mining, and powerline projects) as well as other forms of human disturbances, including residential development and incompatible timber harvest practices. They provide critical habitat for Allegheny woodrats, long-tailed shrews, southern rock voles, and eastern small-footed bats and can provide important habitat for other mammals such as Appalachian cottontails, bobcats, and smoky shrews *(Sorex fumeus)*.

The loss of high-elevation red spruce and hemlock forest contributed to the extirpation of snowshoe hare and the decline of other mammals, including southern rock voles. This unique forest habitat and associated mammal fauna are likely to continue to be impacted by climate change, introduced species (e.g., hemlock wooly adelgid), and conversion to non-forested land uses. The eastern water shrew, which requires high-quality montane streams surrounded by old forest and high-elevation wetlands, is vulnerable to a variety of land uses that could eliminate or degrade its requisite habitat. Mammal SGCN in other parts of the state are similarly threatened by habitat loss and degradation. For example, urbanization has increased the level of competition and disease transmission between some SGCN and other species (e.g., raccoons) that adapt well to human-altered landscapes. Gray fox have been elevated to SGCN status due to wide-ranging population declines that may implicate canine distemper virus, a disease carried by other mammal species (Indiana DNR 2025).

Gray fox (Urocyon cinereoargenteus)
(Tammy Mealman, USFWS)

Bats face particular threats to their insect food source through pesticide use and pollution. They are also sensitive to disturbance during hibernation and while in maternity colonies located in tree cavities, rock outcrops (eastern small-footed bats), and human structures. The removal of large tree snags and forest cover affects species such as the Indiana bat, northern long-eared bat, and eastern red bat. At present, the greatest threat faced by a number of bat species is white-nose syndrome (WNS). Caused by a fungus (*Pseudogymnoascus destructans*), WNS was first detected in New York in the winter of 2006–2007 and has rapidly spread throughout the Eastern U.S., decimating bat populations in most states east of the Mississippi River (Turner et al. 2011). The eastern small-footed bat is already an uncommon cave bat in the Northeast and is vulnerable to extirpation by chance events. Maryland's other cave hibernating bats (e.g., the northern long-eared bat) used to be more common but have declined >90%, putting their population(s) at risk for chance stochastic events such as WNS to affect isolated colonies concentrated in hibernacula.

One of the biggest threats to migratory bat species is direct mortality from interactions with industrial wind turbines, estimated to kill as many as 888,000 migratory bats in North America per year (Smallwood 2013). Wind turbines can pose a threat to non-migratory bats as well. In an effort to track the effects of wind turbines on Endangered species, the U.S. Fish and Wildlife Service (USFWS) documents Indiana (n=28) and northern long-eared (n=35) bat fatalities at wind energy facilities (Pruitt & Reed 2022; USFWS 2024).

Marine mammals face threats from pollutants and toxins dumped in the ocean as well as entanglement and capture in fishing gear, incidental take, and injuries/mortality from ship strikes. The coastal type of bottlenose dolphin (Tamanend's bottlenose dolphin) has suffered viral outbreaks, especially around 2013–2015, resulting in deaths and strandings. There is also growing concern about the effects of anthropogenic noise pollution on deep-diving marine mammals. The possible effects of offshore wind turbine development on marine mammals and other marine taxa have been flagged for further study.

Conservation Actions and Information Needs for Mammal SGCN

Some of the conservation actions needed to address threats to specific SGCN are presented in recovery plans for federally listed species (e.g., Indiana bat, certain whale species) (Table 3.9). For many mammal SGCN, the protection of critical forest, wetland, and rock outcrop habitat represents the most urgent and important conservation need. The best—and in some cases, only—remaining habitat for some species is confined to MD DNR lands. For this reason, incorporating species and habitat conservation needs into public land management planning takes on an even greater importance. Landscape habitat models may help provide more effective conservation strategies for species with large home ranges (e.g., bobcat) or that occur as metapopulations and require large forested landscapes with minimal fragmentation (e.g., Allegheny woodrat). The restoration of high-elevation red spruce-hemlock forest, along with efforts to minimize impacts from hemlock wooly adelgid, would provide important habitat for several mammal SGCN as well as other SGCN taxa, and may even provide opportunities for population reintroductions. Public education and working with mining, wind energy, and other industries that commonly cause disturbance in bat habitat could help to minimize mortality and deter the presence of invasive or pest species, such as domestic cats, near SGCN habitat.

To determine additional conservation measures, specific information or research is needed for some SGCN. The fossorial and nocturnal habits of many SGCN mammals make inventory, monitoring, and research on basic biology and habitat a particular challenge for this group. For wide-ranging species, understanding the landscape configuration needed to maintain metapopulations is of primary importance. Tasks such as documenting the migratory flyways of bats and determining how to deter collisions with wind turbines are becoming more pressing issues as wind power development increases in the eastern U.S. Best management practices also need to be developed, improved, and/or distributed to minimize the impacts of agricultural and timber harvest activities on forest and wetland mammals.

Concerning marine mammals, the aforementioned MMPA of 1972 was monumental in that it provided ecosystem-level protection to all marine mammals in U.S. waters. Before the MMPA, marine mammals were protected by species on an as-needed basis to prevent total depletion of at-risk species, but the MMPA reaches across all marine mammal categories in its prohibition of take or harassment of marine mammals. The MMPA is carried out by the Secretary of the Interior through USFWS and by the Department of Commerce through the National Oceanic and Atmospheric Administration (NOAA). NOAA oversees the management of most marine mammals in Maryland, including cetaceans, such as whales and dolphins, and pinnipeds, such as seals. The only marine mammal SGCN not managed by NOAA is the West Indian manatee, for which USFWS is responsible.

The National Aquarium in Baltimore is responsible for live stranded marine animals in Maryland. Occasionally, this includes the capture, rehabilitation, and potential release of an individual. Upon request, the Marine Mammal and Sea Turtle Stranding (MMSTS) Program may assist with such stranding events, though they typically respond to dead strandings. It is the goal of MMSTS to recover and collect data from as many scientifically viable animals as possible, which may include a necropsy examination to investigate the cause of death. This in turn contributes to the body of research regarding these animals and assists in our understanding of their relative locations, population sizes, and causes of death.

To research the potential impacts of offshore wind development, acoustic monitoring sensors (hydrophones) have collected marine mammal sounds and gathered much needed data on the presence, habitat use, and migration patterns of these species. These data will inform various protection measures, including the implementation of "slow zones" to reduce ship strikes when northern right whales are detected. Phone apps like Whale Alert and Ocean Alert help mariners know when and where marine species have been spotted to help reduce vessel strikes. Coordinated by NOAA, Take Reduction Teams develop recommendations to reduce serious injury and incidental mortality of cetaceans from commercial fishing (NOAA 2026h).

Table 3.9 Existing federal recovery plans for mammal SGCN

Mammal Species	Federal Recovery Plan	Recent Action
Delmarva fox squirrel	USFWS 1993	2014: Draft post-delisting monitoring plan
Indiana bat	USFWS 2007	2024: Initiation of 5-year review
Northern long-eared bat	Forthcoming	2022: Changed from Threatened to Endangered
Blue whale	NOAA Fisheries 2020	2020: 5-year review
Fin whale	NOAA Fisheries 2010	2023: 5-year review, summary, & evaluation
Humpback whale	NOAA Fisheries 1991	2023: Initiation of 5-year review for some distinct populations
North Atlantic right whale	NOAA Fisheries 2004	2022: 5-year review
Sei whale	NOAA Fisheries 2011	2021: 5-year review, summary, & evaluation
Sperm whale	NOAA Fisheries 2010	2021: Initiation of 5-year review

Table 3.10 Mammal SGCN in Maryland

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Allegheny woodrat	*Neotoma magister*	G3	S1		E	A
American mink	*Neogale vison*	G5	S4			C
Appalachian cottontail	*Sylvilagus obscurus*	G4	S1		I	A
Blue whale	*Balaenoptera musculus*	G3G4	S1	E	E	A
Bobcat	*Lynx rufus*	G5	S3		I	C
Bottlenose dolphin	*Tursiops truncatus*	G5	S4			C
Delmarva fox squirrel	*Sciurus niger cinereus*	G5T3	S1		I	A
Eastern red bat	*Lasiurus borealis*	G3G4	S3S4			B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Eastern small-footed bat	*Myotis leibii*	G4	S1		E	A
Eastern spotted skunk	*Spilogale putorius*	G4	S1			A
Eastern water shrew	*Sorex albibarbis*	G5	S1		E	A
Fin whale	*Balaenoptera physalus*	G3G4	S1S2	E	E	A
Gray fox	*Urocyon cinereoargenteus*	G5	S5			C
Harbor porpoise	*Phocoena phocoena*	G4G5	S4			C
Hoary bat	*Lasiurus cinereus*	G3G4	S3S4			B
Humpback whale	*Megaptera novaeangliae*	G4	S1S2		E	A
Indiana bat	*Myotis sodalis*	G2	S1	E	E	A
Least shrew	*Cryptotis parva*	G5	S3S5			C
Least weasel	*Mustela nivalis*	G5	S2S3		I	B
Little brown bat	*Myotis lucifugus*	G3G4	S1			A
Long-tailed shrew	*Sorex dispar*	G4	S2		I	B
Minke whale	*Balaenoptera acutorostrata*	G5	S1			A
North Atlantic right whale	*Eubalaena glacialis*	G1	S1	E	E	A
Northern long-eared bat	*Myotis septentrionalis*	G2G3	S1	E	E	A
Sei whale	*Balaenoptera borealis*	G5?	S1	E	E	A
Silver-haired bat	*Lasionycteris noctivagans*	G4	SU			D
Smoky shrew	*Sorex fumeus*	G5	S2S3		I	B
Southeastern shrew	*Sorex longirostris*	G5	S3S4			C
Southern bog lemming	*Synaptomys cooperi*	G5	S3			C
Southern pygmy shrew	*Sorex hoyi winnemana*	G5T4	S2			B
Southern rock vole	*Microtus chrotorrhinus carolinensis*	G5T3	S1		E	A
Sperm whale	*Physeter macrocephalus*	G3G4	S1	E	E	A
Tricolored bat	*Perimyotis subflavus*	G3G4	S1	PE		A
West Indian manatee	*Trichechus manatus*	G2G3	S1N	T		A

[1] = See Table 3.5 for S-rank and G-rank definitions
[2] = T (Threatened); E (Endangered); I (In Need of Conservation); PE (Proposed Endangered)
[3] = See Table 3.7 for Conservation Status definitions

Birds of Maryland

Birds are the most familiar and widely enjoyed wildlife in North America. As of 2024, 463 species of birds have been documented at least once in the state as represented in the "Official List of the Birds of Maryland" (MOS 2024). This list includes one species that has been extirpated from the state (greater prairie chicken), two extinct species (passenger pigeon and Carolina parakeet), five introduced species that have become naturalized, and a large number of species that have made their way into Maryland only once or a few times since records were first kept in 1804.

Northern bobwhite (Colinus virginianus) (John White)

Most Maryland birds are migratory and do not spend the entire year in the state, although some, such as the pileated woodpecker and northern bobwhite *(Colinus virginianus)*, are non-migratory and permanent year-round residents. Many species that breed in the state migrate to other areas outside of the breeding season. Some more northerly breeding species migrate south to Maryland and spend the winter here, while other species simply pass through the state during spring and fall migration periods. Less common are species like golden-crowned kinglet *(Regulus satrapa)* and dark-eyed junco *(Junco hyemalis)* that breed in western Maryland, but whose numbers increase when wintering individuals from the north occupy the entire state. Marine birds occur in the waters offshore with seasonally based abundance and distribution patterns, but their specific presence largely depends on the location of concentrations of their fish prey. Two hundred and nine species were documented as possibly, probably, or confirmed breeding in the state during data collection for the Third Breeding Bird Atlas from 2020 to 2024 (G. Foley, unpublished data). Although a number of other species only migrate through or overwinter in Maryland, their success while they are in the state can be critical to their continued survival.

Maryland's importance to birds has been recognized by several organizations that have designated specific areas as particularly valuable to seabirds, wading birds, waterfowl, shorebirds, and others. The Atlantic Coast Joint Venture (ACJV) designated much of Maryland's coastal regions as Waterfowl Focus Areas in their 2005 ACJV Waterfowl Implementation Plan. Focus Areas include the Atlantic Coastal Bays, the Blackwater–Nanticoke River region on the Delmarva Peninsula, the Chester River and Kent County Bayshore region, the Choptank River region, the Eastern Shore's Eastern Bay region, the Patuxent River region, the Tangier Sound and Bay islands, and the Tidal Potomac region (ACJV 2005).

The Mid-Atlantic/New England Maritime Regional Working Group for Waterbirds (MANEM), a regional partnership working to conserve waterbirds in the Northeast, identified Important Waterbird Areas for breeding seabirds, wading birds, and marshbirds for 11 states and four provinces in the Northeast. MANEM maps for each of the mentioned groups of waterbirds are available for each state, including Maryland. Key areas for shorebird and marine bird conservation were developed by working groups for shorebirds (Atlantic Flyway Shorebird Business Strategy group) and marine birds (Northwest Atlantic Marine Bird Cooperative). Information from these and other efforts led to the creation of focal area maps for coastal areas in Maryland for shorebirds, waterbirds, landbirds, and waterfowl.

In Maryland, concentrations of high priority landbirds, waterbirds, and/or shorebirds have led to the designation of 43 areas as Important Bird Areas (IBAs) by the National Audubon Society. Of the 43, six IBAs are of global significance, meaning that the IBA contains bird species of global conservation concern or the site meets other criteria based on the species limited range and high density in the IBA. IBAs are found in every region of Maryland, with the majority of higher ranked IBAs in coastal regions (National Audubon Society 2013). At regional and local scales, target areas in Maryland have been or are being identified for particular species (e.g., cerulean warbler *[Setophaga cerulea]*, golden-winged warbler *[Vermivora chrysoptera]*, rusty blackbird *[Euphagus carolinus]*, and American woodcock *[Scolopax minor]*) or groups of species (e.g., forest interior breeding birds, nightjars) based on habitat needs and known concentrations.

Maryland's landscape encompasses six physiographic regions, as described in Chapter 2: Lower Coastal Plain, Upper Coastal Plain, Piedmont, Ridge and Valley, Blue Ridge, and Appalachian Plateau. The diversity of habitats within these regions directly accounts for the diversity of birds found in the state. Because of this physiographic diversity, three Bird Conservation Regions (BCRs) occur in Maryland: New England/Mid-Atlantic Coast, Piedmont, and Appalachian Mountains. The Regions were designated by the North American Bird Conservation Initiative (NABCI) to represent ecologically distinct regions with similar bird communities, habitats, and resource management issues. Each BCR addresses different suites of species and issues, and some have designated priority areas for focal species. Additionally, numerous conservation plans address the unique guilds or groups of bird species that occur within BCRs and across the entire Atlantic Coast region.

Bird SGCN of Maryland

One hundred and forty-six species of birds have been listed by the 2025 SWAP revision process as SGCN in Maryland (Table 3.12). This number includes two subspecies, for which the full species are also included; it does not include the five bird species on the new SAPS list. Of these 146 species and subspecies, 34 are state-listed, 18 of which are listed as Threatened or Endangered. 60 species are also of conservation concern across the Northeastern U.S. region (TCI & NEFWDTC 2023). The remaining species were included because they are of national or international concern (IUCN 2026), the best available current scientific information indicates that their populations are in decline, and/or they require more specialized habitat types that are likely to be degraded. For example, regional rusty blackbird populations have declined steeply in recent years, and Maryland has joined efforts to identify key wintering and migration wetland areas. Coordinated regional surveys are also underway for nightjars (eastern whip-poor-will *[Antrostomus vociferus]*, common nighthawk *[Chordeiles minor]*, chuck-will's-widow

[Antrostomus carolinensis]) based on suspected declines and the difficulty of surveying nocturnal species.

Birds federally listed as Endangered that formerly bred in Maryland include roseate tern *(Sterna dougallii)* and red-cockaded woodpecker *(Leuconotopicus borealis)*. The bald eagle *(Haliaeetus leucocephalus)* was removed from the federal list of Threatened and Endangered species in 2007, but the Atlantic coast breeding population of piping plovers *(Charadrius melodus)* is still federally listed as Threatened; both bird species are listed as SGCN in Maryland. Fourteen species are considered by the MD DNR to be Endangered in the state: Wilson's plover *(Anarhynchus wilsonia)*, piping plover, upland sandpiper *(Bartramia longicauda)*, black rail *(Laterallus jamaicensis)*, common tern *(Sterna hirundo)*, gull-billed tern *(Gelochelidon nilotica)*, royal tern *(Thalasseus maximus)*, black skimmer *(Rynchops niger)*, short-eared owl *(Asio flammeus)*, sedge wren *(Cistothorus stellaris)*, loggerhead shrike *(Lanius ludovicianus)*, Swainson's warbler *(Limnothlypis swainsonii)*, mourning warbler *(Geothlypis philadelphia)*, and American goshawk *(Astur atricapillus)*. Species listed as Threatened in the state are American bittern *(Botaurus lentiginosus)*, Rufa red knot *(Calidris canutus rufa)*, least tern *(Sternula antillarum)*, and Nashville warbler *(Leiothlypis ruficapilla)*. For additional ranks, see Appendices 3a and 3b.

Montane Bird SGCN

Forests dominate the Blue Ridge, Ridge and Valley, and Appalachian Plateau provinces more than any other part of the state. They include mostly a mix of mature and younger sapling and pole stage forests with just scattered small remnants of old growth forest. Although most forests are dominated by hardwoods, more northern forest types with a conifer component are also present. Where they occur, old growth forests in this region tend to support higher densities of several forest bird SGCN. In addition, bog and fen wetland complexes, cliff and rock outcrops, beaver-created wetlands, and large managed grasslands provide habitats for a great diversity of bird SGCN. Because some of these habitats occur nowhere else in the state, a number of bird species breed exclusively, or nearly so, in these regions, especially in the Appalachian Plateau. Some of these species are at or near the southern extent of their breeding ranges, such as Nashville warbler, mourning warbler, northern saw-whet owl *(Aegolius acadicus)*, Canada warbler, and alder flycatcher *(Empidonax alnorum)*. Eight state-listed species and an additional 11 bird SGCN breed only in western Maryland's montane region, including American goshawk, pine siskin *(Spinus pinus)*, winter wren *(Troglodytes hiemalis)*, red-breasted nuthatch *(Sitta canadensis)*, and golden-winged warbler.

Northern saw-whet owl (Aegolius acadicus)
(George Jett)

Although historically a predominantly forested landscape, the Appalachian Plateau region includes some areas of anthropogenic grasslands resulting from strip mine reclamation and agricultural practices (e.g., hayfields, pasture). These habitats provide some of the few remaining areas in Maryland where area-sensitive grassland nesting birds such as northern harrier *(Circus hudsonius)* and upland sandpiper *(Bartramia longicauda)* still breed.

The mountain ridges of Maryland feature concentrations of migrating raptors by day and songbirds by night, where migrants also stop to feed and rest on their journeys. Satellite tracking studies of golden eagles *(Aquila chrysaetos)* have reinforced hawk watch data showing that the regional population concentrates along just a few mountain ridges as birds pass over Maryland (Katzner et al. 2012). In addition, ongoing studies at higher elevations in forested areas have shown they are regularly used as wintering grounds by golden eagles.

Bird SGCN of the Piedmont

The forests, riparian corridors, wetland habitats, and open areas of the Piedmont Bird Conservation Region support roughly 140 breeding bird species (Carter et al. 2000). Six bird species have a disproportionately large share of their global populations breeding within this area, which extends from southern Virginia to northern New Jersey (Kearney 2003; Watson 2014). These include four SGCN deciduous forest nesting species—wood thrush *(Hylocichla mustelina)*, Acadian flycatcher *(Empidonax virescens)*, scarlet tanager *(Piranga olivacea)*, and Louisiana waterthrush *(Parkesia motacilla)*—and one SGCN associated with early successional habitats, the prairie warbler *(Setophaga discolor)*. Willow flycatcher *(Empidonax traillii)* and American kestrel *(Falco sparverius)* also breed more commonly in the Piedmont section of the state.

Prairie warbler (Setophaga discolor) (George Jett)

The Piedmont is in the heart of these species' geographic ranges and, therefore, forest conservation in this region could especially benefit and sustain their populations over the long term. Regional planning efforts have also identified the importance of the Piedmont for protected habitat corridors for forest and grassland species, maximizing opportunities to preserve habitats for breeding and migratory priority species in rapidly increasing urban and suburban areas (Watson 2014).

Due to the concentration of human population growth, changes in farming practices, and alteration of natural fire frequencies, the Maryland Piedmont now forms a particularly fragmented mosaic of forest and mostly anthropogenic grassland, which limits the success of birds that depend on large blocks of these habitats for successful nesting. For example, broad-winged hawk *(Buteo platypterus)*, brown creeper *(Certhia americana)*, Kentucky warbler *(Geothlypis formosa)*, and cerulean warbler have shown declines in the Piedmont, likely due to forest loss and fragmentation. In addition to forest-dependent species, Maryland's Piedmont habitats traditionally supported grassland species such as the vesper sparrow *(Pooecetes* *gramineus),* grasshopper sparrow *(Ammodramus savannarum),* and eastern meadowlark *(Sturnella magna)* (Kearney 2003), the populations of which have greatly declined due in part to habitat loss. Bobolink *(Dolichonyx oryzivorus),* American barn owl *(Tyto furcata),* American kestrel, and upland sandpiper were also once more common in the grassland habitats of this region of Maryland. Birds of shrublands and early successional habitats—such as the northern bobwhite, American woodcock, and yellow-breasted chat *(Icteria virens)*—have also seen large population declines as farming practices have changed and urbanization has increased in the Piedmont. Loss of habitat to development, changes in farming practices (e.g., lack of hedgerows), and other factors have also led to the loss of loggerhead shrike as a breeding bird in recent years in Maryland and surrounding states. The continued expansion of development in this area of the state as well as in the region represents a particular challenge regarding bird conservation for SGCN that occur in Maryland's Piedmont.

Bird SGCN of the Coastal Plain

The avifauna of the Upper and Lower Coastal Plain is transitional and contains a mix of species mostly centered in southeastern North America, with some additional species coming into the area from more inland regions. Of the Coastal Plain breeders, many SGCN are associated with wetland habitats, although some are associated with upland forests, shrublands, and grasslands. As would be expected, waterfowl, marshbirds, shorebirds, and colonial nesting waterbirds, are important components of this region's avifauna (Kushlan et al. 2002). Of the perching birds, Coastal Plain specialists include marsh wren *(Cistothorus palustris),* Swainson's warbler, saltmarsh sparrow *(Ammospiza caudacuta),* seaside sparrow *(Ammospiza maritima),* Coastal Plain swamp sparrow *(Melospiza georgiana nigrescens),* Ipswich sparrow *(Passerculus sandwichensis princeps),* and boat-tailed grackle *(Quiscalus major).*

Saltmarsh sparrow (Ammospiza caudacuta)
(Bri Benvenuti, USFWS)

The Chesapeake Bay is a major wintering area for waterfowl in the Atlantic Flyway, including brant *(Branta bernicla),* redhead *(Aythya americana),* canvasback *(Aythya valisineria),* and long-tailed duck *(Clangula hyemalis)*. Several SGCN also breed in the Chesapeake Bay region, including American black duck *(Anas rubripes),* blue-winged teal *(Spatula discors),* and gadwall *(Mareca strepera),* all of which have declined in the state (Costanzo & Hindman 2007; G. Foley, unpublished data). The Bay is also very important for wintering and migrating red-throated loons *(Gavia stellata)* and horned grebes *(Podiceps auritus)*; migrating northern gannets *(Morus bassanus)* and saltmarsh sparrows; and breeding rails and sparrows, according to an analysis of the importance of the Chesapeake Bay to avian populations during different parts of their life cycle (Watts 2013). Overall, the Chesapeake Bay supports 67 breeding species, 87 wintering species, and 138 migrants that are dependent on this estuary (Watts 2013), many of which are SGCN.

Marshbirds are species that breed and sometimes live exclusively in marshes, including species such as rails, gallinules, pied-billed grebe *(Podilymbus podiceps)*, marsh wren, and a few sparrows. Efforts to assess Maryland's marshbird populations began in the early 1990s (Brinker et al. 2001). Compared to most other groups of birds, many aspects of marshbird biology remain poorly understood. Information is lacking or incomplete, for example, with regard to breeding and winter distribution, migration patterns, threats, and limiting factors (Watts 2013). Many breeding marshbirds are included on the SGCN list due to documented declines in Maryland and the wider region. Of great concern is the disappearance of Endangered black rails from many of their former locations; they were located in only two atlas blocks during the recent Breeding Bird Atlas (G. Foley, unpublished data). This reflects the region-wide decline estimated to be as high as 90% according to the Eastern Black Rail Conservation and Management Working Group (ACJV 2020). Marshes and wetlands of the Coastal Plain also provide important breeding habitat for other rails, ducks, shorebirds, raptors, wrens, and sparrows. A region-wide collaboration, the Saltmarsh Habitat and Avian Research Program, provides data on trends and productivity of a suite of marshbird SGCN that are critical for effective conservation of these species.

Colonial nesting waterbirds are particularly vulnerable to disturbance or loss of breeding areas, as they concentrate into very limited areas during the nesting season. Since 1989, MD DNR has had an active colonial waterbird management program to assess and monitor these vulnerable populations. Regional management coordinated through MANEM and the Atlantic Flyway Council Technical Section's Colonial Waterbird and Shorebird Working Groups provides regional assessments of waterbird population status and trends. More recently, the Integrated Waterbird Management and Monitoring Program, coordinated by USFWS, has worked to provide breeding, wintering, and migration habitat for shorebirds, waterfowl, and wading birds as they occupy different areas throughout the year along the Atlantic Coast. Twenty-four species of colonial waterbirds nest currently, or nested historically, in Maryland. This group includes terns, gulls, herons, egrets, and ibises, along with black skimmer and brown pelican *(Pelecanus occidentalis).*

In Maryland, nesting black skimmers, common terns, royal terns, and Forster's terns *(Sterna forsteri)* continue to experience significant declines, while double-crested cormorants nesting on man-made structures like bridges have increased at a dramatic rate (Brinker et al. 2007; G. Foley, unpublished data). Numerous islands important to colonial waterbirds have eroded away and those that remain continue to shrink due to erosion and sea-level rise. Nests are increasingly vulnerable to overwash during high tides and storm events. Although the number of Chesapeake Bay colonies has increased for great blue heron, decreases have been documented for other species (e.g., snowy egret [*Egretta thula*], glossy ibis [*Plegadis falcinellus*], and black-crowned night heron [Nycticorax nycticorax]) due to the loss of foraging and nesting habitats (Watts et al. 2007; G. Foley, unpublished data).

Case Study: Maryland's Artificial Tern Raft

To stabilize the declining numbers of common terns in Maryland, the Tern Raft project was launched in 2021. The project, a joint effort between MD DNR, the Maryland Coastal Bays Program (MCBP), and Audubon Mid-Atlantic, proved the viability of such artificial habitats during the 2021 pilot season, during which common terns began nesting. At the time, relatively few common terns remained nesting in the Coastal Bays due to the loss of nearly all small islands with breeding beaches in these waterways. The raft, hosting 23 nests in its pilot year, immediately became the largest nesting colony in the Coastal Bays area.

The constructed raft (Archer Larned, MCBP)

The Tern Raft is a 48-foot-by-48-foot wood-framed artificial island that serves as breeding habitat for common terns, whose natural nesting areas are under threat from sea-level rise. The raft floats in the Chincoteague Bay in Worcester County and is deployed each spring by combining 18 8-foot by 16-foot platform sections latched together. In the interest of providing habitat as close to natural conditions as possible, the surface is covered with broken clam shells, with wooden chick houses and artificial grasses providing the necessary shelter nesting terns would otherwise have available to them in dune environments. The raft is disassembled in the fall when the birds move on for their yearly migrations and reassembled the following spring ahead of nesting season.

Common terns (Sterna hirundo) using the raft (Kim Abplanalp, MCBP)

Since the inception of the project, the successful Tern Raft has become the most productive breeding site for common terns in Maryland. Over 1,100 common tern chicks have fledged from the site, and it boasts an 80% return rate for breeding pairs. American oystercatchers (*Haematopus palliatus*), a state watchlist breeder, also regularly use the site. Royal terns began using the site in 2025. Like common terns, royal terns are endangered in Maryland and considered highly rare state breeders. Royal terns built 29 nests on the raft in 2025, from which eight chicks fledged.

The Tern Raft is intended to be used as a temporary measure to retain nesting common terns in the Coastal Bays while breeding habitat is restored by creating small islands suitable for nesting sites, allowing colonial nesting birds to easily move to appropriate, non-floating habitats as they become available. See the Small Coastal Plain Islands KWH description in Chapter 4 for more details on these habitats.

Maryland's Chesapeake Bay and Atlantic Coastal Bays provide the primary habitats where migrating shorebirds stop to feed and rest, where shorebirds spend the winter, and where rare piping plovers and nighthawks breed. Although a number of shorebird populations in North America have stabilized after large declines during the early 1980s and mid-1990s, several species that pass through (e.g., whimbrel *[Numenius phaeopus],* Rufa red knot, semipalmated sandpiper *[Calidris pusilla]*) or winter in Maryland (e.g., ruddy turnstone *[Arenaria interpres],* lesser yellowlegs *[Tringa flavipes],* sanderling *[Calidris alba]*) continued to show significant population declines in the early 2000s (Andres et al. 2012). Shorebird populations are regularly monitored in Maryland by the National Park Service (NPS) at Assateague Island National Seashore, as well as occasional Atlantic coast regional coordinated efforts (Clark & Niles 2000; Hunter 2003). Conservation actions in North America are provided in the U.S. Shorebird Conservation Plan (Brown et al. 2001), and the U.S. Shorebird Conservation Partnership Council oversees the implementation of the regional, national, and international goals of the Plan.


Left: *Piping plover ((Charadrius melodus)* (Don Freiday, USFWS); **Right:** ***P****rotected sand dunes of Assateague Island, where the piping plover, endangered in Maryland, nests* (Stephen Badger, MD DNR).

The piping plover, federally listed as Threatened and state-listed as Endangered, is a tiny dune-nesting shorebird that nests on Maryland's Assateague Island and on other Atlantic coastal beaches (USFWS 1996). The species is slowly recovering due to education of beach users, aided by signs and light fencing, the latter sometimes also being predator resistant. The Atlantic Flyway Shorebird Business Plan (NFWF 2018) presents a coordinated approach to shorebird conservation. As a business strategy instead of a conservation plan, this strategy identifies the needs of species at greatest risk; examines necessary actions, including funding; and presents those individuals and groups which are instrumental in the recovery process, along with analysis of possible outcomes. The goal of this conservation business strategy is to create a long-term platform for stability and recovery of the focal species identified.

Remaining forested areas in the Upper and Lower Coastal Plain, especially those dominated by hardwoods, provide places for migrating songbirds to rest and refuel on their long journeys to regions north or south of Maryland. Forested corridors along rivers—particularly the Pocomoke River—have been shown to be particularly important to these migrants. Coastal Plain river corridors and Chesapeake Bay shorelines support the recovered bald eagle population at all times of the year (Watts et al. 2007). In larger forest blocks, breeding birds whose optimal habitat is forest interior form a diverse, species-rich community that can include as many as 10 species of warblers and another 11 species that depend on this habitat. In Lower Coastal Plain uplands, a mosaic of anthropogenic grasslands (e.g., hayfields, wildlife habitat plantings), shrubs, and young forest provides a landscape that supports species such as grasshopper sparrow, vesper sparrow, eastern meadowlark, yellow-breasted chat, and prairie warbler. This mosaic landscape is critical to maintain remaining northern bobwhite populations, whose range in Maryland has been largely reduced to the Lower Eastern Shore.

Marine Bird SGCN

American oystercatcher (Haematopus palliatus) (George Jett)

The birds of Maryland's oceanic waters are the least understood and least studied group of birds in the state and in the region. To try to address information gaps, the Atlantic Marine Bird Cooperative is working to support surveys and research for marine birds. This group has also identified conservation target species for the region, most of which at least pass through offshore Maryland on a regular basis. Studies from the 1970s (Rowlett 1980) and 1980s (Powers 1983), compilations of data (O'Connell et al. 2009), as well as observations from pelagic boat trips for birdwatching have provided basic information on the presence and timing of the occurrence of over 20 marine bird species in the waters off Maryland's shore, not including gulls and terns. Although more recent studies in advance of offshore wind development have provided additional information on deepwater marine birds, the distribution, seasonal movements, population status, and specific habitat preferences throughout the year remain poorly understood for many species. More information is available for birds using nearshore areas due to the ease of observation from shore compared to areas that must be reached by boat or flown over with aircraft to document species' presence and activity. Spring and fall migration periods bring the majority of marine birds to the state, although several species (loons, scoters, gannets) winter here in large numbers and some species (shearwaters, storm-petrels) can increase in abundance in the summer.

Marine birds in Maryland use pelagic habitats on the continental shelf that vary from shallow areas close to shore, to open waters beyond the three-mile state boundary, to areas above deep canyons on the ocean floor miles from the coast. The presence and location of marine birds is very much influenced by the presence of their prey, which depends on temperature and salinity as dictated by oceanic currents and weather conditions, and which can also be influenced by ocean depth and underlying physical features of the ocean floor. Concentrations of shellfish and other food sources around shoals and artificial reefs provide nearshore feeding grounds for wintering loons, grebes, and scoters. Migrating gannets move along the coast by the thousands, plunge diving on schooling fish, with a number of birds remaining over winter in Maryland waters. Further offshore, concentrations of pelagic birds can be found where fish and cephalopod prey are abundant, including near upwellings from deep canyons in the ocean floor at the outer edge of the continental shelf, where *Sargassum* mats are brought in by the Gulf Stream and where fishing trawlers and processing vessels are dumping offal. In these situations, mixed groups of shearwaters and petrels, which can number in the hundreds, are often found where food is concentrated. Several terns, jaegers, alcids (puffins, murres, razorbills), storm-petrels, black-legged kittiwake *(Rissa tridactyla)*, and two species of phalarope round out the diversity of marine birds occurring regularly offshore of Maryland. These species, especially storm-petrels and phalaropes, tend to aggregate where zooplankton, planktonic crustaceans, and small fish are concentrated at the surface. Although data to assess population trends for marine birds are limited, it has been estimated that loons, scoters, phalaropes, Sargasso shearwater *(Puffinus lherminieri)*, black-legged kittiwake, and Leach's storm-petrel *(Hydrobates leucorhous)* are declining. Changes in food availability and challenges in breeding areas, such as habitat loss and contamination, are likely contributing to these declines.

Threats to Bird SGCN

Although bird SGCN are a diverse group, many of them (> 40 species) are highly area-sensitive and negatively affected by the loss and fragmentation of their respective habitats. For example, forest nesting species—such as worm-eating warbler *(Helmitheros vermivorum)*, cerulean warbler, and broad-winged hawk—typically only breed in large contiguous forest tracts and nest success tends to decline in increasingly fragmented areas. Area-sensitive grassland nesting birds such as Henslow's sparrow *(Centronyx henslowii)* and short-eared owl, as well as some wetland species like sedge wren and saltmarsh sparrow, show similar patterns.

Broad-winged hawk (Buteo platypterus) with a snake (Courtney Celley, USFWS)

In addition to area sensitivity, some species require a mosaic of habitats at the landscape level to persist, such as northern bobwhite. Most loss and fragmentation has resulted from residential and commercial development, but agriculture and infra structure such as roads and powerlines are also a major source. Of more recent concern is forest loss and fragmentation from wind power developments on ridgetops and the potential for further fragmentation from hydrofracking. Conversion of native forest communities to commercial pine plantations further alters the suitability of the habitat for most forest-dwelling SGCN, and some bird species, such as northern saw-whet owl, are dependent on high-elevation red spruce-hemlock habitats that have been greatly reduced in size by this conversion and even further impacted by climate change.

Changes in composition and structure of forests and shrublands from altered fire regimes, invasive insect pests like hemlock wooly adelgid, overbrowsing by deer, and invasive plant species can all have serious impacts on critical habitat for nesting birds. Forest fragmentation increases edge habitat, making it easier for nest parasites like cowbirds—which tend to prefer more open areas—to parasitize nests, reducing nest success for forest-dwelling bird SGCN. Grassland birds such as dickcissel and bobolink are further threatened by modern agricultural practices such as earlier and more frequent mowing. Wetland birds are impacted by changes to their environment from threats such as invasive plant species (especially *Phragmites*), plastic pollution and other contaminants, and lack of beaver-created wetlands.

Beach-nesting, migrating, and wintering shorebirds and colonial waterbirds face special challenges as they are concentrated in areas with increased recreational use, expanding gull populations, shoreline development, and alteration of natural shoreline processes. In addition, sea-level rise has seriously reduced suitable nesting habitat for terns as islands in the Chesapeake and Coastal Bays have continued to disappear. Disturbance of colonial waterbird colonies is of special concern given the potential to negatively affect the breeding success of a large group of birds by impacting just one or a few areas. These colonies and beach-nesting shorebirds can also be seriously impacted by increased predator populations.

The vast saltmarsh habitats of Maryland support the regional stronghold of rails and sparrows, including black rail, saltmarsh sparrow, and Coastal Plain swamp sparrow. Contamination and drainage of these and other marsh habitats through development and mosquito control efforts can be a serious problem for marsh-nesting species. Climate change has also severely impacted coastal marsh habitats through sea-level rise, combined with an increase in frequency and severity of storms and tidal surges in coastal areas during the nesting season. This is of particular concern due in part to the outsized role that Maryland's saltmarshes play in these species' conservation. For example, in the case of the saltmarsh sparrow, it is estimated that Maryland's marshes contain approximately 25% of the global population (ACJV 2024).

Marine birds are impacted by overfishing, entanglement in fishing gear, contamination, and climate alterations that impact the presence and abundance of their food sources. The development of offshore wind energy facilities has the potential to impact marine birds and other birds that migrate offshore, although the degree and severity of impacts can be difficult to predict.

Not including marine birds, 24 bird SGCN do not breed in Maryland, but only overwinter or stop in Maryland during migration. Migratory stopover or wintering habitat is critical for these species, most of which are shorebirds or waterfowl. Disturbance of beach habitats, the reduction of horseshoe crab eggs for shorebirds (especially Rufa red knot), and degradation of aquatic habitats for waterfowl threaten these species groups during winter and migration periods

Many migrant songbirds travel at night and stop along the way to rest, forage, and acquire energy for the next flight (Moore 2018). These periods of stopover are critically important for successful completion of the migratory journey for long- to medium-distance passerine and near-passerine species, such as warblers, vireos, thrushes, flycatchers, and sparrows (Newton 2007). Recent studies using weather surveillance radar (C. E. Nemes & E. B. Cohen, unpublished data) show that migrating songbirds in the region regularly concentrate in certain areas of the state, with some variation depending on time of year (i.e., fall or spring migration). Regional stopover hotspot maps show where stopover "hotspots" occur: high and medium stopover density areas, as compared to all locations within that region, for spring (Figure 3.2) and autumn (Figure 3.3) migration. Protection of migratory corridors and stopover habitat in these areas is critical to support regional populations

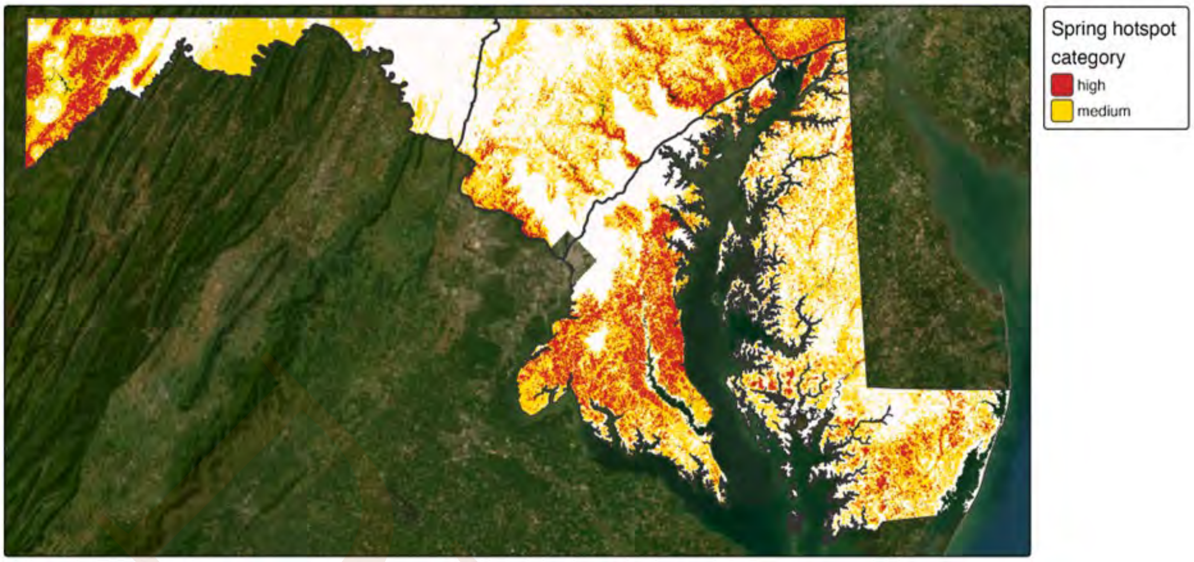


Figure 3.2 Importance of spring stopover hotspots within each bird conservation region of Maryland (Montane, Piedmont, and Coastal Plain).

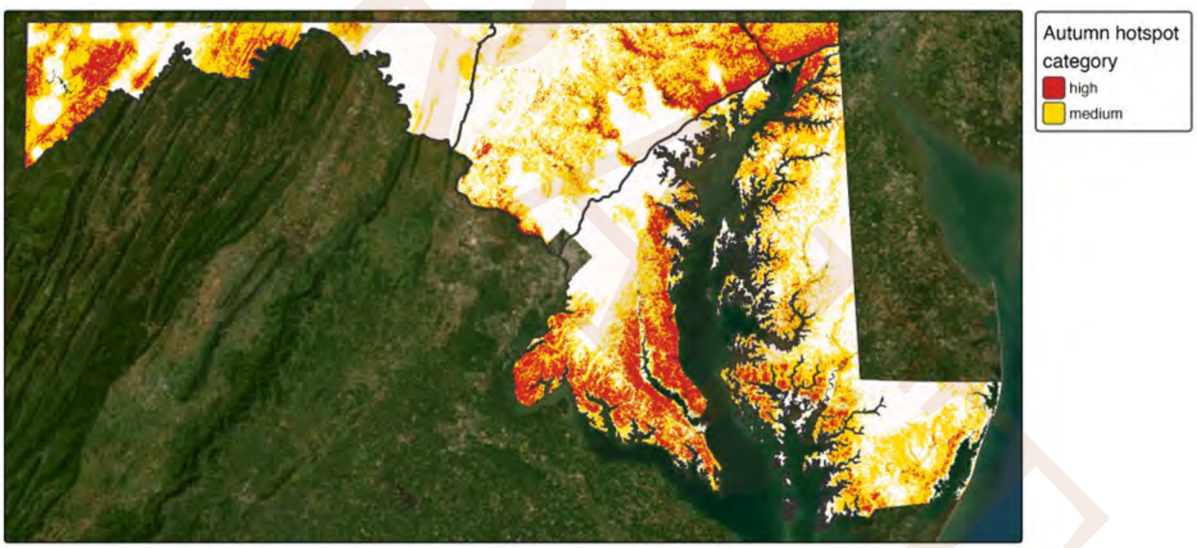


Figure 3.3 Importance of autumn stopover hotspots within each bird conservation region of Maryland (Montane, Piedmont, and Coastal Plain).

Several general threats to birds also affect SGCN to differing degrees. Collisions with wind turbines, cell towers, building windows, and other human structures kill many thousands of birds each year. During migration, landbirds are especially vulnerable to these collisions. The Threatscape threat index (Cabrera-Cruz et al., in preparation) (Figure 3.4) is a measure of the potential collision mortality risk from six sources: aircraft, buildings, communication towers, power lines, roads, and wind turbines. The spatial distribution of collision risk varies across Maryland and is highest in densely urbanized areas where multiple threat sources are present, but birds are vulnerable to collision wherever structures occur. Risk from at least one collision source occurs across most of the state, even in suburban and rural locations.

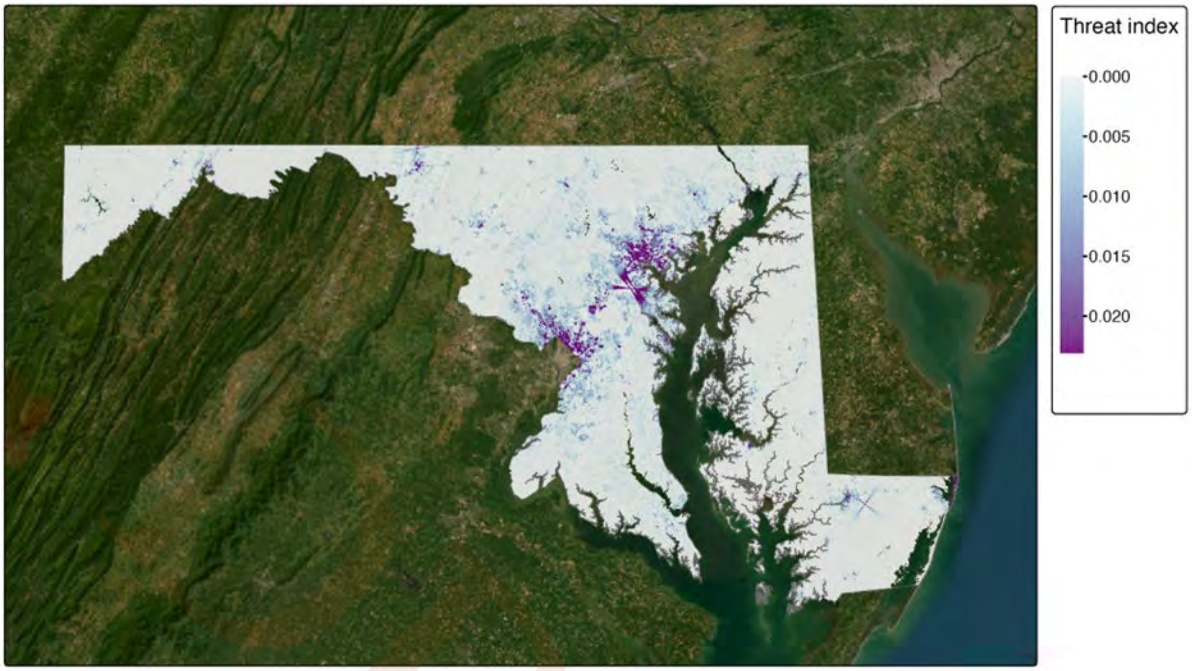


Figure 3.4 Potential risk of mortality from collisions with anthropogenic structures ("Threatscape" threat index; Cabrera-Cruz et al., in preparation).

Timbering activities in certain habitats during the breeding season may impact nesting forest birds. West Nile virus and other diseases may have significantly reduced populations of some species such as ruffed grouse *(Bonasa umbellus)* and American goshawk. SGCN face competition for nest sites with introduced bird species, and free-ranging domestic cats are estimated to kill billions of birds annually in the U.S. (Loss et al. 2013). Finally, aside from more direct threats such as sea-level rise, climate change has led to phenological mismatches for a number of bird species, aerial insectivores in particular. This is because aerial insectivores tend to be neotropical migrants, rely on insects being available when they migrate, and have few alternative food sources. Climate change has altered the timeframes of both insect and bird ecological functions, leading to less overlap and therefore a reduced food source during the migratory season.

Conservation Actions and Information Needs for Bird SGCN

State and regional efforts to identify conservation actions and information needs for birds has been extensive, more so than for any other SGCN taxonomic group. For example, Partners in Flight has produced conservation plans that include Maryland SGCN, and Bird Conservation Region plans have been completed, or species of concern have otherwise been identified, for all the regions in Maryland designated by the North American Bird Conservation Initiative. Recommendations for waterbird, seabird, shorebird, and waterfowl SGCN are included in other regional plans. These plans help to provide population targets and landscape-level habitat information that can be used to identify priority areas for conservation through acquisition and easement programs, as well as habitat restoration.

Particularly needed are habitats for area-sensitive and northern habitat species, as well as those species requiring a mosaic landscape of particular habitats. The designation of Important Bird

Areas (IBA) by Audubon Maryland-DC assists with this effort by identifying habitats supporting suites of SGCN and working to protect them. In addition, information needs and conservation actions for breeding federally-listed species (e.g., piping plover, red-cockaded woodpecker) can be found in their respective recovery plans. Support for the recovery plans for federally listed Endangered and Threatened species is included in the implementation of the SWAP (Table 3.11). Partnerships like the Maryland Bird Conservation Partnership are key to networking and coordinating the efforts of local and regional groups for the most effective and efficient conservation of Maryland's bird SGCN and their habitats.

Given the mobility of birds, planning at the landscape level and the consideration of species' needs during their full life cycle is particularly important. Coordination of monitoring for birds and the use of standardized protocols are likewise important to assess population status and trends across broad landscapes (Lambert et al. 2009). To address the special needs of bird SGCN, more information continues to be needed on significant migratory corridors, stopover areas, and overwintering requirements; area sensitivity (forest, grassland, shrubland, and marsh species); and nocturnal species and marine birds. Even for some more well-studied SCGN species, details of their habitat requirements and impacts of threats throughout their life cycle are not understood well enough for effective conservation. Building on information collected during the most recent Breeding Bird Atlas (2020–2024) could help to fill information gaps for select species and indicate where improvements in habitat conservation and restoration could be most beneficial for bird SGCN. Maps of migration stopover hotspots (Figure 3.5) can help direct land easement and acquisition efforts as well as management for critical food resources, which change with the migration season.

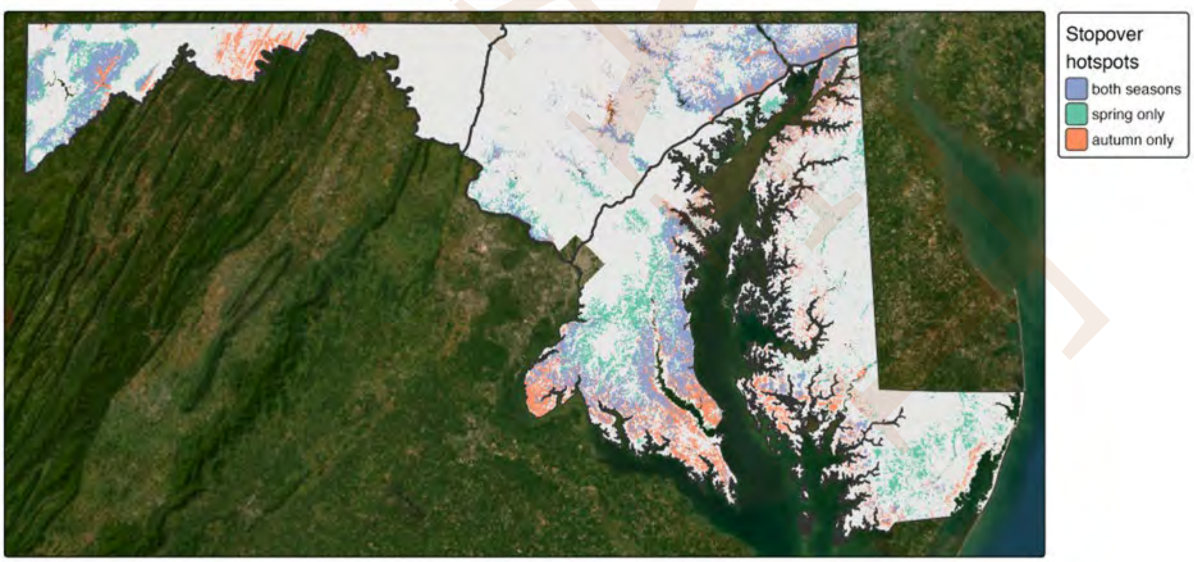


Figure 3.5 Seasonal importance of stopover hotspots within each bird conservation region of Maryland.

Fragmentation and habitat destruction for forest interior as well as area-sensitive grassland species can be limited by protecting the remaining large blocks of unfragmented forests and grasslands, controlling urban sprawl through implementation of the state's smart growth initiatives, smart siting of energy developments and transportation corridors, improving plans for timber harvests, appropriate siting of trails and recreation areas, and limiting the conversion of forests to monotypic pine plantations. Work with the public can encourage the protection of SGCN at migratory stopover sites, beach-nesting sites, and waterbird nesting colonies, and it can also help control the threat of predation by free-ranging cats. Programs that encourage private landowners to create or preserve habitat are key for several SGCN.

Control of introduced and invasive species, predators, and deer populations continues to be needed to conserve some nesting bird species. Food resources of bird SGCN can be protected by limiting the use of certain pesticides and the overharvest of horseshoe crabs and forage fish. Encouraging farming practices, utility right-of-way management, and reclaimed strip mine practices that favor grassland and shrub-scrub nesting species—practices such as late mowing, hedgerow establishment, and reduced pesticide use—can benefit a number of grassland and early successional forest bird SGCN. Best Management Practices (BMPs), such as those created for Virginia Piedmont birds (Wolter et al. 2008) and golden-winged warbler habitats in the Appalachian region (Golden-winged Warbler Working Group 2013), can be good sources for conservation practices for bird SGCN. Creation of additional BMPs would be beneficial in many instances, especially for work with private and public land managers.

Collaboration is vital in the realm of bird conservation work. In order to minimize and monitor mortality due to collisions with structures, for example, it will be vital to work with a variety of partners to develop, encourage, and implement practices that minimize the use of inappropriate lighting at night. Continued research is needed to better understand the impacts of diseases like West Nile virus and highly pathogenic avian influenza (HPAI) as well. An increase in research and better synthesis of data between invertebrate and bird monitoring efforts would help to conserve insectivorous bird populations.

Finally, in the absence of once-available natural resources and/or cycles, human intervention can act as a stand-in when necessary. Restoration of natural fire frequencies, shoreline processes, and beaver populations can create breeding habitat for certain SGCN. The temporary deployment of tern nesting rafts (i.e., artificial islands) and the creation of small coastal islands to replace those that have been lost contribute greatly to the persistence of breeding colonial waterbirds. Retention and improvement of aquatic and wetland habitats for bird SGCN can be achieved by controlling *Phragmites*, restoring marshes, enforcing wetland protection laws, limiting excess nutrient and pollutant inputs, and reducing bycatch by commercial fisheries.

Table 3.11 Existing federal recovery plans for bird SGCN

Bird Species	Federal Recovery Plan	Recent Action
Black rail	USFWS 2025 Draft	2025: Draft recovery plan
Piping plover	USFWS 1996	2024: Initiation of 5-year review
Red-cockaded woodpecker	USFWS 2003	2018: 5-year review, summary, & evaluation
Roseate tern	USFWS 1998	2025: Initiation of 5-year review
Rufa red knot	USFWS 2023	2023: Finalized recovery plan

Table 3.12 Bird SGCN in Maryland

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Acadian flycatcher	*Empidonax virescens*	G5	S5B			C
Alder flycatcher	*Empidonax alnorum*	G5	S2B		I	B
American barn owl	*Tyto furcata*	G5	S2B		I	B
American bittern	*Botaurus lentiginosus*	G5	S1B		T	A
American black duck	*Anas rubripes*	G5	S3S4B			C
American goshawk	*Astur atricapillus*	G5	SHB		E*	E
American kestrel	*Falco sparverius*	G5	S3S4B			C
American oystercatcher	*Haematopus palliatus*	G5	S3B			C
American peregrine falcon	*Falco peregrinus anatum*	G4T4	S2S3		I	B
American redstart	*Setophaga ruticilla*	G5	S3S4B			C
American woodcock	*Scolopax minor*	G5	S3S4B			C
Bald eagle	*Haliaeetus leucocephalus*	G5	S3S4			C
Baltimore oriole	*Icterus galbula*	G5	S4B			C
Bank swallow	*Riparia riparia*	G5	S3B			C
Bicknell's thrush	*Catharus bicknelli*	G4	S2M			B
Black rail	*Laterallus jamaicensis*	G3	S1	T	E	A
Black scoter	*Melanitta americana*	G5	S3N			C
Black skimmer	*Rynchops niger*	G5	S1B		E	A
Black-and-white warbler	*Mniotilta varia*	G5	S4B			C
Black-bellied plover	*Pluvialis squatarola*	G5	S3N			C
Black-billed cuckoo	*Coccyzus erythropthalmus*	G5	S3B			C
Black-crowned night heron	*Nycticorax nycticorax*	G5	S2S3B			B
Black-legged kittiwake	*Rissa tridactyla*	G5	S3N			C
Black-throated blue warbler	*Setophaga caerulescens*	G5	S3S4B			C

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Black-throated green warbler	*Setophaga virens*	G5	S4B			C
Blackburnian warbler	*Setophaga fusca*	G5	S3B			C
Blue-winged teal	*Spatula discors*	G5	S1B			A
Blue-winged warbler	*Vermivora cyanoptera*	G5	S3B			C
Boat-tailed grackle	*Quiscalus major*	G5	S3B			C
Bobolink	*Dolichonyx oryzivorus*	G5	S3B			C
Brant	*Branta bernicla*	G5	S3N			C
Broad-winged hawk	*Buteo platypterus*	G5	S3B			C
Brown creeper	*Certhia americana*	G5	S3B			C
Brown pelican	*Pelecanus occidentalis*	G4	S1B			A
Canada warbler	*Cardellina canadensis*	G5	S2B			B
Canvasback	*Aythya valisineria*	G5	S3S4N			C
Cerulean warbler	*Setophaga cerulea*	G4	S3B			C
Chimney swift	*Chaetura pelagica*	G4G5	S5B			C
Chuck-will's-widow	*Antrostomus carolinensis*	G5	S3S4B			C
Coastal Plain swamp sparrow	*Melospiza georgiana nigrescens*	G5T3	S2B		I	A
Common gallinule	*Gallinula galeata*	G5	S2S3B		I	B
Common goldeneye	*Bucephala clangula*	G5	S2N			B
Common loon	*Gavia immer*	G5	S3S4N			C
Common nighthawk	*Chordeiles minor*	G5	S1B			A
Common tern	*Sterna hirundo*	G5	S1B		E	A
Cory's shearwater	*Calonectris borealis*	GNR	S3N			C
Dark-eyed junco	*Junco hyemalis*	G5	S3B			C
Dickcissel	*Spiza americana*	G5	S3B			C
Dunlin	*Calidris alpina*	G5	S3N			C
Eastern meadowlark	*Sturnella magna*	G5	S4B			C

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Eastern whip-poor-will	*Antrostomus vociferus*	G5	S3S4B			C
Forster's tern	*Sterna forsteri*	G5	S2B		I	B
Gadwall	*Mareca strepera*	G5	S1S2B			A
Glossy ibis	*Plegadis falcinellus*	G5	S1B			A
Golden eagle	*Aquila chrysaetos*	G5	S1N			A
Golden-crowned kinglet	*Regulus satrapa*	G5	S3B			C
Golden-winged warbler	*Vermivora chrysoptera*	G3	S1B		I	A
Grasshopper sparrow	*Ammodramus savannarum*	G5	S4B			C
Great blue heron	*Ardea herodias*	G5	S4B			C
Great egret	*Ardea alba*	G5	S3B			C
Greater scaup	*Aythya marila*	G5	S4N			C
Greater yellowlegs	*Tringa melanoleuca*	G5	S3M			C
Gull-billed tern	*Gelochelidon nilotica*	G5	SHB		E	E
Henslow's sparrow	*Centronyx henslowii*	G4	S1S2B		I	A
Hooded warbler	*Setophaga citrina*	G5	S3S4B			C
Horned grebe	*Podiceps auritus*	G5	S4N			C
Ipswich sparrow	*Passerculus sandwichensis princeps*	G5T1	S1N			A
Kentucky warbler	*Geothlypis formosa*	G5	S3S4B			C
King rail	*Rallus elegans*	G4	S2B			B
Laughing gull	*Leucophaeus atricilla*	G5	S1B			A
Leach's storm-petrel	*Hydrobates leucorhous*	G5	S2N			B
Least bittern	*Botaurus exilis*	G4	S3B		I	C
Least flycatcher	*Empidonax minimus*	G5	S3B			C
Least tern	*Sternula antillarum*	G4	S2B		T	B
Lesser scaup	*Aythya affinis*	G5	S4N			C
Lesser yellowlegs	*Tringa flavipes*	G5	S2S3N			B
Little blue heron	*Egretta caerulea*	G5	S1B			A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Loggerhead shrike	*Lanius ludovicianus*	G4	SHB		E	E
Long-eared owl	*Asio otus*	G5	S1B			A
Long-tailed duck	*Clangula hyemalis*	G5	S3N			C
Louisiana waterthrush	*Parkesia motacilla*	G5	S4S5B			C
Magnolia warbler	*Setophaga magnolia*	G5	S3S4B			C
Marsh wren	*Cistothorus palustris*	G5	S3S4B			C
Mourning warbler	*Geothlypis philadelphia*	G5	S1B		E	A
Nashville warbler	*Leiothlypis ruficapilla*	G5	S1B		T	A
Nelson's sparrow	*Ammospiza nelsoni*	G5	S1N			A
Northern bobwhite	*Colinus virginianus*	G4G5	S3S4			C
Northern gannet	*Morus bassanus*	G5	S3N			C
Northern harrier	*Circus hudsonius*	G5	S2B		I	B
Northern parula	*Setophaga americana*	G5	S4S5B			C
Northern saw-whet owl	*Aegolius acadicus*	G5	S1B			A
Northern waterthrush	*Parkesia noveboracensis*	G5	S2B		I	B
Olive-sided flycatcher	*Contopus cooperi*	G4	SHB		X	E
Ovenbird	*Seiurus aurocapilla*	G5	S4S5B			C
Pied-billed grebe	*Podilymbus podiceps*	G5	S2S3B			B
Pine siskin	*Spinus pinus*	G5	S1B			A
Piping plover	*Charadrius melodus*	G3	S1B	T	E	A
Prairie warbler	*Setophaga discolor*	G5	S4B			C
Prothonotary warbler	*Protonotaria citrea*	G5	S4B			C
Red phalarope	*Phalaropus fulicarius*	G5	S3N			C
Red-breasted nuthatch	*Sitta canadensis*	G5	S3B			C
Red-cockaded woodpecker	*Leuconotopicus borealis*	G3	SHB	T	X	E

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Red-necked phalarope	*Phalaropus lobatus*	G4G5	S3M			C
Red-throated loon	*Gavia stellata*	G5	S3S4N			C
Redhead	*Aythya americana*	G5	S2N			B
Roseate tern	*Sterna dougallii*	G4	SXB	E	X	E
Royal tern	*Thalasseus maximus*	G5	S1B		E	A
Ruddy turnstone	*Arenaria interpres*	G5	S1N			A
Rufa red knot	*Calidris canutus rufa*	G4T2	S1M	T	T	A
Ruffed grouse	*Bonasa umbellus*	G5	S3			C
Rusty blackbird	*Euphagus carolinus*	G4	S2S3N			B
Saltmarsh sparrow	*Ammospiza caudacuta*	G2	S2B		I	A
Sanderling	*Calidris alba*	G5	S3N			C
Sandwich tern	*Thalasseus sandvicensis*	G5	S1B			A
Sargasso shearwater	*Puffinus lherminieri*	G4G5	S3N			C
Savannah sparrow	*Passerculus sandwichensis*	G5	S3B			C
Scarlet tanager	*Piranga olivacea*	G5	S4S5B			C
Seaside sparrow	*Ammospiza maritima*	G4	S3S4B			C
Sedge wren	*Cistothorus stellaris*	G5	S1B		E	A
Semipalmated sandpiper	*Calidris pusilla*	G5	S3M			C
Sharp-shinned hawk	*Accipiter striatus*	G5	S2B			B
Short-billed dowitcher	*Limnodromus griseus*	G3	S3M			B
Short-eared owl	*Asio flammeus*	G5	S1B		E	A
Snowy egret	*Egretta thula*	G5	S2B			B
Sora	*Porzana carolina*	G5	S1B,S3M			B
Spotted sandpiper	*Actitis macularius*	G5	S3B			C
Surf scoter	*Melanitta perspicillata*	G5	S4N			C
Swainson's thrush	*Catharus ustulatus*	G5	SHB		X	E

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Swainson's warbler	*Limnothlypis swainsonii*	G4	S1B		E	A
Swamp sparrow	*Melospiza georgiana*	G5	S3B			C
Tricolored heron	*Egretta tricolor*	G5	S1B			A
Upland sandpiper	*Bartramia longicauda*	G5	S1B		E	A
Veery	*Catharus fuscescens*	G5	S3S4B			C
Vesper sparrow	*Pooecetes gramineus*	G5	S3B			C
Whimbrel	*Numenius phaeopus*	G5	S2M			B
White-winged scoter	*Melanitta deglandi*	G5	S2N			B
Willet	*Tringa semipalmata*	G5	S3B			C
Willow flycatcher	*Empidonax traillii*	G5	S3S4B			C
Wilson's plover	*Anarhynchus wilsonia*	G5	SHB		E	E
Winter wren	*Troglodytes hiemalis*	G5	S2B			B
Wood thrush	*Hylocichla mustelina*	G4	S5B			C
Worm-eating warbler	*Helmitheros vermivorum*	G4G5	S4B			C
Yellow warbler	*Setophaga petechia*	G5	S4B			C
Yellow-breasted chat	*Icteria virens*	G5	S4B			C
Yellow-crowned night heron	*Nyctanassa violacea*	G5	S3B			C
Yellow-throated vireo	*Vireo flavifrons*	G5	S4B			C

[1] = See Table 3.5 for S-rank and G-rank definitions
[2] = T (Threatened); E (Endangered); I (In Need of Conservation); X (Endangered Extirpated)
[3] = See Table 3.7 for Conservation Status definitions
* = a qualifier denoting the species is listed in a limited geographic area only

Reptiles and Amphibians of Maryland

Maryland herpetofauna, also known as “herps,” includes 42 amphibian and 47 reptile species that are native inhabitants of the state. Of these 89 species, more than half (48) are considered SGCN in Maryland, with an additional five listed as SAPS. The first few subsections of this section are dedicated to describing the general state and requirements of all herpetofauna in the state, whereas the latter subsections are dedicated solely to these 48 SGCN.

Although reptiles and amphibians are often found in the same habitats, moist-skinned amphibians are most abundant in cool, damp forests, such as those of the western counties, and in or near aquatic or wetland habitats throughout the state. By contrast, most reptiles (snakes, lizards, and some kinds of turtles) are more suited to warm and dry environments, where their dry and relatively impermeable skin conserves water. Amphibians generally are intolerant of even low concentrations of salt water, but the marine environment is not a barrier to a number of reptiles in Maryland, most notably sea turtles.

MD DNR and the Natural History Society of Maryland concluded a five-year-long Maryland Amphibian and Reptile Atlas (MARA) survey project in 2015. This effort updated the previously published complete account of Maryland herps (Harris 1975), which had become out of date. Johns Hopkins University Press published *The Maryland Amphibian and Reptile Atlas* (Cunningham & Nazdrowicz 2018), which documents species accounts with life history information and distribution results of Maryland's herpetofauna (see *Case Study* below for additional information on MARA).

Reptiles

Native reptile species in Maryland include 18 turtles, 6 lizards, and 23 snakes. Maryland's 18 turtles range from the highly aquatic eastern spiny softshell *(Apalone spinifera)* and the terrestrial eastern box turtle *(Terrapene carolina)* to the five sea turtles that visit offshore ocean waters, the Chesapeake Bay, and Maryland's coastal estuaries during the warmer months. Although most other turtles cannot tolerate brackish water, the diamond-backed terrapin *(Malaclemys terrapin)* lives primarily in this habitat, and a few primarily freshwater species, such as snapping turtle and eastern mud turtle *(Kinosternon subrubrum)*, sometimes venture into brackish habitats. Most of the other species are stream and pond inhabitants, such as the widespread painted turtle and northern red-bellied cooter. Most species have a varied diet, though the state-Endangered northern map turtle *(Graptemys geographica)* feeds primarily on mollusks, including native mussels and snails as well as invasive species like zebra mussels or mystery snails (Gacheny et al. 2021).

Maryland's six lizards are small, four-legged, slender, and long-tailed reptiles. The common five-lined skink and the eastern fence lizard are widespread and, by inference, tolerate a wide range of habitats. The little brown skink, however, is restricted to the eastern half of the state; lizard SGCN also have restricted ranges, as discussed in later subsections. Lizards are frequently found in more open, sunnier, and drier habitats, including light gaps in forests or barren areas.

The 23 documented native snake species in Maryland range from the tiny, earthworm-like eastern wormsnake to the thick-bodied, heavy, and venomous timber rattlesnake *(Crotalus horridus).* About half of Maryland snakes lay eggs and the rest give live birth, with females retaining eggs during development. Maryland's snakes are carnivorous, eating a range of foods from invertebrates to small mammals. Some

Timber rattlesnake (Scott Smith, MD DNR) have specialized diets, such as the Endangered rainbow snake *(Farancia erytrogramma)* that feeds primarily on eels; the rarely seen queensnake *(Regina septemvittata),* which feeds on recently molted (i.e., soft) crayfish; and the eastern hog-nosed snake, which focuses on toads. Most snakes are terrestrial or even arboreal, and a few, such as the watersnakes, are semiaquatic. Only two species in Maryland are venomous, the aforementioned timber rattlesnake and copperhead *(Agkistrodon contortrix).*

Amphibians

Maryland's list of documented native amphibians includes 22 salamanders and 20 frogs and toads. Additionally, a single siren population (species currently undetermined) occurs in a lake near College Park. This population was likely introduced.

Longtail salamander (Eurycea longicauda) (Mark Tegges)

Many amphibians require vernal or other fish-free ponds, slow-moving streams, springs, or non-tidal wetlands for breeding. Nearly all of the 22 species of salamanders found in Maryland are associated with these freshwater aquatic environments, with a few notable exceptions, such as the widespread and completely terrestrial eastern red-backed salamander. Many salamanders spend the winter hibernating underground and beneath rocks and logs and then travel to seek traditional aquatic breeding sites shortly after emergence from hibernation in late winter or early spring. When habitats are fragmented, it often becomes difficult or impossible for these salamanders to reach breeding sites—desiccation occurs when formerly shaded forests dry out, predation increases when cover is lost, and mortality results when adults try to cross roads. If their wetland breeding sites and surrounding upland buffers are altered or destroyed, then breeding may become impossible, unless alternative sites can be found (Semlitsch & Bodie 2003).

Although all Maryland frog and toad species lay eggs in water, toads and some frogs are terrestrial as adults, the latter living in cool, damp habitats where their moist skin does not readily desiccate. Each species of frog and toad has a distinctive mating call, usually made at night in spring and summer when most breeding activity occurs. After breeding, most frogs and toads go silent, and then their presence is much harder to detect.

Reptile and Amphibian SGCN of Maryland

Forty-eight species of amphibians and reptiles have been identified by the SWAP process as SGCN in Maryland (Table 3.14), with an additional five on the SAPS list not covered in this chapter. Of these 48 SGCN, 19 are amphibians and 29 are reptiles. Five reptile SGCN are listed as federally Endangered or federally Threatened: bog turtle *(Glyptemys muhlenbergii),* green sea turtle *(Chelonia mydas),* and loggerhead sea turtle *(Caretta caretta)* are listed as Threatened, and the Kemp's ridley *(Lepidochelys kempii)* and leatherback *(Dermochelys coriacea)* sea turtles are listed as Endangered. Eight amphibian SGCN and 10 reptile SGCN are state-listed, including 6 amphibians and 9 reptiles listed as Threatened or Endangered; 1 amphibian and 1 reptile listed as In Need of Conservation; and 1 amphibian listed as Endangered Extirpated. Furthermore, 2 amphibian and 9 reptile SGCN are of international concern (IUCN 2026), and 8 amphibian and 17 reptile SGCN are of conservation concern in the Northeastern U.S. region (TCI & NEFWDTC 2023). For more explanation and additional ranks, see Appendices 3a and 3b.

Freshwater Reptile and Amphibian SGCN

Most of Maryland's freshwater aquatic and wetland SGCN herpetofauna are amphibians, although many turtles and a few snakes also have aquatic affinities. The 19 amphibian SGCN exhibit a wide range of dependency on watery habitats during their lifetime. At one extreme is the eastern hellbender *(Cryptobranchus alleganiensis)*, which is wholly aquatic and spends its entire life submerged in boulder-strewn rivers in western Maryland. At the other extreme, species like Wehrle's salamander *(Plethodon wehrlei)* and green salamander *(Aneides aeneus)* can live on mountain tops and in other drier habitats by finding cool, moist crevices in boulders and caves and moist soils under rocks and logs, as well as by foraging at night. The majority of the 14 salamanders and five frogs and toads on the SGCN list require vernal pools, ponds, springs, or streamside wetlands for reproduction. After mating and laying eggs, the adults may remain nearby while the eggs develop into larval forms (i.e., tadpoles) before transforming into adults and leaving their watery habitats. Species particularly dependent on vernal pools and Delmarva Bay habitats include barking treefrog *(Dryophytes gratiosus)*, carpenter frog *(Lithobates virgatipes)*, eastern tiger salamander *(Ambystoma tigrinum)*, Jefferson salamander *(Ambystoma jeffersonianum)*, and upland chorus frog *(Pseudacris feriarum)*.

Eastern hellbender (Cryptobranchus alleganiensis)
(Lori Pruitt, USFWS)

Four of Maryland's amphibian species belong to *Ambystomatidae*, the mole salamanders, a family in which the rate of population decline is greater than the average for all other amphibians (Stuart et al. 2004). One of these four species, the eastern tiger salamander, is state-listed as Endangered in Maryland.

Three new native species have also been identified in Maryland in recent years. All three are included in the SWAP in some capacity: striped mud turtle *(Kinosternon baurii)* on the SGCN list, Atlantic coast leopard frog and southern two-lined salamander on the SAPS list. The striped mud turtle was first documented in southern Maryland after the release of the 2015 SWAP revision and has since been observed on the Eastern Shore as well. The Atlantic Coast leopard frog was first identified in 2012 and described in 2014 (Newman et al 2012, Feinberg et al 2014).

The southern two-lined salamander was discovered as occurring on the state's southern Eastern Shore in 2008. These species were previously overlooked due to their similarity to other native species. Our knowledge of the Maryland distribution and life history of these species is still limited and in need of additional research—though we know enough about the striped mud turtle to have some understanding of its needs, hence its 2025 addition to the SGCN list.

Reptile SGCN that regularly live in or near freshwater habitats include eight turtles and four snake species. Of the turtles, the eastern spiny softshell (state-listed as In Need of Conservation) and northern map turtle (state-listed as Endangered) spend much of their time submerged in larger rivers or basking on river structures, rarely leaving the water except to nest. Wood turtles *(Glyptemys insculpta*) are more terrestrial than the other riverine turtles, dividing their time between the associated floodplains and upland habitats during the active season and brumating (i.e., overwintering) in coldwater streams during the winter. The spotted turtle *(Clemmys guttata)* and especially the bog turtle inhabit freshwater wetlands, only occasionally making movements away from the water. Wetland-dependent snake SGCN include eastern ribbonsnake *(Thamnophis sauritus)* and plain-bellied watersnake *(Nerodia erythrogaster)*, formerly known as red-bellied watersnake. Queensnakes occur in freshwater streams with abundant crayfish populations. The state-Endangered rainbow snake is limited to southern sections of the Potomac River and lives in tributary streams, marshes, and swamps as it hunts eels and other aquatic prey at night.

Reptile SGCN of Upland Habitats

Most of the remaining reptile SGCN are primarily associated with upland forests, rock outcrops, open fields, grassy glades, and other terrestrial habitats. The well-known eastern box turtle lives in moist and dry forests throughout much of Maryland, though habitat loss and diseases are negatively impacting many of these populations. A new population of the state-Endangered northern coal skink *(Plestiodon anthracinus)* was discovered in western Maryland in 2013; however, the shale barren habitat where it was found is scarce and considered a rare habitat in the state. A number of snakes associated with upland habitats are secretive, living underground or otherwise hidden, and are difficult to survey, such as the northern mole kingsnake *(Lampropeltis rhombomaculata)*. This species, along with smooth greensnake *(Opheodrys vernalis)*, is found in meadows and open woods, with the latter species restricted to western Maryland. The mountain earthsnake *(Virginia valeriae pulchra)* and timber rattlesnake are also restricted to western Maryland today, although the timber rattlesnake historically occurred further east into the Piedmont.

Marine and Estuarine Reptile SGCN

Maryland's marine turtles are large to massive, have their forefeet modified as flippers, and have specialized salt glands to maintain proper water balance while living in the marine environment. Most observations of these turtles come from documentation of sea turtle strandings along Maryland's coastline and in the Chesapeake Bay, or capture in fishing nets and fish traps. However, the loggerhead sea turtle has been documented successfully nesting on the beaches of Assateague Island. Most sea turtles observed in the Chesapeake and Coastal Bays are juveniles and non-breeding subadults, which use these estuaries to feed on various crabs, mollusks, and other invertebrates during the warmer summer months.

Leatherback sea turtle (Dermochelys coriacea)
(George Jett)

The two most common species in Maryland are the loggerhead and Kemp's ridley sea turtles; the MARA project documented 51 sightings in 40 atlas blocks for the former and 13 blocks for the latter (Cunningham & Nazdrowicz 2018). Leatherback and green sea turtles are reported less widely, with 7 and 2 atlas blocks, respectively. The Atlantic hawksbill has only been documented in the ocean well off Maryland's coast; in fact, it has been relegated to the SAPS list for the 2025 SWAP revision due to this lack of data and documentation, leaving four remaining sea turtle SGCN.

The only truly estuarine reptile in Maryland, the diamond-backed terrapin, is designated as Maryland's state reptile and is one of the Chesapeake's most iconic creatures. It lives in brackish waters and coastal marshes and lays its eggs on sandy beaches and bay islands from late May to early July. Historically, this turtle was a food source for Native Americans and early European colonists. Many thousands of pounds of terrapins were harvested and sold annually into the early 1900s. The market for this species was greatly reduced over the next half-century, but the high demand in Asian markets beginning in the 1990s added significant pressure on the population (Kennedy 2018). Terrapins were commercially harvested until 2007, when the Maryland legislature enacted a ban on commercial take and limited possession (Maryland Natural Resources Code §4-902).

Threats to Reptile and Amphibian SGCN

Globally, amphibian and reptile populations are in decline (IUCN 2026). This is the result of a combination of threats of varying severity, including habitat loss, pollution, climate change, disease, invasive species, and over-exploitation (Cox et al. 2022, Leudtke et al. 2023). According to the IUCN, amphibians are the most threatened vertebrate group, with 40.7% of amphibians globally threatened (Leudtke et al. 2023). Reptiles are third, behind mammals, with 21.1% of species globally threatened (Cox et al. 2022). Besides direct threats to populations, amphibian and reptile SGCN also rely on many Key Wildlife Habitats (Chapter 4), from the Delmarva Bays and sandy dunes of the Eastern Shore to the hardwood forests and coldwater streams of the Piedmont and Appalachian Plateau. All these habitats are impacted by one or more threats.

Almost all amphibian SGCN rely on freshwater streams, vernal pools, ponds, or other freshwater wetlands for all or some of their life stages. The 22 species of salamanders found in Maryland may be negatively impacted by urbanization and associated alterations of stream habitat (Price et al. 2011). Threats such as pollution, acid mine drainage, and sedimentation due to erosion and run-off from impervious surfaces may seriously impact populations of these species by making water conditions unsuitable (Barrett & Price 2014). Per- and polyfluoroalkyl substances (PFAS), which have been used in products for decades, pose another threat to aquatic reptiles and amphibians (Gonkowski & Ochoa-Herrera 2024). Exposure in the aquatic environment, as well as through diet, may impact populations directly and the food web more broadly through bioaccumulation and biomagnification (Flynn et al. 2021, 2022). As long-lived animals, turtles may be particularly vulnerable to these "forever chemicals," which have the potential to accumulate in tissues over time (Beale et al. 2022a,b).

The impacts of deforestation include changes in water temperature, soil temperature, sedimentation, and a decrease in organic inputs that maintain a food base for amphibian SGCN. These threats are especially of concern in western Maryland, where nine of the 13 salamander SGCN are found. Wehrle's and green salamanders, for example, rely on moist rock crevices and associated arboreal habitat, making them especially vulnerable to the destruction of rock outcrops and the removal of surrounding forest canopy that alters substrate moisture (Corser 2001, Waldron & Humphries 2005, Brand et al. 2014). Forest reptiles such as mountain earthsnake and eastern box turtle are also threatened by deforestation and fragmentation due to timber harvests, habitat conversion, and road construction. Furthermore, the natural process of forest succession can negatively impact species that have restricted ranges due to habitat loss. Timber rattlesnakes and copperheads, which also rely on rock outcrops for multiple biological processes (e.g., hunting, basking, and hibernation), are threatened by encroachment on these limited sites (Ernst & Ernst 2012). Eastern tiger salamanders reproduce in Delmarva Bays on the Eastern Shore, where forest succession limits their habitat as well.

Bog turtle (Glyptemys muhlenbergii) (USFWS)

In some areas of the state, hydrological changes and groundwater withdrawal threaten the continued presence of critical water bodies for aquatic species. The loss of beaver impoundments, overgrazing, and ditching and draining of marshes and wetlands have further impacted populations of some amphibians and reptiles through the loss of habitat, including the federally listed bog turtle (Zappalorti 2023). The bog turtle has been on the Turtle Conservation Coalition's list of the world's most endangered tortoises and freshwater turtles since 2003 and is considered critically threatened (TCC 2018, 2025). Aquatic snakes (e.g., rainbow snake and plain-bellied watersnake) and turtles that rely on riverine and pool habitats (e.g., wood turtle, eastern spiny softshell, and northern map turtle) face threats similar to amphibian SGCN. Runoff from impervious surfaces and open upland after heavy rain events can cause catastrophic flooding that displaces or kills vulnerable individuals (Norden 1999, Nickerson et al. 2007, Jones & Sievert 2009, Unger et al. 2021, Goncalves et al. 2024). Hibernating turtles can be especially susceptible to these events (Jones & Sievert 2009, Hillman & Waling 2025). Alterations to natural stream flow for hydroelectric power may also change hydrology in ways that negatively impact species. High flow rates from dam releases for electric generation as well as recreational activities alter habitat and impact biological processes of state-Endangered species like the eastern hellbender and the northern map turtle (Gacheny et al. 2021, Bárcenas-García et al. 2022).

Species' use of different habitats at different times of the year for breeding, overwintering, and development further increases the vulnerability to landscape-level fragmentation and the loss of travel corridors (Jackson et al. 2015). Movements between these habitats frequently result in road mortalities negatively impacting populations of frogs and toads, salamanders, turtles, and snakes (Marsh & Jaeger 2015, Howell & Seigel 2019). In the marine environment, sea turtles and terrapins are subject to boat collisions. and propeller strikes, entanglement and incidental take in fishing nets, predation of nests, human disturbance along nesting beaches, and ingestion of trash. The diamond-backed terrapin is also threatened as a non-target capture (i.e., bycatch) in commercial and recreational crab traps (Chambers & Maerz 2018). In addition, shoreline development and structural stabilization often cut off access to or altogether eliminate nesting areas for the terrapin and northern map turtle (Winters et al. 2015, Levasseur et al. 2023). Projects that include living shorelines with habitat or attenuating structures that reduce erosion but allow movement between water and land are currently being implemented and may benefit species like diamondback terrapins while also protecting homes (Grothues et al. 2025).

A significant cause of decline for reptiles and amphibians is overcollection and illegal trade. These groups are increasingly threatened by collection for food, medicinal purposes, and the pet trade (Stuart et al. 2004, Rosen & Smith 2010, Luiselli et al. 2016, Easter et al. 2023). The life history characteristics of turtles in particular make them at risk of population declines, as they are slow to reach reproductive maturity and have incredibly low egg and juvenile survival. Tackling this issue of illegal and unsustainable trade is made more difficult by barriers that include insufficient funding, capacity shortages, and lack of data (Sevin et al. 2022, Wixted & Christman 2022, Wixted 2024, Christman et al. 2025). Snakes in general and venomous snakes in particular are harassed and often killed when perceived to be a threat. The hibernacula of timber rattlesnakes are particularly vulnerable to harassment, destruction, and illegal collecting activities. Human activity in sensitive habitats—even those that seem innocuous—could do harm. For example, moving rocks in streams to create rock cairns not only destroys essential habitat for stream dwelling species like the eastern hellbender, but has also resulted in killing individuals (Unger et al. 2017).

Reptiles and amphibians are threatened by several established pathogens, such as *Ophidiomyces ophiodiicola* (Oo), Ranaviruses (e.g., FV3), *Batrachochytrium dendrobatidis* (Bd), and *B. salamandrivorans* (Bsal), as well as some potentially emerging pathogens such as *Emydomyces testavorans* (Emte). Snake fungal disease, caused by the fungus *Ophidiomyces ophiodiicola*, was first documented in timber rattlesnakes in the northeastern U.S. in 2006 and has since been documented in wild snake populations throughout the eastern U.S. (Allender et. al. 2011, Clark et al. 2011, Lorch et. al. 2016). Ranaviruses are now known to affect over 200 reptile and amphibian species (Marschang et al. 2025), up from the estimated 100 when the previous SWAP revision was published in 2016. The virus can live for weeks outside the host in aquatic conditions and is usually fatal to juvenile individuals, although adults can also be susceptible to or transmit Ranavirus to other individuals (Brunner et al. 2025). The disease spreads quickly through populations that tend to congregate in large groups, with some infected populations suffering 90% mortality (NE PARC 2014). Bd and Bsal are chytrid fungi that cause the disease chytridiomycosis (Berger et al. 2015). Bd has been detected throughout North America, although the response to infection is variable and complex, with limited evidence of declines attributed to infection in the eastern United States (Lips 2016). However, infection combined with environmental stress could lead to high mortality and extirpation for vulnerable species like the eastern hellbender (Lips et al. 2006, Novotny et al. 2024).

Bsal has not yet been documented in North America, but the probability of its introduction is high and could lead to high biodiversity loss in the Appalachian region due to its high salamander diversity. Lab studies have shown that four of the 22 salamanders (eastern newt, green salamander, red salamander, and northern two-lined salamander) that inhabit Maryland are susceptible and considered moderate to very high conservation risk (Gray et al. 2023). Coinfection of Bd and Bsal may be even more lethal, as demonstrated in the eastern newt (Longo et al. 2019). While many salamander species have been listed as injurious wildlife and cannot be imported, there is still the potential for other popular pet-trade species that may be carriers to make it into the U.S. (AFWA 2024a). Finally, Emte—a recently described fungus that causes shell lesions—poses a serious risk to freshwater turtle populations, having been detected only recently in wild populations (Woodburn et al. 2019, Lambert et al. 2021, Fredrickson et al. 2024, White et al. 2025). Adding complexity to this disease threat, individuals may be infected with a pathogen (or more than one), and even show signs of disease, but no positive detection may be made (Daleo et al. 2025).

Conservation Actions and Information Needs for Reptile and Amphibian SGCN

In order to better conserve reptile and amphibian SGCN, the seasonal movements and needs of all life stages should be investigated for a number of species. Understanding the impacts of roads, development, and forest harvest practices on SGCN would also assist in their conservation. Direct inputs of contaminants to aquatic environments can be reduced through improved stormwater management practices, minimizing and mitigating acid mine drainage, controlling illegal dumping and wastewater inputs, minimizing the use of pesticides, and establishing adequate buffers of upland habitat. State and local wetland laws should be amended with larger buffers (i.e., life zones) as needed to protect significant habitats for amphibian and reptile SGCN. Compatible management of the landscape to conserve aquatic habitats needs to include the reduction of impervious surfaces, groundwater withdrawal, stream bank erosion, and watershed deforestation through better design and placement of developments, and improved timber harvest and agricultural practices. Restoration of key wetland habitats (e.g., beaver impoundments) and the plugging of ditches can help to address wetland losses.

Road mortality may be minimized or mitigated through improved road design and placement, as well as the installation of wildlife tunnels and causeways for safe passage corridors in key locations. For marine and estuarine turtles, collision injuries and impacts from recreational and commercial harvest activities may be reduced by working with the fishing industry, recreational boaters, and crab harvesters on various strategies. Increased education may help reduce nest disturbances of beach-nesting species. Enforcement of existing state regulations on possession and trade of amphibians and reptiles and revision of those regulations for further protection are critical (AFWA 2024b). In addition, education and outreach are needed to reduce illegal collecting and killing of reptiles and amphibians.

Other inventory needs, research needs, and actions for conservation are included in sea turtle recovery plans; the bog turtle recovery plan; and the regional plans for the box turtle, spotted turtle, wood turtle, and diamond-backed terrapin. To improve population status regionally, the USFWS, National Marine Fisheries Service (NMFS), and other partners coordinate the actions identified by the Federal Recovery Plans for some species (Table 3.13). In addition to these recovery plans, Partners for Amphibian and Reptile Conservation has used the Important Bird Areas program as a model for herpetofauna habitat conservation. The resulting 2012 Priority Amphibian and Reptile Conservation Areas Report identifies valuable habitat for priority amphibians and reptiles based on designations of species rarity and richness, local and regional implementation responsibility, and landscape integrity (PARC 2012). Most recently, the IUCN Amphibian Conservation Action Plan, which was released in 2024, includes guidance on threats, informed decision-making, and species management (Wren et al. 2024). There is also a recognized national and regional need for advocacy focused on conservation and the use of an ecosystem approach to incorporate protection of amphibian and reptilian species into existing management plans (SE PARC 2004, NE PARC 2010)

More locally, a Virginia Sea Turtle Conservation Plan provides updated research on the distribution and abundance of sea turtles in the Chesapeake and Atlantic waters of Virginia. The plan discusses threats and conservation strategies for loggerhead, Kemp's ridley, green, leatherback, and hawksbill sea turtles (Virginia DNR 2025). A recovery plan (USFWS 2001) and conservation plan (Erb 2019) for the federally listed bog turtle are being implemented in Maryland. Recent conservation plans for wood turtle (Jones et al. 2018), spotted turtle (Wiley et al. 2022), and box turtle (Roberts & Erb 2023) have also been developed with cooperation from other states in the region. These plans contain detailed status assessments, distribution information, and prioritized conservation actions based on surveys and other research results.

Case Study: Maryland Amphibian and Reptile Atlas (MARA)

Grid-based atlas projects began over 50 years ago with the Atlas of the British Flora (Perring & Walters 1962), in which 1,500 botanists mapped the distribution of 2,000 plant species to a 10-km (6.2 mi) grid. Since then, hundreds of similar atlases, many of which mapped bird distributions, have been conducted in numerous countries. Maryland has been fortunate to have completed three statewide breeding bird atlas projects: the first in 1983–1987 (Robbins & Blom 1996), the second about 20 years later in 2002–2006 (Ellison 2010), and the most recent in 2020–2024 (G. Foley, unpublished). Conclusions about changes in species distributions over those years are able to be documented throughout Maryland because of the relatively standard data gathering methods used for these atlases and the volume of data collected. This information is an essential part of assessing and documenting the conservation status of our biodiversity.

The abundance and distribution of a number of Maryland's amphibians and reptiles were thought to be in decline for many years. The increasing challenges that amphibians and reptiles face—primarily resulting from human-induced causes such as habitat loss, pollution, introduced diseases, and over-harvesting or collecting—raise concerns for their continued success and even survival. Unfortunately, sufficient data were lacking to have a good handle on the status of many herps in Maryland. Observed declines based on anecdotal evidence highlighted the need for more rigorous and complete documentation of current amphibian and reptile populations.

In the 1930s and 1940s, the Natural History Society of Maryland (NHSM) published distributional surveys of Maryland's reptile species, including *The Reptiles of Maryland and the District of Columbia* (McCauley 1945). Fifteen years later, the curator of the Department of Herpetology at the NHSM, John E. Cooper, published a paper on the distribution of amphibians and reptiles for the state (Cooper 1960). In 1969, Herbert S. Harris, Jr. published the first distributional survey of every amphibian and reptile known to occur in Maryland, and he updated the publication in 1975. No updated, complete survey of reptile and amphibian distributions had been published since then. Although distributional data have been collected dating back to the 1930s, no systematic and replicable survey of all herpetofauna had ever been conducted in Maryland.

To fill this need, the NHSM and MD DNR completed the Maryland Amphibian and Reptile Atlas (MARA) community science project, using State Wildlife Grant funding and thousands of hours of volunteer effort. The project's goal was to map the current distribution of all 89 native species of amphibians and reptiles within the state in a manner that is repeatable, thus establishing a baseline and aiding species conservation status assessments both now and in the future. Understanding patterns of change at county and statewide scales is necessary for land managers, regulators, and citizens to make better decisions to conserve the herpetofauna of Maryland.

MARA began in 2009 with a one-year pilot project to iron out logistics. However, the bulk of the fieldwork was conducted in a five-year window beginning in January 2010. With the help of social media outlets, including Facebook and Meetup, MARA also became an important educational tool, as hundreds of people across Maryland spent roughly 30,000 hours searching for herps and reported nearly 35,000 herp sightings.

The data were collected and visualized in real time, both in map and tabular formats, through MD DNR's online database website. Similar to the breeding bird atlas projects, a book with species accounts, life history information, and distribution results was written by various people involved with MARA and was published in 2018 (Cunningham & Nazdrowicz 2018). While the linked database still exists, the book is currently the best way to view the collected data. Figure 3.6 shows a comparison of a MARA distribution map and a Harris distribution map.

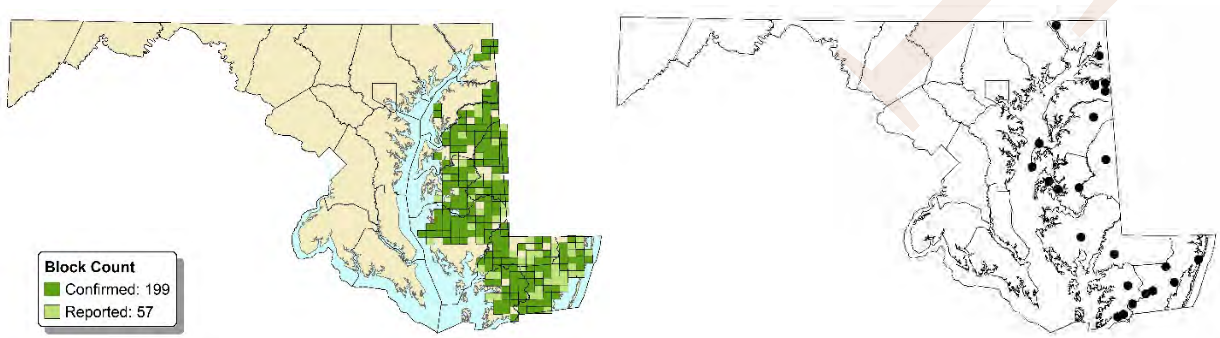


Figure 3.6 New Jersey chorus frog distribution map comparison: MARA 2018 (left) and Harris 1975 (right). Sources: Cunningham & Nazdrowicz 2018, Harris 1975.

MARA provided valuable data for the 2015 SWAP revision to inform the development of the updated SGCN list. Some species, such as upland chorus frog, six-lined racerunner *(Aspidoscelis* *sexlineata),* northern mole kingsnake, and Coastal Plain milksnake (though it has since been replaced with eastern milksnake *[Lampropeltis Triangulum]* due to taxonomic uncertainty) were added because their ranges have been reduced since Harris's 1975 publication. On the other hand, a number of species were removed from the SGCN list because they did not appear to have undergone range restrictions since Harris's publication, and more active volunteers agreed that these species did not seem to be in decline. These removed species included the New Jersey chorus frog, northern red-bellied cooter, and eastern hognose snake.

An undetermined species of siren was discovered also in Maryland during the MARA project, and around 25 introduced, non-native species were documented during the process as well. Some of these include Florida softshell turtle, Mississippi map turtle, yellow-bellied slider, savannah monitor, green anole, American alligator, red-tailed boa, Burmese python, Cuban treefrog, and northwestern salamander, which was found hitchhiking on a Christmas tree from the Pacific Northwest.

During the 2025 SWAP period, MARA data were used in Status Assessments and state listing decisions for Maryland's rare and declining species. More specifically, the distribution identified during MARA is a critical piece of information for identifying the total area of occupancy in the state. Additionally, MD DNR staff have identified a need for targeted surveys to fill in distribution gaps for a suite of species including mole kingsnake, scarletsnake (*Cemophora coccinea),* and mud salamander *(Pseudotriton montanus).*

Table 3.13 Existing federal recovery plans for reptile SGCN

Reptile Species	Federal Recovery Plan	Recent Action
Bog turtle	USFWS 2001	2022: Interim Species Status Assessment/Biological Report for the Northern Population of the Bog Turtle published; 2018: Initiation of 5-year review
Green sea turtle	NOAA Fisheries and USFWS 1991	2023: Designation of critical habitat; 2016: Final Rule to list eleven Distinct Population Segments of the Green Sea Turtle as Endangered or Threatened and revision of current listings under the ESA
Kemp's Ridley sea turtle	NOAA Fisheries and USFWS 2011	2021: Initiation of 5-year review
Leatherback sea turtle	NOAA Fisheries and USFWS 1992	2025: 90-Day finding on petition to revise critical habitat; 2020: 12-Month finding on a petition to identify the NW Atlantic Leatherback Turtle as a Distinct Population Segment and list it as Threatened under ESA
Loggerhead sea turtle	NOAA Fisheries and USFWS 2008	2019: Initiation of 5-year review; 2014: Designation of critical habitat

Table 3.14 Reptile and amphibian SGCN in Maryland

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Reptiles						
Bog turtle	*Glyptemys muhlenbergii*	G2G3	S2	T	T	A
Copperhead	*Agkistrodon contortrix*	G5	S5			C
Eastern box turtle	*Terrapene carolina*	G5	S5			C
Eastern kingsnake	*Lampropeltis getula*	G5	S4			C
Eastern milksnake	*Lampropeltis triangulum*	G5	S4			C
Eastern mud turtle	*Kinosternon subrubrum*	G5	S5			C
Eastern musk turtle	*Sternotherus odoratus*	G5	S4			C
Eastern ribbonsnake	*Thamnophis sauritus*	G5	S4			C
Eastern spiny softshell	*Apalone spinifera*	G5	S1		I	A
Green sea turtle	*Chelonia mydas*	G4	S1N	T	T	A
Kemp's ridley sea turtle	*Lepidochelys kempii*	G2	S1N	E	E	A
Leatherback sea turtle	*Dermochelys coriacea*	G2G3	S1N	E	E	A
Loggerhead sea turtle	*Caretta caretta*	G2G4	S1B, S1S2N	T	T	A
Mountain earthsnake	*Virginia valeriae pulchra*	G5T3T4	S1S2		E	A
Northern coal skink	*Plestiodon anthracinus*	G5	S1		E	A
Diamond-backed terrapin	*Malaclemys terrapin*	G4	S4			C
Northern map turtle	*Graptemys geographica*	G4G5	S1		E*	A
Northern mole kingsnake	*Lampropeltis rhombomaculata*	G4	S1			A
Plain-bellied watersnake	*Nerodia erythrogaster*	G5	S2S3			B
Queensnake	*Regina septemvittata*	G5	S4			C
Rainbow snake	*Farancia erytrogramma*	G4	S1		E	A
Red cornsnake	*Pantherophis guttatus*	G5	S2			B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Scarletsnake	*Cemophora coccinea*	G5	S1			A
Six-lined racerunner	*Aspidoscelis sexlineata*	G5	S3			C
Smooth greensnake	*Opheodrys vernalis*	G5	S3S4			C
Spotted turtle	*Clemmys guttata*	G5	S3S4			C
Striped mud turtle	*Kinosternon baurii*	G4G5	SU			D
Timber rattlesnake	*Crotalus horridus*	G4	S3			C
Wood turtle	*Glyptemys insculpta*	G2G3	S2S3			A
Amphibians						
Barking treefrog	*Dryophytes gratiosus*	G5	S1		E	A
Carpenter frog	*Lithobates virgatipes*	G4	S3			C
Common mudpuppy	*Necturus maculosus*	G5	SX		X	E
Eastern hellbender	*Cryptobranchus alleganiensis*	G3	S1		E	A
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*	G5	S2S3		E	B
Eastern spadefoot	*Scaphiopus holbrookii*	G5	S5			C
Eastern tiger salamander	*Ambystoma tigrinum*	G5	S1		E	A
Green salamander	*Aneides aeneus*	G3G4	S1		E	A
Jefferson salamander	*Ambystoma jeffersonianum*	G4	S3			C
Longtail salamander	*Eurycea longicauda*	G5	S5			C
Mountain chorus frog	*Pseudacris brachyphona*	G5	SH		E	E
Mountain dusky salamander	*Desmognathus ochrophaeus*	G5	S5			C
Mud salamander	*Pseudotriton montanus*	G5	S2?			B
Red salamander	*Pseudotriton ruber*	G5	S5			C
Seal salamander	*Desmognathus monticola*	G5	S4			C
Spring salamander	*Gyrinophilus porphyriticus*	G5	S4			C

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Upland chorus frog	*Pseudacris feriarum*	G5	S4			C
Valley and Ridge salamander	*Plethodon hoffmani*	G5	S4			C
Wehrle's salamander	*Plethodon wehrlei*	G4	S2		I	B

[1] = See Table 3.5 for S-rank and G-rank definitions
[2] = T (Threatened); E (Endangered); I (In Need of Conservation); X (Endangered Extirpated)
[3] = See Table 3.7 for Conservation Status definitions
* = a qualifier denoting the species is listed in a limited geographic area only

Fishes of Maryland

It is estimated that some several hundred species of fishes reside in Maryland's waters. This includes the Chesapeake Bay, Coastal Bays, Atlantic Ocean, and rivers, streams, lakes, and ponds, whether natural or artificial. Of this number, 34 are considered SGCN in Maryland, with an additional 15 on the SAPS list. The first few subsections of this section are spent describing the general state and requirements of all fishes in the state, whereas the latter subsections are dedicated to these 34 SGCN.

Brook trout (Salvelinus fontinalis) (Kerry Wixted, MD DNR)

Various species of fishes reside in estuarine, marine, and/or freshwater environments, depending on their needs. Some fishes are residents of bays and estuaries, including hogchoker and northern pipefish. Anadromous fishes—those that utilize Maryland's freshwater for spawning but spend the rest of their life in saline or brackish waters—include striped bass, shad, and river herring. Other species (e.g., red drum, tautog, Atlantic croaker) spawn in marine waters but rely upon bays and estuaries for juvenile development. Purely marine species of fishes, such as bluefin tuna and marlin, tend to be highly migratory, traveling long distances during their life spans. Finally, some of the state's fish species are freshwater residents, such as brook trout *(Salvelinus fontinalis)* and mud sunfish *(Acantharchus pomotis).*

In addition to native species, numerous fishes have also been stocked in Maryland's streams for more than 170 years, including largemouth bass, brown and rainbow trout, and common carp (Boward et al. 1999). MD DNR Fishing and Boating Services (FABS) currently stocks a number of ponds, lakes, and streams with warm water species and stocks approximately 240,000 coldwater trout annually (MD DNR 2025a).

The Fishery Management Plan (FMP) Workgroup of the Chesapeake Bay Program (CBP) led the development of some of the first Chesapeake Bay-specific fish management plans guiding conservation of the major commercial, recreational and ecologically valuable fish species in the Bay, including shad and river herring (CBP 1989a), striped bass (CBP 1989b), and summer flounder (CBP 1991a). The latest full Fishery Management Plan includes updates for 27 FMPs encompassing 30 species (MD DNR 2025b). Fisheries management expanded to the ecosystem level when representatives from a number of organizations focused on the health of the Chesapeake Bay came together to develop a Fisheries Ecosystem Plan (Chesapeake Bay Fisheries Ecosystem Advisory Panel 2006). This Ecosystem Plan describes the structure and function of the Chesapeake Bay ecosystem, focusing on the interactions between key fisheries species in an effort to move beyond traditional fisheries management tools like controlling harvest limits. Based on this foundational plan, detailed ecosystem-based reports were developed for fisheries species and species groups including *Alosines* (i.e, shad) (MDSG 2011), striped bass (MDSG 2009a), and menhaden (MDSG 2009b).

The Atlantic States Marine Fisheries Commission (ASMFC), Mid-Atlantic Fishery Management Council (MAFMC), and National Marine Fisheries Service (NMFS) have also developed FMPs for numerous fishes that are found in the state's Atlantic Ocean, Coastal Bays, and Chesapeake Bay. These plans, addendums, amendments, and framework changes promote species conservation and habitat needs to achieve interstate management goals.

Marine and Estuarine Fishes

Maryland's marine and estuarine waters host a diverse array of fishes, with the Chesapeake Bay hosting 350 species of fishes, the Coastal Bays more than 140, and the Atlantic Ocean being home to hundreds more (MD DNR 2004b; Pyzik et al. 2004). Many marine species have existing FMPs that are used to guide their conservation (e.g., striped bass, spiny dogfish, and scup). Many questions on the status of forage species, trophic interactions, and the loss of critical spawning and nursery habitat also remain unanswered. Sharks, marlin, and tuna are highly migratory species that move over large areas of the ocean and are not permanent residents of the state's marine waters. As a result, their management requires regional, national, and international (e.g., IUCN, CITES) partnerships. NMFS monitors the status of highly migratory species and has a fishery management plan (MD DNR 2025b) outlining conservation efforts for billfishes, sharks, tuna, and swordfish. This plan is amended regularly for management, conservation, and habitat needs.

Blackbanded sunfish (Enneacanthus chaetodon) (Tino Strauss)

Freshwater Fishes

MD DNR's Maryland Biological Stream Survey (MBSS) has sampled thousands of sites since 1995, compiling a robust inventory of the status and distribution of the nearly 100 freshwater fish species found in the state (MD DNR 2026b). The survey samples streams representing the four ecological stream types: Highlands Warmwater, Highlands Coldwater, Eastern Piedmont, and Coastal Plain. Eighteen species of freshwater fish were found to occur in all geographic regions. Coastal Plain streams had the most fish species (86), followed by Eastern Piedmont streams (72 species). The combined highlands had a total of 70 species. The most common fishes in Maryland's streams include the blacknose dace, blue ridge sculpin, mudminnow, creek chub, and tessellated darter. Rare species—many of which are SGCN, as discussed below—include blackbanded sunfish *(Enneacanthus chaetodon)*, ironcolor shiner *(Alburnops chalybaeus)*, stonecat *(Noturus flavus)*, and stripeback darter *(Percina notogramma)*. MBSS continues to maintain the best available scientific information regarding population status, abundance, and distribution of non-game freshwater fishes in the state.

Non-native fishes have been widely introduced in Maryland dating as far back as 1854 (Smith & Bean 1899). Many introductions were made to establish and maintain recreational fisheries, while others resulted from the illegal release of unused bait, unwanted aquarium pets, or of fishes purchased from live seafood markets. At least 20–25 introduced fishes now inhabit Maryland's waters. In recent years, mimic shiner and bluehead chub, likely introduced as bait, have expanded in many tributaries to the Potomac River. Chesapeake channa (formerly known as northern snakehead) and blue catfish in particular have expanded widely throughout tributaries of the Chesapeake Bay. In response, as part of the Whole Watershed Program, MD DNR has implemented commercial and recreational harvest incentives to reduce numbers of these invasive species (MD DNR 2026c).

Fish SGCN of Maryland

Thirty-four fishes have been identified by the SWAP process as SGCN in Maryland (Table 3.16). Of these, for the sake of categorization, 21 are considered freshwater and 13 are considered marine or estuarine—though, as previously mentioned, a number of fishes in fact travel between fresh, saline, and/or brackish waters over the course of their life cycles. Two of these SGCN, the Atlantic *(Acipenser oxyrinchus)* and shortnose *(Acipenser brevirostrum)* sturgeons, are federally listed as Endangered. Fourteen fish SGCN are state-listed, 6 of which are listed as Endangered, 3 as Threatened, 3 as In Need of Conservation, and 2 as Endangered Extirpated. Additionally, 11 are of national or international concern (IUCN 2026) and 28 are of conservation concern in the Northeastern U.S. region (Terwilliger & NFWDTC 2023). Any species that does not fall into one or more of these categories was designated as an SGCN due to concerns about declining populations, habitat loss, and/or other reasons. For additional ranks, see Appendices 3a and 3b.

In Maryland, sharks are found in the Atlantic Ocean, Coastal Bays, the Chesapeake Bay, and its larger tributaries. They use these areas for pupping, nurseries, and foraging. Sharks are slow growing, long lived, late maturing, and have long reproductive cycles which makes cooperative management of these migratory species important for conservation and responsible harvest.

Shark management tools (e.g., seasons, possession limits) are found in several FMPs. As a member of the Atlantic States Marine Fisheries Commission (ASMFC), the State of Maryland implements management measures found in the Interstate Fishery Management Plan for Coastal Sharks and the associated addendums in state waters (0–3 nautical miles). For the most part, that fishery management plan is complementary to federal management covering the exclusive economic zone (3–200 nautical miles) by the National Oceanic and Atmospheric Administration's (NOAA) Consolidated Atlantic Highly Migratory Species Management Plan. For some sharks, such as blue sharks, shortfin mako, and porbeagle, NOAA is the authority for managing binding Recommendations and non-binding Resolutions from the International Commission for the Conservation of Atlantic Tunas.

Sandbar shark (Carcharhinus plumbeus) (G.P. Schmahl, NOAA)

Shark SGCN that use Maryland waters—or are available from Ocean City—are included in ASMFC and NOAA fishery management plans, which prohibit both commercial and recreational harvest. The Coastal Bays, particularly Chincoteague Bay, and lower Chesapeake Bay are known nursery areas for sandbar sharks (*Carcharhinus plumbeus*) (Wesche 1997). Atlantic angel (*Squatina dumeril*), dusky (*Carcharhinus obscurus*), sandbar, longfin mako (*Isurus paucus*), sand tiger (*Carcharias taurus*), whale (*Rhincodon typus*), and white (*Carcharodon carcharias*) sharks are found in the ocean. Longfin mako sharks are rare and reports of the filter feeding whale sharks are also rare but occasionally filter in from offshore anglers.

Horseshoe crabs (*Limulus polyphemus*) move from the ocean into Chesapeake Bay and Coastal Bays from May through July. Some horseshoe crabs overwinter inshore, especially as juveniles. They spawn on sandy beaches on the new and full moon high tides. Spawning dates are determined based on lunar phase and temperature; a minimum water temperature of 18 °C initiates spawning activity. Sandy beaches are critical habitat for spawning horseshoe crabs.

Horseshoe crabs ((Limulus polyphemus) (Dick Arnold)

Horseshoe crabs also play an ecological role in that horseshoe crab eggs provide sustenance for migrating shorebirds and fish. Migrating shorebirds use the horseshoe crab eggs as fuel to migrate north to the Hudson area from South America in order to nest. The migration distance is as long as 6,000 miles and the shorebirds can increase their weight to complete their migration in as little as two weeks.

Horseshoe crabs are managed by the ASMFC and are harvested for bait and biomedical uses. Horseshoe crab populations in the Delaware Bay region (which includes Maryland) have been characterized as stable to increasing, approaching historical high abundances last reached in the late 1990s. However, studies continue to show local declining populations in nearby areas and therefore continued need for concern (Crosby 2025).

Coastal waters serve as important habitat to Atlantic sturgeon and shortnose sturgeon. These fishes also frequent the Chesapeake Bay estuary and its tidal tributaries. These tidal waters are an important habitat for these species, utilized as adult spawning grounds and as juvenile nurseries. Atlantic sturgeon populations can spawn during spring and fall with a fall-spawning population of Atlantic sturgeon inhabiting Marshyhope Creek in the Nanticoke River basin. This fall-spawning life history strategy was previously unrecognized.

Hickory shad (*Alosa mediocris*) and American shad (*Alosa sapidissima*) congregate in large schools during the early months of spring. Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), which are collectively known as river, herring migrate long distances from the sea to spawn in freshwater. Together, these anadromous species utilize spawning habitats in both Coastal Plain and Piedmont streams of Maryland. Populations of these species remain depleted from historical levels due to a combination of habitat loss, stream blockages, overfishing, ocean bycatch, exposure to invasive predators, and pollution. Extensive restoration efforts including hatchery propagation and the removal of stream blockages, such as the removal of the Patapso River's Bloede Dam in 2018, have been largely successful at increasing their abundance in bay tributaries, especially that of hickory shad.

Congregating in large schools during the early months of spring, hickory shad (*Alosa mediocris*); American shad (*Alosa sapidissima*); and river herring, collectively alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), migrate long distances from the sea to spawn in freshwater. These anadromous species utilize spawning habitats in both Coastal Plain and Piedmont streams of Maryland. Populations of these species remain depleted from historical levels due to a combination of habitat loss, stream blockages, overfishing, ocean bycatch, exposure to invasive predators, and pollution (ASMFC 2020, 2024). Extensive restoration efforts including hatchery propagation and the removal of stream blockages, such as the removal of the Patapso River's Bloede Dam in 2018, have been largely successful at increasing their abundance in bay tributaries, especially that of hickory shad.

Coastal Plain streams and rivers support a variety of fish SGCN. In smaller Coastal Plain streams, the solitary and secretive mud sunfish lurks in slow water, hidden among soft substrate and submerged vegetation. Two additional SGCN fishes, blackbanded sunfish and banded sunfish *(Enneacanthus obesus)*, are perfectly adapted to the naturally low-oxygen, acidic blackwater swamps that characterize forested lowlands of the Eastern Shore. Ironcolor shiner and swamp darter *(Etheostoma fusiforme)* can also be found in these dystrophic habitats.

The Chesapeake logperch *(Percina bimaculata)*, a species described in 2008 (Near 2008), is a resident of the Susquehanna River and its larger tributaries, including Deer Creek. This species is a habitat generalist, and is equally at home in fast-flowing, cobble-strewn riffles in Piedmont streams as it is in slow, vegetated habitats common within the Coastal Plain. Although once known from the Potomac River, the distribution of the Chesapeake logperch now includes only the waters of the Upper Chesapeake Bay and the Lower Susquehanna River in Maryland and southeastern Pennsylvania.

From the Piedmont province and west, Maryland's fish SGCN are associated with higher-gradient streams with an abundance of cobble, gravel, and other coarse substrates. For example, the stonecat is a small, nocturnal catfish that seeks shelter during daylight hours under large submerged boulders. It is a species that was eliminated from a large portion of its historical range in western Maryland as a result of poor coal mining practices. Several more SGCN in this region are restricted to clean, coldwater habitats. For example, the mottled sculpin *(Cottus bairdii)* is a small, bottom-dwelling insectivorous fish found in high-gradient, coldwater streams of the Youghiogheny River basin. As a species that requires clean coarse substrate to spawn, the mottled sculpin tends to be especially susceptible to sedimentation. The longnose sucker *(Catostomus catostomus)*, a species that may be extirpated from the state, was once (and may still be) a coldwater Youghiogheny River dweller. Brook trout, a coldwater specialist that ranges from the Appalachian Plateau to the eastern Piedmont, prefers stream temperatures below 20ºC year-round to survive. SGCN of western Maryland also include checkered sculpin *(Cottus sp. 7)* and Allegheny pearl dace *(Margariscus margarita)*, two limestone stream specialists restricted to spring-fed streams flowing through the karst terrain of the Great Valley of Maryland near Hagerstown.

Threats to Fish SGCN

The dependence of fish SGCN on aquatic environments makes them vulnerable to negative inputs to streams, rivers, estuaries, and the Atlantic Ocean. For example, run-off from roads, impervious surfaces, and farm fields can directly contaminate SGCN habitats through inputs of road salt, oil, pesticides, herbicides, nutrients, and excessive fine sediments. All flowing water bodies are further influenced by upstream inputs, and accumulations of toxins, sediments, and nutrients can be particularly acute in large rivers and estuaries. Removal of trees from a watershed in general and especially from riparian areas can reduce the quality and quantity of fish habitat by increasing stream temperature, stream bank erosion, and decreasing instream woody debris, rootwads, and leaf litter. The influx of silt that often accompanies deforestation can bury important spawning and feeding habitats, negatively affecting SGCN like stripeback darter and mottled sculpin.

Any changes in pH, temperature, and turbidity from acid mine drainage, livestock grazing, urbanization, and other sources can make habitats unsuitable for fish SGCN. For example, brook trout, the only trout species native to Maryland, are particularly sensitive to temperature changes that occur when forest cover is removed. This species has suffered drastic population declines, in eastern Maryland especially. As a species that thrives in cold water, their population decline is attributed to runoff from roofs, roadsides, and other impervious surfaces; loss of trees along streams; and climate change.

Human activities in or near aquatic environments can adversely affect SGCN and their habitats. Bridge construction and demolition, dredging, and vessel strikes have adversely affected SGCN of large rivers such as the shortnose and Atlantic sturgeons and can impact spawning runs of shad, river herring, and other migratory fishes (Litwiler 2001). Similarly, the practice of stream ditching and channelization, common on the Delmarva Peninsula, can adversely impact SGCN like mud sunfish. Surface and groundwater withdrawals for drinking water and irrigation are an increasing threat to stream and river habitats, especially in rapidly urbanizing areas. Dams and other barriers to fish passage (e.g., road culverts) isolate populations and disrupt the habitat connectivity that many resident and migratory fishes require to remain a viable part of Maryland's fauna. These barriers prevent the upstream and downstream movement of fishes in response to stressors and may hinder their ability to adapt to altered flow and temperature regimes expected with climate change.

Pesticide applications, such as those for mosquito control, can reduce aquatic prey species important to many fish SGCN. There are emerging contaminants such as forever chemicals (e.g., PFAS) as well as contaminants associated with the breakdown of tires (e.g., 6PPD- quinone) that are of growing concern regarding their impacts to aquatic organisms.

Atlantic sturgeon (Acipenser oxyrinchus) (Stan Belback)

Overharvest particularly affected populations of shad, river herring, sharks, and sturgeon. For example, many sharks were overharvested when commercial fishermen were encouraged to target them in the 1980s. Management rebuilding tools such as fisheries management plans, stock assessments, surveys, moratoriums, and fish passage are part of the solution, although life history and environmental factors can also affect recovery time. For example, shark populations can take a long time to recover because of their reproduction strategies, fishing mortality (e.g., dusky shark), lack of scientific data, and lack of funding.

Additionally, species introduced for sport, mosquito control, or other means (e.g., bait bucket introductions, released pets) can impact fish SGCN through direct competition and predation. Other non-native, invasive species like the zebra mussel have the capacity to alter the structure and function of aquatic food webs directly and indirectly, affecting fish SGCN and their habitats. Aquatic invasive species are a major threat to fish SGCN, though progress has been made and continues to be made in this area.

Conservation Actions and Information Needs for Fish SGCN

For the effective conservation of fish SGCN, threats to aquatic habitats must be addressed at both local and landscape scales. This is true for headwaters to large rivers, the Chesapeake and Coastal Bays, and the Atlantic Ocean. Minimizing or eliminating stressors that affect aquatic habitats are possible through better land use planning, improved stormwater management, reduction of impervious surfaces, mitigation of acid mine drainage, improved wastewater treatment, improved agricultural and forestry practices, reduction of pesticide use, and maintenance and improvement of riparian buffers. Careful planning to limit the location and extent of deforestation, urbanization, and nutrient inputs is needed to conserve functioning watersheds. The ecological impacts of surface and groundwater withdrawals should be better assessed and research should be conducted to quantify the minimum flow requirements of each fish SGCN. Maps of groundwater and hydrological systems could assist with determining potential impacts and planning restoration activities. Human-made dams should continue to be removed wherever possible. When removal is not an option, fish passage should be improved with ladders or other techniques. Coordination and planning with state and county highway departments should be increased to replace undersized or faulty road culverts and encourage state-of-the-art stream crossing designs that reduce stream alterations and improve connectivity of SGCN habitats.

More information on the seasonal movements and spatial life history requirements of SGCN, including anadromous fishes and sharks, is needed to determine habitat requirements. Recreational management plans are important tools for conservation for some species, such as the brook trout management plan. Regulatory controls are needed to limit the establishment of non-natives and minimize their impact. Research on the impacts of competition between native and non-native species is also needed. Continued regulation is critical for the recovery of SGCN shad, river herring, and sturgeon populations. Reintroduction after habitat restoration has the potential to increase populations of some SGCN.

To restore Atlantic sturgeon, shad, and river herring in the Chesapeake Bay, MD DNR FABS uses a combination of closed fishery, removal of barriers to spawning grounds, and water quality improvements. MD DNR also supplements shad and river herring populations using hatchery-produced fish. Information regarding threats and conservation actions for these fishes can be found in the Fishery Management Plan for Atlantic Sturgeon by the Atlantic States Marine Fisheries Commission (ASMFC 1998) and subsequent addenda, as well as Maryland's regional American Shad Habitat Plan (Bourdon 2021). This is in addition to the original Interstate Fishery Management Plan for American Shad and River Herring and associated amendments, which include compliance and monitoring requirements for states (ASMFC 1985, 1999, 2009, 2010). Federal recovery plans exist for Atlantic and shortnose sturgeon (Table 3.15).

Table 3.15 Existing federal recovery plans for fish SGCN

Fish Species	Federal Recovery Plan	Recent Action
Atlantic sturgeon	NOAA Fisheries 2018	2022: Finalized 5-year review
Shortnose sturgeon	NOAA Fisheries 1998	2010: Biological assessment

Table 3.16 Fish SGCN in Maryland

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Alewife	*Alosa pseudoharengus*	G5	S5			C
Allegheny pearl dace	*Margariscus margarita*	G5	S2S3		I	B
American brook lamprey	*Lethenteron appendix*	G4	S2		T	B
American shad	*Alosa sapidissima*	G5	S3			C
Atlantic angel shark	*Squatina dumeril*	GNR	SNR			D
Atlantic sturgeon	*Acipenser oxyrinchus*	G3	S1	E	E	A
Banded sunfish	*Enneacanthus obesus*	G5	S3S4			C

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Blackbanded sunfish	*Enneacanthus chaetodon*	G3	S1		E	A
Blueback herring	*Alosa aestivalis*	G3G4	S5			C
Bridle shiner	*Notropis bifrenatus*	G3	SH		X	E
Brook trout	*Salvelinus fontinalis*	G5	S3S4			C
Checkered sculpin	*Cottus sp. 7*	G4Q	S2			B
Chesapeake logperch	*Percina bimaculata*	G1G2	S1S2		T	A
Comely shiner	*Notropis amoenus*	G5	S3			C
Dusky shark	*Carcharhinus obscurus*	G3	SNR			D
Flier	*Centrarchus macropterus*	G5	S2S3		I	B
Glassy darter	*Etheostoma vitreum*	G4G5	S2		T	B
Hickory shad	*Alosa mediocris*	G4	S3			C
Horseshoe crab	*Limulus polyphemus*	G5	S3			C
Ironcolor shiner	*Alburnops chalybaeus*	G4	S1		E	A
Johnny darter	*Etheostoma nigrum*	G5	S3			C
Longfin mako	*Isurus paucus*	G2G3	SNR			D
Longnose sucker	*Catostomus catostomus*	G5	SX		X	E
Mottled sculpin	*Cottus bairdii*	G5	S4			C
Mud sunfish	*Acantharchus pomotis*	G4G5	S3			C
Sand tiger shark	*Carcharias taurus*	G3G4	SNR			D
Sandbar shark	*Carcharhinus plumbeus*	G4	SNR			D
Shield darter	*Percina peltata*	G4	S3S4			C
Shortnose sturgeon	*Acipenser brevirostrum*	G3	S1	E	E	A
Stonecat	*Noturus flavus*	G5	S1		E	A
Stripeback darter	*Percina notogramma*	G4	S1		E	A
Striped shiner	*Luxilus chrysocephalus*	G5	S1S2		I	A
Swamp darter	*Etheostoma fusiforme*	G5	S3			C
Whale shark	*Rhincodon typus*	G4G5	SNR			D

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
White shark	*Carcharodon carcharias*	G2	SNR			D

[1] = See Table 3.5 for S-rank and G-rank definitions
[2] = T (Threatened); E (Endangered); I (In Need of Conservation); X (Endangered Extirpated)
[3] = See Table 3.7 for Conservation Status definitions

Invertebrates of Maryland

Though small in size, invertebrates account for the majority of Maryland's wildlife diversity and exert an outsized influence on ecological processes. More than 10,000 named arthropod and mollusk species are known from Maryland, with additional species documented each year. Although not SGCN, the blue crab and eastern oyster are among Maryland's most recognizable invertebrates, forming the state's two most valuable commercial fisheries (NOAA 2024). That being said, the ecosystem services of invertebrates far surpass the value of any extractive industry.

Biological control of crop pests provided by invertebrates in the United States has been valued at approximately $6 billion, while the economic value of invertebrate-driven decomposition is estimated at roughly $500 million (Losey & Vaughan 2006). Pollination services of crops in Maryland alone have been estimated to be worth over $15 million (Patch et al. 2021). Furthermore, by sustaining bird populations, invertebrates can be estimated to contribute approximately $282 million annually to Maryland's economy through birdwatching activities (Losey & Vaughan 2006, USFWS & USCB 2011). Invertebrates also play a critical role in environmental monitoring and water quality; one group, freshwater mussels, even directly improves water quality. For example, in the Susquehanna River watershed, it has been found that mussels denitrify approximately 10,000 pounds of nitrogen annually (Wood et al. 2021).

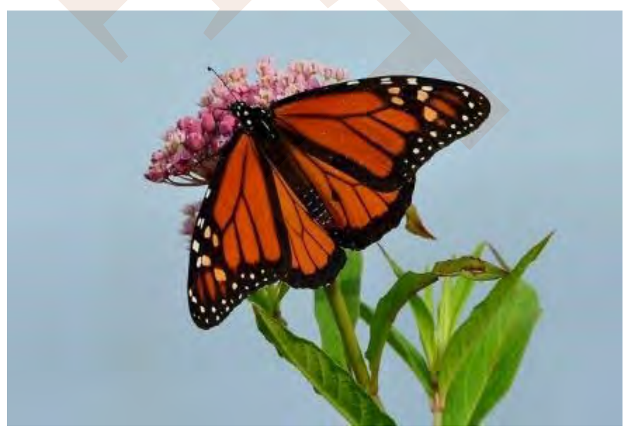
Despite their economic and ecological value, invertebrates in Maryland are not nearly as well-studied as vertebrates. This is due to the overwhelming number of invertebrate species, limited number of taxonomic specialists, and the complexities of the ecological communities of which they are an integral part. However, since the last SWAP revision in 2015, there have been significant advances in invertebrate conservation, including improved understanding of species distributions and conservation needs. This increased attention is partly driven by growing concern over widespread insect abundance declines—around 1% population loss per year—often referred to as the "insect apocalypse" (Wagner et al. 2021).

More optimistically, increased attention to invertebrate conservation has also been driven by growing public interest. Unlike many threatened species, invertebrates are readily observed even in highly urbanized environments and comprise a substantial proportion of community science records. The Maryland Biodiversity Project (MBP) was established as a nonprofit in 2012 to document Maryland's plant and wildlife diversity by combining expert-vetted iNaturalist records with additional verified observations to produce comprehensive sub county-level species lists. In recent years, a dedicated group of MBP volunteers, ranging in age from 15 to over 60, have rediscovered species absent from Maryland's records for decades, especially in more remote areas such as Garrett County. Close collaboration between the MD DNR NHP and MBP has proven essential for maintaining up-to-date assessments of invertebrate population health.

Although Maryland is a relatively small state, its wide variety of ecosystems and habitats supports some of the highest plant species densities in the country, with roughly one-third classified as rare, Threatened, or Endangered—a high proportion compared to neighboring states with much larger land areas (Maryland Botanical Heritage Work Group 2014; Kartesz & BONAP 2015). This diversity is largely due to Maryland's central latitude, where northern and southern species overlap, as well as the state's wide range of elevations and geologic regions, from the Appalachian Mountains to the Atlantic coast. Because invertebrates are closely associated with plants, the state's diverse habitats also support a correspondingly high number of rare invertebrate species.

Maryland's rare invertebrates are particularly associated with wetland/riparian and barren habitats in both upland (i.e., Piedmont and Appalachian Plateau) and lowland (i.e., Coastal Plain) physiographic provinces. For example, important lowland wetland Key Wildlife Habitats (KWHs) for invertebrates include Coastal Plain Seepage Acidic Fen, Delmarva Bay, and Tidal Freshwater Marsh and Shrubland; important lowland barrens include the Coastal Plain Oak-Pine Forest, Coastal Bluff, and Maritime Dune and Grassland. For upland physiographic provinces, important wetland/riparian habitats include Montane Acidic Fen, Coldwater Stream, and Highland Stream; important upland barren habitats include Serpentine Barren, Shale Barren, and Cliff and Rock Outcrop. Other habitats are also important, but most of Maryland's rare invertebrate species are found in upland or lowland areas and in wetlands or barrens. More information about these KWHs and their species associations can be found in Chapter 4.

Counterintuitively, one additional ecosystem category of particular importance is human-influenced habitats such as the Artificial Barren, Managed Grassland, Roadside and Utility Right-of-Way, and Urban and Suburban Greenspace KWHs. Highly disturbed areas prevent natural succession, sustaining barren and grassland habitats and preserving species that might otherwise be lost to canopy closure. However, human-influenced habitats are also particularly susceptible to anthropogenic threats, such as pesticide use and invasive species.

Left: *A monarch caterpillar on a milkweed plant* (Richard Orr); **Right**: *A monarch butterfly* (Orr)

Invertebrate SGCN of Maryland

There are 259 invertebrates listed as SGCN in the 2025 SWAP revision, making up more than one quarter of Maryland's SGCN list; not counting plants, invertebrates account for nearly half of the SGCN list. Sixty-three invertebrate SGCN in 2025 are legally listed in Maryland (COMAR 08.03.08). Regionally, 82 Maryland SGCN are also listed or proposed to be listed as Regional Species of Greatest Conservation Need (RSGCN) or Assessment Priority species by the Northeast Association of Fish and Wildlife Agencies (NEAFWA) (TCI & NEFWDTC 2023); these species are referred to as being "of regional concern" for the remainder of this section, regardless of whether their statuses are confirmed or merely proposed. Globally, 68 SGCN are ranked G3 (globally vulnerable) or rarer by NatureServe; these species are referred to as being "globally rare" for the remainder of this section.

Seven invertebrate SGCN are federally protected or proposed to be protected. The rusty-patch bumble bee (*Bombus affinis*) and dwarf wedgemussel (*Prolasmidonta heterodon*) are federally listed as Endangered. The Puritan tiger beetle (*Ellipsoptera puritana*), yellow lance (*Elliptio lanceolata*), and eastern beach tiger beetle (*Habroscelimorpha dorsalis dorsalis*) are federally listed as Threatened. The Bethany Beach firefly (*Photuris bethaniensis*) and green floater (*Lasmigona subviridis*) are currently Proposed Threatened by the U.S. Fish and Wildlife Service (USFWS). The monarch butterfly is also proposed to be listed as Threatened by USFWS. However, while the monarch occurs in Maryland and faces a number of threats, it is still a fairly widespread migrant and breeder in the state, leading to its removal from the SGCN list and placement on the State Assessment Priority Species (SAPS) list for additional research and inventory.

In 2015, there were 350 invertebrate species listed as SGCN. This apparent reduction in SGCN to 259 species is due to a new category, the aforementioned SAPS list, introduced in the 2025 SWAP revision. There are 780 invertebrate SAPS in 2025, bringing the total assessed number of invertebrate species in the Maryland SWAP to 1,039. The process for assigning SGCN versus SAPS differed slightly for invertebrates due to the large number of species assessed. To be designated as an SGCN, sufficient information was required on a species' distribution, habitat, and specific actionable threats. Species known to be rare but lacking information in one or more of these areas were instead assigned to the SAPS list instead.

Broad threats affecting an entire taxonomic group were not sufficient on their own for listing a species as an SGCN. For example, a rare moth was not designated as an SGCN solely because moths are generally affected by light pollution. However, when a species' distribution and habitat were well understood and the species was documented near a light pollution source, the species could be listed as an SGCN with a targeted conservation action of reducing light pollution in that specific area. Application of this protocol resulted in 118 species being moved from the 2015 SGCN list to the 2025 SAPS list, including some species with existing state legal protection. Placement on the SAPS list does not impact a species' legal status. Rather, it allows survey and conservation efforts to be better prioritized. This approach ensures that species designated as SGCN are accompanied by clearly defined conservation actions. Because of this taxonomic group's outsized presence on the SAPS list, depending on the subgroup in question, SAPS are therefore addressed in this section in more detail than in other sections of this chapter.

Fifty-one invertebrate species were removed in the 2025 SWAP revision compared to the 2015 SWAP revision. Eleven species were removed because of no historical records of occurrence in the state. Twenty-five were removed due to extirpation. Twelve were removed due to being more common and widespread across their range than previously known. Three other species were removed for being vagrants or because of changes in taxonomy.

All species known to occur in Maryland within 13 invertebrate taxonomic groups were evaluated for listing in the 2025 revision. These groups were: dragonflies, damselflies, stoneflies, caddisflies, freshwater mussels, cave and groundwater invertebrates, butterflies, macro-moths, bees, hoverflies, fireflies, and tiger beetles. These groups were able to be fully assessed due to extensive surveys, high detectability, substantial prior research, and/or available expertise. These taxa comprise the majority of listed species, although select species from other groups were included based on expert review and existing information.

Aquatic Invertebrate SGCN: Dragonflies and Damselflies (Odonates)

Little blue dragonlet (Erythrodiplax minuscula) (Judy Gallagher)

Considerable progress has been made over the past few decades in determining the status, distribution, and habitat association of odonates (i.e., insects in the order *Odonata*). This is due in large part to recent publications of excellent field guides and a surge in interest among amateur naturalists. Alongside the efforts of MBP, an odonate expert and a group of dedicated naturalists track and update odonate county records each year. Additionally, the recent publication of “Status of Odonata on the Delmarva Peninsula” (White et al. 2024) has provided a comprehensive assessment of damselflies and dragonflies on Maryland’s Eastern Shore.

Today, at least 186 odonate species have been recorded in Maryland and almost half are listed as either SGCN (47 species) or SAPS (37 species). Many odonates have highly restricted ranges and stringent habitat requirements, and some are associated with rare, unique, and/or high-quality aquatic habitats, such as pristine headwater streams, forested seepage wetlands, montane rivers, and Delmarva Bays. Among the state’s odonate SGCN are 6 globally rare species, 8 species with state legal protection, and 20 species are of regional concern. As a group, few other animal taxa have such a high proportion of species warranting conservation attention, perhaps reflecting, in part, the degraded condition of their freshwater habitats.

Aquatic Invertebrate SGCN: Mayflies, Stoneflies, and Caddisflies (EPT: Ephemeroptera, Plecoptera, Trichoptera)

Mayflies (order Ephemeroptera), stoneflies (order Plecoptera), and caddisflies (order Trichoptera), often referred to as “EPT,” are very sensitive to pollution, sedimentation, and other forms of habitat degradation, so they are important biological indicators for water quality. Through the Maryland Biological Stream Survey (MBSS), the state’s stratified random stream sampling program, we have a relatively robust understanding of EPT communities in first- through fourth-order streams. Still, EPT identification, especially to species level, requires specialized taxonomic training which can pose formidable challenges to documenting species distribution, habitat, threats, and conservation needs. Fortunately, a recent study incorporating new survey work (Hogan & Grubbs 2022) has provided an extensive assessment of stoneflies in

Maryland, including seven new state records. Additionally, Andy Rasmussen of Florida A&M University maintains a distributional checklist of Nearctic Trichoptera (Rasmussen & Morse 2023), which was recently expanded upon with additional records (Hogan et al. 2025). Unfortunately, we do not yet have a comprehensive understanding of mayfly species occurrences in Maryland and were therefore unable to fully assess this taxonomic group. However, select mayfly species were included based on expert opinion and records from the MBSS.

Maryland hosts 122 stonefly species with eight listed as SGCN and 22 listed as SAPS. Of these, 11 are of regional concern and 12 are ranked globally rare by NatureServe. One hundred seventy-two species of caddisfly are found in Maryland, of which 29 are listed as SAPS. Seven Maryland caddisflies are of regional concern and 15 are globally rare. While we do not have complete information for mayflies, Maryland hosts at least 85 species. Fifteen of these are listed as SAPS. Nine of the mayflies are of regional concern and two are globally rare. Because mayflies are difficult to reliably identify from photographs, future assessments will need to rely on collected specimens rather than citizen science projects like MBP.

Aquatic Invertebrate SGCN: Freshwater Mussels

Freshwater mussels belong to the order *Unionoida*, a group of bivalves comprising 998 species worldwide (Graf & Cummings 2021). They are distinguished from other orders of bivalves by a pearly nacre on the inside of the shells, a lack of byssal threads used to permanently attach themselves to hard substrate, and a parasitic larval stage that requires a host fish to complete their reproductive cycle. North America supports the second highest diversity of freshwater mussels with 307 species. Most of this diversity lies in the southeastern United States. Maryland is positioned near the northeastern edge of this region, in a transition area between the South and North Atlantic faunal regions, with 16 native and at least two non-native species of freshwater mussels (Haag 2010).

In addition to having unique reproductive cycles, freshwater mussels have evolved a variety of morphological and behavioral adaptations, such as shell sculpturing and mantle lures. They also play a critical role in aquatic ecosystems by serving as prey for numerous aquatic and terrestrial species; performing particle filtration, nutrient sequestration, and recycling; and modifying habitats, especially when found in dense aggregations known as mussel beds (Vaughn 2018). Empty mussel shells also provide physical habitat for other aquatic organisms as well as long-term storage and release of nutrients and minerals.

Studies and status assessments have revealed alarming declines in freshwater mussels. In the United States, over 70% of the approximately 300 species are declining, threatened, endangered, or extinct (Williams et al. 1993). A similar pattern holds in Maryland, where 13 of the state's 16 native species are identified as SGCN and one species (Atlantic spike *[Elliptio producta]*) is identified as SAPS due to taxonomic uncertainty. These include eight globally rare species and seven state-listed species. At both the state and national level, freshwater mussels represent one of the most imperiled faunal groups (Strayer et al. 2004). Their decline is an indication of their sensitivity to many factors, especially pollution and habitat loss (Downing et al. 2010), along with the condition of many of our streams and rivers.

Triangle floater (Alasmidonta undulata)
(James McCann, MD DNR)

Since 1990, MD DNR NHP and MD DNR Monitoring and Non-tidal Assessment Division (MANTA) have conducted more than 1,500 freshwater mussel surveys in streams, rivers, and impoundments throughout the state (Bogan et al. 2026). These data, along with intensive population monitoring for some high priority species, have provided essential information for conducting species status assessments, identifying important mussel habitat, and prioritizing conservation actions. Presently, three species are state-listed as Endangered, including the dwarf wedgemussel, which is also federally listed as Endangered. Among the most imperiled species are brook floater *(Alasmidonta varicosa)* and green floater. Both are state-listed as Endangered and have been recently considered for federal listing. Although they were once fairly widespread in rivers of the Piedmont and Ridge and Valley physiographic regions, only a few small populations of each species remain; similar declines have been observed in surrounding states. Yellow lance is state- and federally listed as Threatened. It was not known to be extant in Maryland when the 2015 SWAP revision was written because of unresolved taxonomic relationships within the lance-shaped *Elliptio* species. The triangle floater *(Alasmidonta undulata)* was recently downlisted in Maryland from Endangered to Threatened. Although it is typically found in very low numbers, it is fairly widespread in Maryland, occurring from the Delmarva peninsula to the Ridge and Valley. Two other species, the Atlantic spike and creeper (*Strophitus undulatus*), are state-listed as In Need of Conservation. As previously mentioned, though it may be state-listed, the Atlantic spike has been moved to the SAPS list for the 2025 SWAP revision due to recent concerns about its taxonomic validity versus the closely related northern lance *(Elliptio fisheriana).*

Case Study: Planting Trees and "Planting" Mussels

As a tree's canopy spreads over a stream and its roots anchor into the soil, humans and wildlife alike reap the benefits. These include cleaner water through erosion and runoff control, cleaner air through leaves' absorption of carbon dioxide and other particles, and food, shelter, and shade for all life forms. These living, breathing filters benefit the terrestrial habitat and the aquatic habitat. One group that benefits from tree-lined waterways are freshwater mussels.

Town Creek (Matt Ashton, MD DNR)

Due largely to loss and degradation of habitat, more than 70% of mussels in the U.S. are extinct, endangered, or in decline. The best remaining mussel populations occur in relatively intact streams in predominantly forested watersheds. Multiple studies have found diverse mussel populations and rare mussel species correlate with the presence of forested streamside, or riparian buffers.

Collaborating in the Town Creek Watershed

MD DNR's Forest Service (MFS) works with private landowners to get trees in the ground for stream restoration projects that support habitat for sensitive species, like mussels and Brook trout. MFS been planting riparian forest buffers in the Town Creek watershed since 1997 thanks to supportive landowners and funding from the U.S. Environmental Protection Service (EPA). The Town Creek Ecosystem Management Project was funded through a Special Rivers Project grant, eventually expanding to most of Allegany County. More than 100,000 linear feet and 327 acres of buffers have been planted so far by forestry staff and partners. Today, streamside forests along Allegany County waterways stabilize banks and reduce runoff, providing stable stream bottoms required by native mussel species.

Brook floater (Alasmidonta varicosa)
(Matt Ashton, MD DNR)

Following the success of the Forest Service's riparian forest buffer project at improving stream health, staff from MD DNR's Wildlife and Heritage Service (WHS) and Resource Assessment Service (RAS) began planning for release of freshwater mussels in Town Creek in 2015 with the revision of Maryland's previous SWAP, which recognized a need for restoration.

In the summer of 2020, staff "planted" 116 individually marked, hatchery-propagated brook floater in stream bottom enclosures in portions of the creek where riparian buffers had been established. After two months, there was 99% survival among the small mussels, and they'd grown up to a tenth of an inch. Unfortunately, a major flood happened in the river valley a month later and washed away most of the enclosures and their mussels. Encouraged by the initial results, MD DNR repeated the study in 2021 with another 125 brook floater and observed the same pattern. After three months, 98% of the mussels survived and had grown about a tenth of an inch. In the following spring, only one more mussel had died, indicating they grew enough to survive through the winter when food, like phytoplankton, is scarce. From 2022 to 2023, another 373 brook floater were stocked, and 85 of these at least once during annual surveys.

Other studies to culture freshwater mussels in a MD DNR hatchery, develop a mussel restoration plan framework, and conduct a reintroduction of a common species of mussel (eastern elliptio) were all necessary before committing resources to larger restoration projects like the one in Town Creek. This work also required a range of partners to be successful, including Trout Unlimited, Pennsylvania Fish and Boat Commission, and the Virginia Fisheries and Aquatic Wildlife Conservation Center at Harrison Lake National Fish Hatchery.

Freshwater mussels play an important role in streams. One adult mussel can filter 10–15 gallons of water a day, and their presence has been linked to healthy aquatic communities. According to one study (Hoellein et al 2017), a typical mussel population of a stream could remove 56 kilograms of nitrogen per day. With some mussels able to live for decades, these ecosystem services can have enormous effects on Maryland's waters. Just as trees cool and clean runoff from the landscape, mussels can help play a role in cleaning streams. Ultimately, the goal is to restore a healthy, self-sustaining mussel community that will help overall stream health in Town Creek and bring downstream benefits to the Potomac River, and eventually the Chesapeake Bay.

Cave and Groundwater Invertebrate SGCN

This highly diverse group comprises 24 SGCN and 25 SAPS. All are obligate subterranean species that are restricted to cave habitats and/or shallow groundwater springs and seeps (i.e., hypotelminorheic habitats). Most species are aquatic, occurring in cave drip pools, phreatic (groundwater) pools, subterranean streams, shallow groundwater aquifers, and associated spring and seep emergences. Their greatest diversity lies in karst-dominated areas in western Maryland, followed by the Piedmont and the Fall Zone, where the Piedmont abruptly transitions into the Upper Coastal Plain. Most are troglomorphic, meaning they exhibit physical adaptations to subterranean life, such as reduced eyes and pigment. Caves and other subterranean habitats are extremely fragile and subject to numerous threats that could permanently alter or eliminate them.

Franz's cave amphipod (Caecidotea franzi)
(Dan Feller, MD DNR)

This group includes many of the state's rarest, most imperiled species, including at least eight Maryland endemics. The group is represented by 32 crustaceans, 10 flatworms or planarians, 5 spiders, a beetle, and a springtail. Of the 49 species, 26 are globally rare and 19 have state legal protection. Unfortunately, one species, Norden's groundwater isopod (*Caecidotea nordeni*), has been determined to be extirpated after extensive searches failed to relocate the species at the initial location or any other sites. It has therefore been removed from the SGCN list for the 2025 SWAP revision.

Terrestrial Invertebrate SGCN: Butterflies

Butterflies are one of the most surveyed invertebrate taxa in Maryland. As highly conspicuous pollinators, they are well represented on community science platforms such as iNaturalist. Similar to odonates, MBP and other naturalists monitor rare butterfly populations annually, providing a strong understanding of population status and trends. For example, a group of naturalists conducts butterfly counts in Green Ridge State Forest twice a year to track shale barren–associated species.

One hundred and fifty-eight species of butterfly have been found in Maryland with 27 listed as SGCN and 25 listed as SAPS. Of these, 20 are of regional concern, 8 are ranked globally rare by NatureServe, and 17 have state legal protection. Six species were removed from the 2025 SWAP revision, due to either never occurring in Maryland, being extirpated, being a vagrant or stray, or being more common than previously known.

Terrestrial Invertebrate SGCN: Moths

The most substantial invertebrate update in the 2025 SWAP revision is the comprehensive assessment of eight macro-moth families in Maryland (Noctuidae, Geometridae, Sphingidae, Saturniidae, Notodontidae, Lasiocampidae, Drepanidae, and Erebidae). This effort was made possible by the availability of extensive resources, including "Macromoths of Maryland: An Annotated List" (Glaser et al., unpublished, 2005), Bob Patterson's Moth Photographers Group (2026), data from the North Carolina Biodiversity Project moth database (Hall et al. 2026), and the continued inventorying efforts of MBP volunteers.

Ash sphinx (Manduca jasminearum)
(Mike Burchett, MBP)

To date, at least 2,704 moth species have been recorded in Maryland. Of these, 268 species are designated as SAPS due to their apparent rarity and 43 species are listed as SGCN. Twenty-two species are ranked globally rare and 19 are of regional concern. Sixteen moth species have been removed from the 2025 revision for being extirpated. Thirteen moth SGCN are considered ash-dependent and are therefore threatened by the decline of *Fraxinus* species caused by the invasive emerald ash borer (*Agrilus planipennis*).

Terrestrial Invertebrate SGCN: Bees

A comprehensive assessment of Maryland bees represents the second-most substantial invertebrate update in the 2025 revision. Maryland is fortunate to host the United States Geological Survey (USGS) Bee Lab at the Eastern Ecological Science Center within the Patuxent Wildlife Research Refuge. This lab is one of the premier bee data collection and identification centers in the country. Bees from across the United States are processed, identified, and added to the database at the USGS Bee Lab. These records are made publicly available through DiscoverLife.org (Ascher & Pickering, 2020). A key resource used for the SWAP assessment isa soon-to-be-published manuscript from the USGS Bee Lab detailing every bee species found in Maryland and associated conservation actions (Droege et al., in preparation).

Maryland is host to 409 species of bees, 46 of which are listed as SGCN and 141 as SAPS in the 2025 SWAP revision. Seven of these bee species are considered globally rare and 18 are of regional concern. One species, the rusty-patch bumble bee, is both federally and state-listed as Endangered due to its rediscovery in Garrett County in 2022 after no records for 20 years. Three species were removed from the 2025 revision due to extirpation. One additional species, the marine metallic-sweat bee, was removed due to being more common than previously known and apparently secure.

Terrestrial Invertebrate SGCN: Hoverflies (Syrphidae)

The family Syrphidae was evaluated as a taxonomic group for the first time in the 2025 SWAP revision. Commonly known as hoverflies or flower flies, syrphids provide important ecosystem services, including pollination by adults and biological control by larvae. Some species are relatively conspicuous and are frequently detected during flower surveys targeting bees, while others feed on sap or decaying vegetation and are more difficult to detect. A key resource for assessing Syrphidae in Maryland was the syrphid database housed in the Canadian National Collection of Insects, Arachnids, and Nematodes, assembled in support of the *Field Guide to the Flower Flies of Northeastern North America* (Skevington et al. 2019).

At least 184 syrphid species are known to occur in Maryland. Of these, only one species, the painted wood fly (*Blera pictipes*), is listed as an SGCN, while 74 are listed as SAPS, four of which are considered globally rare.

Bethany Beach firefly (Photuris bethaniensis) (Jason Davis, DNREC)

Terrestrial Invertebrate SGCN: Fireflies

Fireflies were also evaluated as a taxonomic group for the first time in the 2025 SWAP revision. In recent years, interest in firefly conservation has increased substantially, driven in part by public concerns over population decline. We have substantially greater understanding of firefly distribution and ecological needs in Maryland due to closer coordination between states through the Xerces Society for Insect Conservation Firefly Working group and a two-year statewide survey of Maryland parks. Identification remains challenging without specimens and flash patterns, but ongoing development of morphology-based identification resources is expected to support future assessments.

Maryland hosts at least 30 species of fireflies, five of which are listed as SGCN and 16 of which are listed as SAPS. At least six are globally rare and nine are of regional concern. The Bethany Beach firefly was proposed for listing as Threatened under the Endangered Species Act in 2024.

Terrestrial Invertebrate SGCN: Tiger Beetles

Maryland hosts 27 species of tiger beetles, 10 of which are SGCN and five of which are SAPS in the 2025 SWAP revision. This relatively well-known beetle group includes seven globally rare taxa, all of which also have state legal protection and are considered of regional concern. Two are also federally listed as Threatened (Puritan tiger beetle and eastern beach tiger beetle). Tiger beetles as a group occur in a variety of habitats, but each of the rare species is highly habitat-specific, requiring highly dynamic habitats whose existence depends on disturbance regimes. These habitats include naturally eroding earthen cliffs along the Chesapeake Bay, pristine coastal beaches, and fire-dependent sandy pine-oak woodlands.

Other Invertebrate SGCN of Maryland

Every species known to be in Maryland of the above taxa were assessed for the 2025 SWAP revision. Several additional taxa groups could not be fully investigated, though they were included selectively due to known conservation concerns. As noted above, the 15 mayflies designated as SAPS fall into this category.

Beyond the fully assessed groups, 11 beetle SGCN and 24 beetle SAPS were identified. Four of these beetles have state legal protection: the Seth Forest water scavenger beetle (*Hydrochus spangleri*), a vernal pool obligate known from only two sites on the Eastern Shore; the six-banded longhorn beetle (*Dryobius sexnotatus*), which may be an old growth sugar maple specialist; and two darkling beetles (family Tenebrionidae), *Helops cisteloides* and *Schoenicus puberulus*, which are restricted to inland sand ridge oak–pine woodlands on the lower Eastern Shore. Other listed beetles include ash specialists, chestnut specialists, lady beetles, and aquatic beetles.

In the insect order Hemiptera, three SGCN and two SAPS were identified, including the state-endangered and globally rare eastern sedge barrens leafhopper (*Limotettix minuendus*). For ants, one SGCN (an ash specialist) and 16 SAPS were identified. Within wasps, 67 SAPS were identified across the families Crabronidae, Vespidae, and Sphecidae. For flies, five SGCN and two SAPS were included, representing bee flies (Bombyliidae), ash gall formers, and pitcher plant specialists. Five mite species—largely pitcher plant or ash specialists—and one ash-specialist sawfly were also listed. In total, 28 ash-specialist invertebrates were listed as SGCN.

This SWAP revision also includes six land snail SGCN and seven land snail SAPS. Seven of these species are globally rare, seven are of regional concern, and four have state legal protection: the Appalachian springsnail (*Fontigens bottimeri*), Blue Ridge springsnail (*Fontigens orolibas*), cherrystone drop (*Hendersonia occulta*), and Maryland glyph (*Glyphyalinia raderi*). Three snail species have been removed due to extirpation or because subsequent review determined that the original specimens did not occur in Maryland. Finally, three crayfish SGCN and two crayfish SAPS are included, all of which are impacted by stream degradation and the expansion of non-native crayfish populations.

Cherrystone drop (Hendersonia occulta) (Timothy Pearce, Carnegie Museum of Natural History)

Some taxa, such as beetles, flies, and wasps, are so diverse that the relatively small number included here represent only a fraction of the species in Maryland. However, by prioritizing groups that are already known or reasonably feasible to assess, we can make more actionable conservation decisions that may also benefit less-studied taxa. One path forward to inventory those diverse groups is through targeted surveys of rare plants to identify monophagous or highly specialized species. Several taxa were not assessed at all due to limited records, a lack of taxonomic expertise, and/or low representation in community science data. Nonetheless, some groups warrant closer attention because sufficient expertise exists and their overall diversity is more manageable. These include the insect orders Mecoptera (scorpionflies), Neuroptera (lacewings), Araneae (spiders), and Orthoptera (grasshoppers/ katydids). Orthopterans may be particularly vulnerable to grassland loss, and some species can be identified by their calls, providing a possible method for future survey efforts. Finally, although the horseshoe crab

(*Limulus polyphemus*) was not assessed within the invertebrate taxa covered here, it is listed as a SGCN within the marine fish section of this SWAP revision.

Threats to Invertebrate SGCN

Like plants, declines in rare invertebrates often serve as early indicators of habitat degradation, preceding impacts to higher trophic levels. One of the greatest challenges facing invertebrate conservation in Maryland is the sheer number of species, which makes conservation of all rare species impossible. This challenge is compounded by the fact that invertebrates, despite representing the majority of animal diversity, receive comparatively few conservation resources. Simply, invertebrates receive less—and often more negative—attention than more charismatic fauna. Thus, there is a huge taxonomic bottleneck limiting invertebrate conservation. Funding limitations further exacerbate this issue resulting in some species declining due to insufficient resources to intervene.

Maryland is fortunate to have the ability to provide legal protection to state-listed species. However, discrepancies between the biological survey record and environmental review process can lead to a lag in those protections. For example, a population of the federally threatened Puritan tiger beetle was discovered along the Severn River, but that information did not reach the Maryland Department of the Environment (MDE) in time to prevent shoreline armoring with riprap at that site. Additionally, there is currently no automatic data-sharing mechanism between MBP and the MD DNR NHP database. As a result, some records are not flagged during environmental review in time to prevent habitat degradation or loss.

Beyond these administrative challenges, habitat loss and degradation represent the primary threats to invertebrates in Maryland. The state is among the most densely populated in the country and lies within close proximity to multiple major population centers. As a result, development associated with low-density residential housing, solar facilities, data centers, and transmission corridors poses an ongoing threat to invertebrate habitats. Development also fragments remaining undeveloped areas. Habitat fragmentation limits the ability of populations to disperse and recolonize sites following local extirpations caused by habitat loss, extreme weather, or disease. The effects of deer browse, predation, and parasitism may also be intensified as populations become concentrated within small, isolated habitat patches. Finally, fragmentation can lead to inbreeding depression by restricting gene flow among isolated populations, increasing the likelihood of reduced fitness and the expression of deleterious traits.

Development that alters water quality or hydrology is a particularly serious threat to aquatic invertebrates. Dams, for example, can have profound impacts on freshwater mussels and have contributed to the extinction of several species in North America. In Maryland, dams have limited mussel population size and reproduction by blocking the movement of host fishes, particularly migratory species such as shad, river herring, and eels (Galbraith et al. 2018). Undersized or failing culverts can produce similar effects in smaller streams by restricting fish passage and degrading aquatic habitat. Vernal pools, which provide the sole breeding habitat for several invertebrate SGCN, may be drained or degraded through development. The loss of beaver impoundments, along with the ditching and draining of marshes and wetlands for agricultural purposes, further threatens dragonfly and damselfly SGCN, as well as other invertebrates that depend on wetlands to complete their life cycles. In addition, cave and groundwater habitats that support several SGCN are exceptionally fragile and have very limited potential for restoration once their catchment basins are polluted or otherwise disturbed.

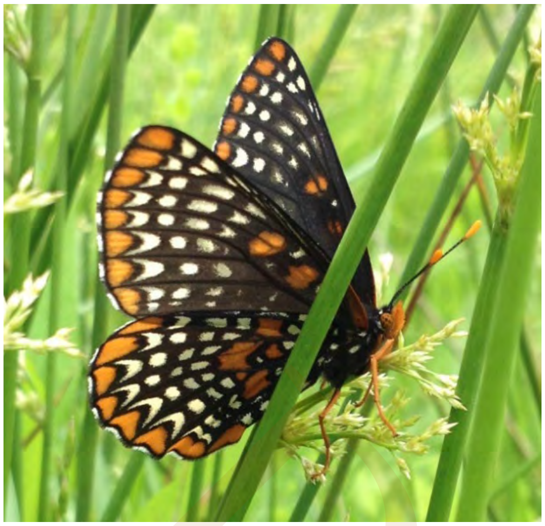
Unfortunately, even protected lands are not immune to development pressures. A recent Maryland law change exempted certain portions of Maryland's Wildlands, such as those within Savage River State Forest, from industrial activities. In addition, the state has limited authority over land-use decisions on federal properties. Maryland hosts the Patuxent Wildlife Research Refuge, a large, undeveloped area that supports numerous rare invertebrate species, particularly bees and odonates. Development of this site would result in the extirpation of hundreds of invertebrate species from the state. Nearby, the Beltsville Agricultural Research Center contains a rare pine barren habitat. The proposed closure of this facility leaves the future of this land uncertain.

Habitat degradation is another key threat to invertebrates, though it can occur in counterintuitive ways. For example, many rare invertebrate species in the state are specialists of barrens and grasslands rather than interior forests. Canopy closure, non-native plant invasion, and forest mesophication pose significant threats to sand dunes in Coastal Plain oak–pine forests on the Eastern Shore, serpentine barrens in central Maryland, and shale barrens in western Maryland. Similarly, Coastal Plain seepage acidic fens and montane acidic fens are also increasingly threatened by canopy closure.

Whether driven by climate change, fire suppression, invasive plant species, or natural succession, these processes are causing the gradual loss and homogenization of unique barren habitats. In some cases, disturbed or developed areas now provide the most suitable remaining habitat. Certain tiger beetle species, for example, are found primarily in powerline corridors or along forestry roads, while many butterfly and bee species benefit from the floral resources available in/along roadsides, utility rights-of-way, suburban gardens, agricultural field edges, and sand or gravel mines. However, these alternative habitats carry their own risks, including frequent mowing or herbicide application, soil compaction, and elevated pollution levels.

Pollution is a major concern for both aquatic and terrestrial invertebrates. Freshwater mussels, crustaceans, odonates, aquatic macroinvertebrates, and spring amphipods are especially sensitive to contamination of water sources from acid mine drainage, sedimentation, and nutrient runoff. Light pollution is harmful to moths, fireflies, and adult EPT taxa because it interferes with orientation, leads to wasted energy, and disrupts mating behavior (Owens et al. 2020). Pesticides are among the most harmful pollutants affecting terrestrial invertebrates. Agricultural pesticide drift is particularly damaging to pollinator taxa, causing both direct mortality and sublethal effects that impair navigation, foraging, and reproduction (Desneux et al. 2007). Pesticide applications targeting forest pests, such as spongy moths or hemlock woolly adelgid, can have substantial non-target effects on rare species that share these habitats. In addition, mosquito control programs conducted by state agencies or residential pest control companies can result in significant non-target exposure when broad-spectrum adulticides are used.

Many invertebrate taxa are specialists on particular hosts, and the decline of these hosts represents a critical threat to rare species. For some freshwater mussel SGCN, dependence on specific host fish species to complete their life cycle exacerbates vulnerability, as these fishes are



Baltimore checkerspot (*Euphydryas phaeton*)
(Scott Smith, MD DNR)

themselves sensitive to the same environmental stressors affecting aquatic systems. For primary consumers in terrestrial systems, hosts are usually plants, either as larval food sources or as providers of pollen. One of the primary drivers of host plant loss in Maryland is intensive browsing by overabundant deer populations. Certain plant species are particularly vulnerable, including white turtlehead (*Chelone glabra*), the host plant of the Baltimore checkerspot (*Euphydryas phaeton*), and sundial lupine (*Lupinus perennis*), a host plant for the frosted elfin (*Callophrys irus*). Deer browsing also contributes to the widespread loss of oak regeneration. This change is significant because oaks support hundreds of invertebrate species (Tallamy 2021).

Invasive species further contribute to the decline of rare invertebrates. This occasionally manifests as direct competition or predation—such as impacts to native mussels from zebra mussels, blue catfish, and rusty crayfish—but often takes the form of indirect effects such as introduced pests and pathogens. The decline of chestnut and ash trees, for example, has led to corresponding declines in their associated specialist invertebrates. If beech diseases continue to expand in Maryland, additional impacts are likely, including potential declines of the early hairstreak butterfly. Pathogens can also affect invertebrates directly. Recent declines in bumble bees have been partially attributed to the spread of *Nosema bombi*, a parasitic microsporidian introduced to North American bees through the importation of European bumble bees (Jacobson et al. 2018).

Climate change represents an emerging threat to invertebrates, with impacts that are often complex and difficult to predict. Sea-level rise, along with shoreline stabilization efforts intended to mitigate its effects, poses a clear threat to Maryland's beach, cliff, and tidal wetland invertebrates, as habitats may be hardened, submerged, eroded, lost to storm surges, or exposed to increased salinity. Increasing drought frequency has the potential to reduce nectar resources in harsh barren habitats, a pattern observed occasionally in shale barrens of western Maryland. Increased temperature variability can also drive population declines. For example, the Baltimore checkerspot butterfly experiences high mortality during winter heat waves (Abarca et al. 2019). In addition, many invertebrate species, particularly in Garrett County, are likely to experience range shifts that may result in their extirpation from Maryland, while other species are expected to expand into the state, a trend already observed in southern Maryland counties. Climate change also poses a growing and poorly understood threat to aquatic invertebrates such as freshwater mussels. Changes in precipitation patterns and water temperatures are expected to alter hydrology, host fish populations, and habitat availability (Hastie et al. 2003; Galbraith et al. 2010). As lower reaches of coastal streams become increasingly saline due to sea-level rise, freshwater mussel habitat is likely to contract toward the Fall Line and may eventually disappear altogether. These transitional reaches near the non-tidal–tidal boundary currently support a diverse and distinctive mussel assemblage, including the alewife floater (*Utterbackiana implicata*) and tidewater mucket (*Atlanticoncha ochracea*).

Lastly, the improper use of ecological resources poses a threat to many invertebrates. Illegal ATV use on forestry roads can place tiger beetle populations at risk. Spelunking threatens rare amphipods and isopods that depend on these habitats. The collection of rare insects for pinning or display has also historically affected some charismatic taxa, including butterflies and tiger beetles. Even activities considered ecologically beneficial can have unintended negative consequences. Captive rearing of butterflies, for example, can reduce genetic diversity and increase pathogen transmission (see the Xerces Society joint statement on captive breeding of monarchs). Similarly, the commercial breeding and sale of bees for pollination purposes can elevate disease risks in native bees, and "bee hotels" have been shown to increase rates of parasitism (MacIvor & Packer 2015).

Conservation Actions and Information Needs for Invertebrate SGCN

Over the past decade, tremendous progress has been made in understanding the conservation needs, occurrences, and distributions of Maryland's invertebrate species. While surveys to discover new records, monitor existing populations, and study life histories remain a priority, our focus is shifting toward applying this knowledge to active conservation. As a part of the 2025 SWAP revision process, we outlined specific, often location-based conservation actions for each invertebrate SGCN, with most of these actions being aimed at recovery rather than simply avoiding extirpation. Fortunately, many invertebrate conservation actions are effective at relatively small scales, making them more practical to implement. These actions may include augmenting and/or reintroducing host plants or invertebrate populations, planting flowering resources, creating no-mow areas or time periods, removing invasive species, installing deer exclosures around host plants, conducting prescribed burns, creating buffers, plugging drainage ditches, and reducing pollution near important waterbodies. Although this list of actions has been generalized for brevity, the list of specific location-based actions generated during the development of the 2025 SWAP will be reviewed, prioritized, and used for future conservation actions.

Effective conservation also requires a broader, landscape-level perspective that considers regional species recovery rather than focusing solely on individual populations. This requires maintaining connectivity between metapopulations through habitat corridors by working with private landowners to establish "stepping stones" on agricultural or urban lands. Collaboration with partners is essential, whether partnering with the State Highway Administration to plant pollinator strips along roadsides, the Maryland Forest Service to conduct prescribed burns, or the Department of Agriculture to reduce pesticide impacts from mosquito control. Finally, public education and engagement are critical. Fact sheets, outreach materials, and social media must emphasize the diversity and ecological importance of Maryland's rare invertebrates, helping the public better understand our agency's conservation efforts.

Table 3.17 Existing federal recovery plans for invertebrate SGCN

Invertebrate Species	Federal Recovery Plan	Recent Action
Insect Species		
Eastern beach tiger beetle	USFWS 1994	2025: Initiation of 5-year review
Puritan tiger beetle	USFWS 1993b	2018: Initiation of 5-year review
Rusty-patch bumble bee	USFWS 2021	2021: Initiation of 5-year review
Other Invertebrate Species		
Dwarf wedgemussel	USFWS 1993a	2025: Initiation of 5-year review
Yellow lance	USFWS 2022	2023: Initiation of 5-year review

Table 3.18 Invertebrate SGCN in Maryland

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Dragonflies and Damselflies (Odonates)						
American emerald	*Cordulia shurtleffii*	G5	S3			C
Appalachian jewelwing	*Calopteryx angustipennis*	G4	S1S2			A
Appalachian snaketail	*Ophiogomphus incurvatus incurvatus*	G3T2T3	S1		E	A
Atlantic bluet	*Enallagma doubledayi*	G5	S1			A
Banded spiketail	*Zoraena obliqua fasciata*	G4T3Q	S1			A
Beaverpond baskettail	*Epitheca canis*	G5	S3			C
Black-tipped darner	*Aeshna tuberculifera*	G5	S2			B
Blackwater bluet	*Enallagma weewa*	G5	S2			B
Burgundy bluet	*Enallagma dubium*	G5	S1			A
Canada darner	*Aeshna canadensis*	G5	S2			B
Coppery emerald	*Somatochlora georgiana*	G3G4	S1			A
Crimson-ringed whiteface	*Leucorrhinia glacialis*	G5	S1			A
Elfin skimmer	*Nannothemis bella*	G4G5	S1		E	A
Fine-lined emerald	*Somatochlora filosa*	G5	S2			B
Frosted whiteface	*Leucorrhinia frigida*	G5	S1			A
Green-faced clubtail	*Hylogomphus viridifrons*	G3G4	S1			A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Green-striped darner	*Aeshna verticalis*	G5	S2			B
Harpoon clubtail	*Phanogomphus descriptus*	G4G5	S1S2			A
Hudsonian whiteface	*Leucorrhinia hudsonica*	G5	S1			A
Laura's clubtail	*Stylurus laurae*	G4	S2S3			B
Little blue dragonlet	*Erythrodiplax minuscula*	G5	S1			A
Maine snaketail	*Ophiogomphus mainensis fastigiatus*	G4G5TU	S1			A
Midland clubtail	*Gomphurus fraternus*	G5	S2			B
Mustached clubtail	*Hylogomphus adelphus*	G5	S1			A
Northern bluet	*Enallagma annexum*	G5	S1			A
Pale bluet	*Enallagma pallidum*	G4	S1			A
Pygmy snaketail	*Ophiogomphus howei*	G3	S1			A
Rainbow bluet	*Enallagma antennatum*	G5	S1			A
Rapids clubtail	*Phanogomphus quadricolor*	G3G4	S2		I	A
Royal river cruiser	*Macromia taeniolata*	G5	S3			C
Rusty snaketail	*Ophiogomphus rupinsulensis*	G5	S2			B
Seepage dancer	*Argia bipunctulata*	G4	S3			C
Selys' sundragon	*Helocordulia selysii*	G4	S2		T	B
Ski-tailed emerald	*Somatochlora elongata*	G5	S2			B
Southern pygmy clubtail	*Lanthus vernalis*	G4	S2			B
Southern sprite	*Nehalennia integricollis*	G5	S1S2			A
Sparkling jewelwing	*Calopteryx dimidiata*	G5	S2			B
Spatterdock darner	*Rhionaeschna mutata*	G4	S1		E	A
Sphagnum sprite	*Nehalennia gracilis*	G5	S2			B
Spine-crowned clubtail	*Hylogomphus abbreviatus*	G4	S1			A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Splendid clubtail	*Gomphurus lineatifrons*	G4	S1			A
St. Croix snaketail	*Ophiogomphus susbehcha*	G1	S1			A
Superb jewelwing	*Calopteryx amata*	G5	S1S2		T	A
Treetop emerald	*Somatochlora provocans*	G4	S1		E	A
Uhler's sundragon	*Helocordulia uhleri*	G5	S3			C
White corporal	*Ladona exusta*	G5	S1		E	A
Zebra clubtail	*Stylurus scudderi*	G5	S1			A
Mayflies, Stoneflies, and Caddisflies (EPT)						
Dusky sallfly	*Alloperla biserrata*	G3	SNR			D
Lash springfly	*Remenus bilobatus*	G4?	SNR			D
Lobed stone	*Acroneuria internata*	G4	SNR			D
Pocahontas sallfly	*Sweltsa pocahontas*	G2G3	S2			A
Shenandoah needlefly	*Megaleuctra flinti*	G2G3	S1			A
Shenandoah sallfly	*Sweltsa palearata*	G2G3	S2			A
Variable needlefly	*Leuctra variabilis*	G3	SNR			D
Vernal springfly	*Helopicus subvarians*	G4	SNR			D
Freshwater Mussels						
Alewife floater	*Utterbackiana implicata*	G5	S3			C
Brook floater	*Alasmidonta varicosa*	G3	S1		E	A
Creeper	*Strophitus undulatus*	G5	S2S3		I	B
Dwarf wedgemussel	*Prolasmidonta heterodon*	G2?	S1	E	E	A
Eastern lampmussel	*Lampsilis radiata*	G5	SU			D
Eastern pondmussel	*Sagittunio nasutus*	G3	S1S2			A
Green floater	*Lasmigona subviridis*	G2G3	S1	PT	E	A
Northern lance	*Elliptio fisheriana*	G4	S3S4			C

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Paper pondshell	*Utterbackia imbecillis*	G5	S3			C
Tidewater mucket	*Atlanticoncha ochracea*	G3G4	S1S2			A
Triangle floater	*Alasmidonta undulata*	G4	S1S2		T	A
Yellow lampmussel	*Lampsilis cariosa*	G3G4	SU			D
Yellow lance	*Elliptio lanceolata*	G2	S1	T	T	A
Cave and Groundwater Invertebrates						
A cave obligate planarian	*Sphalloplana buchanani*	G1G2	SNR			D
A planarian	*Paraplanaria dactyligera*	GNR	S2			B
A planarian	*Procotyla typhlops*	G1G2	S1		E	A
Allegheny spring isopod	*Caecidotea alleghenyensis*	G1G2	S1		E	A
Biggers' cave amphipod	*Stygobromus biggersi*	G2G4	S1		E	A
Capital Area groundwater amphipod	*Stygobromus sextarius*	G1	S1		E	A
Cecil groundwater amphipod	*Stygobromus caecilius*	G1	S1		E	A
Feller's groundwater amphipod	*Stygobromus felleri*	G1	S1		E	A
Franz's cave isopod	*Caecidotea franzi*	G2G4	S1		E	A
Friendly cave amphipod	*Stygobromus amicus*	G1	S1		E	A
Greenbrier cave amphipod	*Stygobromus emarginatus*	G3	S1		E	A
Hoffmaster's cave planarian	*Sphalloplana hoffmasteri*	G3G4	S1		E	A
Holsinger's cave isopod	*Pseudobaicala-sellus holsingeri*	G5	S1		E	A
Maus' cave isopod	*Pseudobaicala-sellus mausi*	G2	S1		E	A
Pennsylvania cave amphipod	*Crangonyx dearolfi*	G2	S1		E	A
Pizzini's cave amphipod	*Stygobromus pizzinii*	G3G4	S1			A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Prettyboy groundwater amphipod	*Stygobromus paxillus*	G1	S1		E	A
Price's cave isopod	*Conasellus pricei*	G5	S3			C
Rappahannock spring amphipod	*Stygobromus foliatus*	G2	S1		E	A
Refton Cave planarian	*Sphalloplana pricei*	G2G3	SNR			D
Rock Creek groundwater amphipod	*Stygobromus kenki*	G2	S1		E	A
Shenandoah Valley cave amphipod	*Stygobromus gracilipes*	G3G4	S1		E	A
Tidewater amphipod	*Stygobromus indentatus*	G3	S1			A
Vandel's cave isopod	*Pseudobaicalasellus vandeli*	G3G4	S1		E	A
Butterflies						
Atlantis fritillary	*Argynnis atlantis*	G5	S1		T	A
Baltimore checkerspot	*Euphydryas phaeton*	G4	S2			B
Black dash	*Euphyes conspicua*	G4G5	S4			C
Bog copper	*Tharsalea epixanthe*	G4G5	S1		E	A
Bronze copper	*Lycaena hyllus*	G5	S4			C
Cobweb skipper	*Hesperia metea*	G4	S3			C
Edwards' hairstreak	*Satyrium edwardsii*	G4	S1		E	A
Frosted elfin	*Callophrys irus*	G3	S1		E	A
Gray comma	*Polygonia progne*	G5	S3			C
Great purple hairstreak	*Atlides halesus*	G5	S2S3			B
Harris's checkerspot	*Chlosyne harrisii*	G4?	S2		T	B
Hoary elfin	*Callophrys polios*	G5	S1		E	A
Indian skipper	*Hesperia sassacus*	G5	S3			C
King's hairstreak	*Satyrium kingi*	G3G4	S1		E	A
Leonard's skipper	*Hesperia leonardus*	G4	S2			B
Long dash	*Limochores mystic*	G5	S3			C

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Mulberry wing	*Poanes massasoit*	G4	S4			C
Northern metalmark	*Calephelis borealis*	G3	S2		T	A
Northern oak hairstreak	*Satyrium favonius ontario*	G5T4	S1S2		E	A
Olympia marble	*Euchloe olympia*	G5	S2		I	B
Palamedes swallowtail	*Pterourus palamedes*	G5	S1		E	A
Pepper and salt skipper	*Amblyscirtes hegon*	G5	S2		I	B
Rare skipper	*Atrytone bulenta*	G3	S1		T	A
Silver-bordered fritillary	*Boloria selene*	G5?	S3			C
Silvery blue	*Glaucopsyche lygdamus*	G5	S2		I	B
Two-spotted skipper	*Euphyes bimacula*	G4	S1		E	A
West Virginia white	*Pieris virginiensis*	G4	S1S2			A
Moths						
A grass miner moth	*Ethmia macelhosiella*	GNR	SNR			D
A twirler moth	*Coleotechnites variiella*	GNR	SNR			D
An owlet moth	*Meropleon titan*	G2G4	S2S4			B
Angel moth	*Olceclostera angelica*	G5	SNR			D
Ash borer moth	*Podosesia syringae*	GNR	SNR			D
Ash leaf cone roller moth	*Caloptilia fraxinella*	GNR	SNR			D
Ash sphinx	*Manduca jasminearum*	G3?	SNR			D
Ash tip borer moth	*Papaipema furcata*	G4	SNR			D
Bald cypress coneworm moth	*Dioryctria pygmaeella*	GNR	SNR			D
Banded ash clearwing moth	*Podosesia aureocincta*	GNR	SNR			D
Barred angle moth	*Macaria subcessaria*	G5	SNR			D
Bold-based zale moth	*Zale lunifera*	G3G4	SNR			D
Braun's ash bark-mining moth	*Marmara fraxinicola*	GNR	SNR			D

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Brown flower moth	*Schinia saturata*	G5	SNR			D
Coastal graphic moth	*Drasteria graphica*	G4	SNR			D
Comstock's sallow moth	*Feralia comstocki*	GNR	SNR			D
Cypress emerald moth	*Nemoria elfa*	G4?	SNR			D
Cypress looper	*Iridopsis pergracilis*	G4G5	SNR			D
Cypress pinion	*Lithophane abita*	G4	SNR			D
Cypress sphinx moth	*Isoparce cupressi*	G4	S1S2			A
Distinguished cypress owlet moth	*Cutina distincta*	G4	SNR			D
Eastern cactus-boring moth	*Melitara prodenialis*	G4	SNR			D
Epauletted pitcher plant moth	*Exyra fax*	G4	SNR			D
Franck's sphinx	*Sphinx franckii*	G4G5	S1S2			A
Fringed dart moth	*Eucoptocnemis fimbriaris*	G4	SNR			D
Gray cypress looper	*Cutina albopunctella*	GNR	SNR			D
Great ash sphinx	*Sphinx chersis*	G4	SNR			D
Grote's sallow moth	*Copivaleria grotei*	G5	SNR			D
Inkblot palpita moth	*Palpita illibalis*	GNR	SNR			D
Joyful holomelina moth	*Virbia laeta*	G5	S1?			A
Melsheimer's sack-bearer	*Cicinnus melsheimeri*	G4	SNR			D
Merry melipotis moth	*Melipotis jucunda*	G5	SNR			D
Ornate bella moth	*Utetheisa ornatrix*	G5	SNR			D
Pine barrens fungus moth	*Chytonix sensilis*	G4	SNR			D
Pine barrens zanclognatha	*Zanclognatha martha*	G4	S1S3			B
Purple plagodis moth	*Plagodis kuetzingi*	G5	SNR			D

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Sand wainscot moth	*Apamea lintneri*	G4	SNR			D
Seaside goldenrod stem borer	*Papaipema duovata*	G2G3	SU			D
Splendid palpita moth	*Palpita magniferalis*	GNR	SNR			D
Tuscarora emerald	*Nemoria tuscarora*	GU	SNR			D
Unexpected cycnia moth	*Cycnia inopinatus*	G4	SNR			D
Zeller's grass miner moth	*Ethmia zelleriella*	GNR	SNR			D
Bees						
A cellophane bee	*Colletes aestivalis*	GNR	SH			E
A cellophane bee	*Colletes speculiferus*	GNR	SNR			D
A cemolobus bee	*Cemolobus ipomoeae*	GNR	SNR			D
A cuckoo bee	*Nomada rubicunda*	GNR	S1S3			B
A cuckoo bee	*Nomada seneciophila*	GNR	S1			A
A dieunomia bee	*Dieunomia nevadensis*	G5	SU			D
A leafcutter bee	*Coelioxys immaculatus*	GNR	SNR			D
A leafcutter bee	*Paranthidium jugatorium*	GNR	SNR			D
A long-horned bee	*Epimelissodes comptus*	GNR	SNR			D
A mason bee	*Osmia chalybea*	G4G5	S1S3			B
A miner bee	*Perdita bradleyi*	GNR	SNR			D
A mining bee	*Andrena braccata*	GNR	SU			D
A mining bee	*Andrena fulvipennis*	GNR	SU			D
A mining bee	*Protandrena abdominalis*	GNR	SU			D
A sweat bee	*Lasioglossum arantium*	GNR	S2S3			B
A sweat bee	*Lasioglossum floridanum*	GNR	SNR			D
A sweat bee	*Lasioglossum nymphale*	GNR	S2S3			B
A sweat bee	*Lasioglossum raleighense*	GNR	SU			D

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
A sweat bee	*Lasioglossum sopinci*	GNR	SNR			D
A sweat bee	*Sphecodes brachycephalus*	GNR	SNR			D
American plasterer bee	*Colletes americanus*	GNR	SNR			D
An andrenid bee	*Andrena lamelliterga*	GNR	SNR			D
An andrenid bee	*Andrena phaceliae*	GNR	SNR			D
Azalea mining bee	*Andrena cornelli*	GNR	SNR			D
Cranesbill miner bee	*Andrena distans*	GNR	SNR			D
Felt's mason bee	*Osmia felti*	G3	SNR			D
Fringed loosestrife oil-collecting bee	*Macropis ciliata*	GNR	S1			A
George Eickwort's sweat bee	*Lasioglossum georgeickworti*	GNR	SU			D
Golden Alexanders miner bee	*Andrena ziziae*	GNR	SNR			D
Half-black bumble bee	*Bombus vagans*	G4	S3			C
Howard's cuckoo nomad bee	*Epeolus howardi*	GNR	SNR			D
Mustard miner bee	*Andrena arabis*	GNR	SNR			D
Nude plasterer bee	*Colletes nudus*	GNR	SNR			D
Pearly-banded bee	*Nomia maneei*	G3?	S1S3			A
Pickerelweed long-horned bee	*Melissodes apicatus*	GNR	SNR			D
Puny cuckoo nomad bee	*Epeolus pusillus*	GNR	SNR			D
Rusty-patch bumble bee	*Bombus affinis*	G2	S1	E	E	A
Summer miner bee	*Protandrena aestivalis*	G5	SNR			D
Sunflower miner bee	*Andrena helianthi*	GNR	SNR			D
Sunflower sweat bee	*Dieunomia heteropoda*	G5	S1S3			B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Texas mason bee	*Osmia texana*	G5	SNR			D
Trout lily miner bee	*Andrena erythronii*	GNR	SNR			D
Two-spotted miner bee	*Andrena accepta*	GNR	SNR			D
Waterleaf mining bee	*Andrena geranii*	GNR	SNR			D
Yellowbanded bumble bee	*Bombus terricola*	G3G4	S1			A
Hoverflies						
Painted wood fly	*Blera pictipes*	G4G5	SNR			D
Fireflies						
Bethany Beach firefly	*Photuris bethaniensis*	G1	S1	PT		A
Keel-necked firefly	*Pyractomena ecostata*	G3	SNR			D
Mysterious lantern firefly	*Photuris mysticalampas*	G1G2	S1			A
Potomac firefly	*Photuris potomaca*	GU	SNR			D
Salt marsh firefly	*Photuris salina*	G3	SNR			D
Tiger Beetles						
Appalachian tiger beetle	*Cicindela ancocisconensis*	G3	S1		E	A
Common claybank tiger beetle	*Cicindela limbalis*	G5	SNR			D
Cow path tiger beetle	*Cicindela purpurea*	G5	S3			C
Eastern beach tiger beetle	*Habroscelimorpha dorsalis dorsalis*	G3T2	S1	T	E	A
Eastern pinebarrens tiger beetle	*Cicindela abdominalis*	G3	S1		E	A
Ghost tiger beetle	*Ellipsoptera lepida*	G3	S1		E	A
Northern barrens tiger beetle	*Cicindela patruela*	G3	S1		E	A
Puritan tiger beetle	*Ellipsoptera puritana*	G1G2	S1S2	T	E	A
Splendid tiger beetle	*Cicindela splendida*	G5	S1			A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
White tiger beetle	*Habroscelimorpha dorsalis media*	G3T3	S1		E	A
Other Invertebrates						
A carpenter ant	*Colobopsis mississippiensis*	GNR	SNR			D
A dytiscid beetle	*Hoperius planatus*	GNR	S2			B
A tenebrionid beetle	*Helops cisteloides*	GNR	S1		E	A
A tenebrionid beetle	*Schoenicus puberulus*	GNR	S1		E	A
Allegheny crayfish	*Faxonius obscurus*	G5	S3			C
An ash seed weevil	*Lignyodes bischoffi*	G5	SNR			D
An ash seed weevil	*Lignyodes fraxini*	GNR	SNR			D
An ash seed weevil	*Lignyodes helvolus*	GNR	SNR			D
An ash seed weevil	*Lignyodes horridulus*	GNR	SNR			D
Angular disc snail	*Discus catskillensis*	G5	S1			A
Appalachian springsnail	*Fontigens bottimeri*	G2G3	S2		I	A
Ash bullet gall midge	*Dasineura pellex*	GNR	SNR			D
Ash flower gall mite	*Aceria fraxiniflora*	GNR	SNA			D
Ash key gall mite	*Aceria fraxinivora*	GNR	SNA			D
Ash leaf gall mite	*Aceria fraxini*	GNR	SNR			D
Blackheaded ash sawfly	*Tethida barda*	GNR	SNR			D
Blue Ridge springsnail	*Fontigens orolibas*	G3	S1		E	A
Cambarus sp. C (formerly acuminate crayfish)	*Cambarus sp. n.*	G4Q	S2		I	B
Charlie Brown's flea beetle	*Capraita sexmaculata*	GNR	SNR			D
Cherrystone drop	*Hendersonia occulta*	G4	S2		I	B
Eastern ash bark beetle	*Hylesinus aculeatus*	G5	SNR			D

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Eastern sedge barrens leafhopper	*Limotettix minuendus*	G1	S1		E	A
Encircled borer	*Agrilus subcinctus*	GNR	SNR			D
Fringetree lace bug	*Leptoypha mutica*	GNR	SNR			D
Pitcher plant midge	*Metriocnemus knabi*	G5	SNR			D
Pitcher plant mite	*Sarraceniopus gibsoni*	GNR	SNR			D
Pitcher plant mosquito	*Wyeomyia smithii*	G5	S2			B
Pitcher plant flesh fly	*Fletcherimyia fletcheri*	G5	SNR			D
Riley's 13-year cicada	*Magicicada tredecim*	GNR	SNR			D
Rock crayfish	*Cambarus carinirostris*	G5	SNR			D
Seth Forest water scavenger beetle	*Hydrochus spangleri*	G1	S1		E	A
Spruce knob threetooth	*Triodopsis picea*	G3	S1			A
Striped whitelip	*Webbhelix multilineata*	G5	S1			A
Swollen ash gall midge	*Dasineura tumidosae*	GNR	SNR			D

[1] = See Table 3.5 for S-rank and G-rank definitions
[2] = T (Threatened); E (Endangered); I (In Need of Conservation); PT (Proposed Threatened)
[3] = See Table 3.7 for Conservation Status definitions

Plants of Maryland

Plants form the basis of nearly every ecosystem, provide essential habitat and/or food for most faunal life forms and, of course, are intricately linked, directly or indirectly, to the survival of all SGCN. Native plants are also economically important, as they support pollinators necessary for agricultural production and healthy ecosystems globally. Furthermore, plant diversity is becoming especially important as ecosystems are pressured by the effects of climate change (Spohn et al. 2023).

Plants are reliable indicators of site conditions and reflect biological and ecological patterns across landscapes. Plants are more readily measurable than other biota or environmental conditions. Most U.S. states did not include plants in their discussion of SGCN during the first SWAP process in 2005; however, the development and revision of SWAPs provide an excellent opportunity for states to advance the conservation of declining, rare, threatened, and endangered plant species. MD DNR NHP developed a list of plant species for inclusion in the 2015 SWAP revision and now fully incorporates plants into the 2025 SWAP revision as SGCN (Table 3.20).

Maryland's contribution to regional biodiversity is far greater than its small size would suggest. Maryland ranks among the smaller states (42/50), and when compared with our close neighbors, Pennsylvania and Virginia, we are not only smaller, but we are also more densely populated. Yet Maryland DNR NHP tracks some 740 taxa of rare, threatened, and endangered plant species. The state's diverse hydrology and geology support 57 Key Wildlife Habitats (KWHs) within 75 broader Ecological Community Groups (Harrison 2022). Owing to its longitude—from the barrier islands along the Atlantic Coast to the high elevations of Garrett County, about 250 miles west—Maryland is comprised of five distinctly different Physiographic Provinces: Atlantic Coastal Plain, Piedmont, Blue Ridge, Ridge and Valley, and the Appalachian Plateau. As previously stated in Chapter 2, the Coastal Plain has been split into the Lower and Upper Coastal Plain for the purposes of this SWAP revision. Chapter 2 also contains descriptions of rare plant species and communities that can be found in each province.

Additional floristic complexity has been provided by the ebb and flow of climatic changes over geological time. Maryland is located south of the Wisconsinan glacial maxima during the Pleistocene Epoch (ending approximately 11,700 years before present), during which time the southern states, like Maryland, served as a refuge for migrating plant and animal species, many of which remain as part of our natural heritage today (Maryland Botanical Heritage Workgroup 2014). Maryland flora includes more than 2,918 taxa of which 2,099 are considered native (Knapp & Naczi 2021); totals have been amended as needed by the Maryland Plant Atlas Working Group. Understanding the distribution and abundance of all plant species is the goal of the Maryland Plant Atlas. The Maryland Plant Atlas aims to provide distribution maps for all native and naturalized plants in Maryland based on the most recent and accurate data, to provide information about Maryland's plants to the public, and to promote conservation by increasing public awareness of plant diversity.

Canby's dropwort (Tiedemannia canbyi)
(Dave Suiter, USFWS)

Plant SGCN of Maryland

Since 1980, staff of MD DNR NHP have worked with partners and numerous active naturalists to review, research, and revise the list of rare plants in the state. Of the 740 plants currently considered by NHP as rare, threatened, endangered, or extirpated, 454 have been listed by the 2025 SWAP process as SGCN in Maryland (Table 3.20). Given that plants are not typically included in a state's SWAP, plant SGCN were determined in a different manner than the other taxonomic groups. MD DNR NHP applied the SGCN categorization matrix (Figure 3.1) to the 740 listed plant species and included all species in status groups A and B on the SGCN list. This restricts the designation to plants that are globally rare and vulnerable, imperiled, or critically imperiled within Maryland. By limiting plant SGCN to these two categories, Maryland focuses its conservation resources on the most biologically precarious flora.

Of these 454 SGCN, 83 are state-listed as Threatened and 241 are listed as Endangered. The remaining 130 species are of conservation concern due to factors such as high threats, limited habitat, declines in the species' range, and/or the number and size of the remaining populations. Seventy SGCN taxa are considered globally rare (G1–G3, T1–T3). Not including the two federally listed plants that no longer occur in Maryland, seven species are federally listed (three Threatened and four Endangered), and seven species are narrow endemics. For additional state and global ranks, see Appendix 3a.

In Maryland regulations, Threatened species are defined in part as "any species of flora or fauna which appears likely, within the foreseeable future, to become endangered…" (COMAR 08.03.08.01). Plant species with this status occur in less than 20 populations in Maryland and typically have a limited within-state range. For example, white fringed orchid (*Platanthera blephariglottis*), a species restricted to the Atlantic Coastal Plain, occurs in the Coastal Plain Seepage Acidic Fen KWH (see Chapter 4 for more information on KWHs). This species occurs in approximately 19 populations, but 83% of these populations are very small, containing 1–25 individuals. Additionally, the range of this species in Maryland has contracted from seven to only four counties having extant populations.

Maryland regulations define Endangered species in part as "any species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy..." (COMAR 08.03.08.01). Plant species with this status occur in fewer than five populations and typically are extremely habitat-limited and often occur at single sites. An illustrative example is Appalachian sandwort (*Geocarpon glabrum*), a plant of high elevations in the Appalachian Mountains that occupies a single site in the Blue Ridge of Maryland in the Cliff and Rock Outcrop KWH.

Threats to Plant SGCN

Threats to plants are similar to the threats faced by Maryland's animal species with one added source of risk: plants cannot physically move away from any direct or indirect threat. The limited colonizing ability of many plant species is a major obstacle to the restoration of plant communities. The alteration of historical ecosystem processes, such as fire, and changes in the spatial arrangement of habitats via habitat destruction and fragmentation are key threats largely because plants are not mobile. Further, even if ecosystem processes are reinstituted, many previously occupied habitat patches may remain unoccupied and the linkages between habitat patches will remain fragmented due to insurmountable barriers to gene flow via seed and pollen. Loss of historical disturbance regimes, intensive urbanization, and human-mediated manipulation of species composition have led to the homogenization of plant species and loss of diversity over large areas. These, coupled with the limited capacity of the underground seed bank to aid recovery, have led to a rapid decline in both species diversity and composition of plant communities. Finally, the overabundance of white-tailed deer has been directly implicated in the altered species richness and abundance of Maryland orchids (Knapp & Wiegand 2014) and other rare species (Maryland Botanical Heritage Workgroup 2014). Other major threats include widespread infestation of invasive species, the emergence of new diseases, and pervasive shifts in climatic patterns (Stein et al. 2000).

Conservation Actions and Information Needs for Plant SGCN

Conservation efforts for plants are a relatively recent trend in conservation planning. While the U.S. Endangered Species Act was established in 1970, it was not until 1977 that the first plant species were federally listed. Inequalities still exist between federally listed animals and plants: under law, Threatened and Endangered animals cannot be captured or killed anywhere in the U.S., but the taking of Threatened and Endangered plants is prohibited only on federal or state-owned lands (USFWS 1973). The U.S. Fish and Wildlife Service lists only four SGCN Maryland plants as Endangered and three as Threatened, while state regulations list 241 plants as Endangered and 83 as Threatened. In addition to this formal listing, MD DNR maintains a larger list of 740 plant species that are either rare, Threatened, Endangered or Endangered Extirpated, the result of a thorough review process by state botanists and other plant experts.

Outreach and education are important actions in advancing the conservation of rare plants. To this end, MD DNR provides information to assist with identifying and maintaining habitat for Maryland's rare, Threatened, and Endangered plant species and other native plants in general, in an effort to keep additional species from becoming rare. Maryland's Wild Acres program was developed to help landowners with habitats for plants and wildlife, as well as the quarterly HabiChat newsletter. As stated above, the Maryland Plant Atlas provides online distribution maps for all native and naturalized plants in Maryland based on the most recent and accurate data. This effort aims to promote plant conservation by increasing public awareness of and interest in plant diversity.

Additional conservation actions for plant SGCN are similar to those for animal SGCN. Properties with significant or unique KWHs and SGCN are directly conserved through land acquisition and easement programs. These properties are then managed to maintain or restore ecosystem processes that those habitats and species need to survive. Fortunately, some plant conservation actions are effective at relatively small scales, making them more practical to implement. These actions may include conducting targeted research and inventory projects, creating no-mow areas or time periods, removing encroaching invasive species, installing deer exclosures around rare plants, conducting prescribed burns, working with developers to avoid and minimize impacts from developments, designating habitat buffers, and plugging drainage ditches to restore wetlands with rare wetland plants.

Rare plants take on the role of "canary in the coal mine" for Maryland's habitats, signaling through their decline that the system is unhealthy. Plants factor into many conservation decisions and actions in Maryland. By incorporating plants into the SWAP through habitat classifications and the SGCN plant list, the Plan highlights the importance of conserving plant life along with wildlife. Because SGCN plants are so closely aligned with KWHs, the threats and conservation actions listed in Appendix 6b are essentially the same as would apply to each KWH.

Table 3.19 Existing federal recovery plans for plant SGCN

Plant Species	Federal Recovery Plan	Recent Action
Canby's dropwort	USFWS 1990	2021: Initiation of 5-year review
Harperella	USFWS 1991	2024: Finalized 5-year review
Northeastern bulrush	USFWS 1993	2024: Proposed for deletion
Sandplain gerardia	USFWS 1989	2019: Finalized 5-year review; needs taxonomic work

Seabeach amaranth	USFWS 1996	2023: Finalized 5-year review
Sensitive joint-vetch	USFWS 1995	2025: Finalized 5-year review
Swamp pink	USFWS 1991	2019: Initiation of 5-year review

Table 3.20 Plant SGCN in Maryland

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Alderleaf buckthorn	*Rhamnus alnifolia*	G5	S1			A
Allegheny plum	*Prunus alleghaniensis*	G4	S2		T	B
American bugbane	*Actaea podocarpa*	G4	S2			B
American chestnut	*Castanea dentata*	G3	S2S3			A
American feverfew	*Parthenium integrifolium*	G5	S1		E	A
American fly honeysuckle	*Lonicera canadensis*	G5	S1		E	A
American frog's-bit	*Limnobium spongia*	G4	S1		E	A
American ginseng	*Panax quinquefolius*	G3G4	S2S3			A
American gromwell	*Lithospermum latifolium*	G4	S1		E	A
American harebell	*Campanula rotundifolia*	G5	S2			B
American larch	*Larix laricina*	G5	S1		E	A
American mannagrass	*Glyceria grandis*	G5	S1		E	A
Angular-fruit milkvine	*Gonolobus suberosus* var. *suberosus*	G5T5	S2			B
Appalachian sandwort	*Geocarpon glabrum*	G4	S1		E	A
Atamasco lily	*Zephyranthes atamasca*	G4G5	S1		E	A
Balsam fir	*Abies balsamea*	G5	S1			A
Bashful bulrush	*Trichophorum planifolium*	G4G5	S2			B
Beach plum	*Prunus maritima*	G4	S1		E	A
Beaked dodder	*Cuscuta rostrata*	G4	S1		E	A
Bearberry	*Arctostaphylos uva-ursi*	G5	S1		E	A
Big floatingheart	*Nymphoides aquatica*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Big shellbark hickory	*Carya laciniosa*	G5	S1		E	A
Black-fruit spikerush	*Eleocharis melanocarpa*	G4	S1		E	A
Black-stem spleenwort	*Asplenium resiliens*	G5	S1			A
Blue monkshood	*Aconitum uncinatum*	G4	S1		E	A
Blue ridge sedge	*Carex lucorum*	G5	S1			A
Blue wild indigo	*Baptisia australis*	G3G4	S2		T	A
Blunt-lobe grapefern	*Sceptridium oneidense*	G4	S1		E	A
Bog buckbean	*Menyanthes trifoliata*	G5	S1		E	A
Bog clubmoss	*Lycopodiella inundata*	G5	S2			B
Bog fern	*Coryphopteris simulata*	G4G5	S2		T	B
Bog Jacob's ladder	*Polemonium vanbruntiae*	G3G4	S2		T	B
Box huckleberry	*Gaylussacia brachycera*	G3	S1		E	A
Bradley's spleenwort	*Asplenium bradleyi*	G4	S1		T	A
Braun's robin's-plantain	*Erigeron pulchellus* var. *brauniae*	G5T4	S1			A
Bristly sarsaparilla	*Aralia hispida*	G5	S1		E	A
Broad-glumed brome	*Bromus latiglumis*	G5	S1		E	A
Broadleaf bunchflower	*Veratrum hybridum*	G5	S1		E	A
Broadleaf water-milfoil	*Myriophyllum heterophyllum*	G5	S1			A
Brown-fruit rush	*Juncus pelocarpus*	G5	S1		E	A
Bulb-bearing water-hemlock	*Cicuta bulbifera*	G5	S1		E	A
Bunchberry	*Chamaepericl-ymenum canadese*	G5	S1		E	A
Bur oak	*Quercus macrocarpa*	G5	S1S2			A
Butternut	*Juglans cinerea*	G3	S2S3			A
Buxbaum's sedge	*Carex buxbaumii*	G5	S2		T	B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Canada burnet	*Sanguisorba canadensis*	G5	S2		T	B
Canada yew	*Taxus canadensis*	G5	S2		T	B
Canadian milkvetch	*Astragalus canadensis*	G5	S1		E	A
Canby's dropwort	*Tiedemannia canbyi*	G2	S1	E	E	A
Canby's lobelia	*Lobelia canbyi*	G4	S2		E	B
Canby's mountain-lover	*Paxistima canbyi*	G2?	S1		E	A
Capitate beakrush	*Rhynchospora cephalantha*	G5	S1		E	A
Carey's sedge	*Carex careyana*	G4G5	S1		E	A
Carolina anglepod	*Matelea carolinensis*	G4	S2S3		T	B
Carolina ash	*Fraxinus caroliniana*	G4G5	S2			B
Carolina clubmoss	*Pseudolycopod-iella caroliniana*	G4	S1		E	A
Carolina fimbry	*Fimbristylis caroliniana*	G4	S1S2			A
Carolina sandwort	*Sabulina caroliniana*	G5	S1		E	A
Catchfly cutgrass	*Leersia lenticularis*	G5	S1		E	A
Chapman's redtop	*Tridens chapmanii*	G5T3	S1			A
Cliff stonecrop	*Sedum glaucophyllum*	G4	S2		T	B
Climbing dogbane	*Thyrsanthella difformis*	G4G5	S1		E	A
Climbing fern	*Lygodium palmatum*	G4	S2		T	B
Climbing fumitory	*Adlumia fungosa*	G4	S2		T	B
Climbing milkweed	*Matelea obliqua*	G4?	S1S2		E	A
Clinton lily	*Clintonia borealis*	G5	S2		T	B
Clinton's woodfern	*Dryopteris clintoniana*	G5	S1		E	A
Cloud sedge	*Carex haydenii*	G5	S1		E	A
Club-head cutgrass	*Leersia hexandra*	G5	S1		E	A
Coast bedstraw	*Galium hispidulum*	G5	S1		E	A
Coastal sedge	*Carex exilis*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Coastal butterfly pea	*Centrosema virginianum*	G5	S2			B
Coastal water-hyssop	*Bacopa monnieri*	G5?	S1			A
Common clammyweed	*Polanisia dodecandra*	G5	S1		E	A
Common snowberry	*Symphoricarpos albus*	G5	S1		T	A
Coppery St. John's-wort	*Hypericum denticulatum*	G5	S2		T	B
Coville's phacelia	*Phacelia covillei*	G3	S2		T	A
Cream tick-trefoil	*Desmodium ochroleucum*	G2G3	S1		E	A
Creeping burhead	*Echinodorus cordifolius*	G5	S1		E	A
Creeping snowberry	*Gaultheria hispidula*	G5	S1		E	A
Creeping St. John's-wort	*Hypericum adpressum*	G3	S1		E	A
Crested coralroot	*Hexalectris spicata*	G5	S1		E	A
Crossleaf milkwort	*Polygala cruciata*	G5	S2		T	B
Cymose beakrush	*Rhynchospora recognita*	G5?	S2			B
Cypress-knee sedge	*Carex decomposita*	G3G4	S1		E	A
Davis' sedge	*Carex davisii*	G4	S1		E	A
Pinebarrens death-camas	*Stenanthium leimanthoides*	G4Q	S1		E	A
Deciduous holly	*Ilex decidua*	G5	S2			B
Devil's-bit	*Chamaelirium luteum*	G4G5	S2			B
Downy phlox	*Phlox pilosa*	G5	S1		E	A
Downy willowherb	*Epilobium densum*	G5	S1		E	A
Drooping bluegrass	*Poa saltuensis*	G5	S1		E	A
Drowned hornrush	*Rhynchospora inundata*	G4	S1		E	A
Drummond's aster	*Symphyotrichum drummondii*	G5	S1			A
Dwarf bulrush	*Cyperus subsquarrosus*	G5	S1		E	A
Dwarf crested iris	*Iris cristata*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Dwarf huckleberry	*Gaylussacia dumosa*	G5	S1		E	A
Dwarf iris	*Iris verna* var. *verna*	G5T5	S1		E	A
Dwarf prairie willow	*Salix occidentalis*	G5T5	S2			B
Dwarf sundew	*Drosera brevifolia*	G5	S1			A
Dwarf umbrella-sedge	*Fuirena pumila*	G5	S2S3			B
Earleaf false foxglove	*Agalinis auriculata*	G3	S1		E	A
Early buttercup	*Ranunculus fascicularis*	G5	S1		E	A
Early coralroot	*Corallorhiza trifida*	G5	S1		E	A
Eastern bloodleaf	*Iresine rhizomatosa*	G5	S1		E	A
Eastern featherbells	*Stenanthium gramineum*	G4	S1		T	A
Eastern leatherwood	*Dirca palustris*	G5	S2		T	B
Eastern silvery aster	*Symphyotrichum concolor*	G5	S1		E	A
Eastern straw sedge	*Carex straminea*	G5	S1S2			A
Ebony sedge	*Carex eburnea*	G5	S1		E	A
Elliott's rush	*Juncus elliottii*	G4G5	S1			A
Engelmann's arrowhead	*Sagittaria engelmanniana*	G5?	S2		T	B
Epling's hedge-nettle	*Stachys eplingii*	G1G2	S1			A
Evergreen bayberry	*Morella caroliniensis*	G5	S2		T	B
Featherfoil	*Hottonia inflata*	G4	S1		T	A
Fernald's mannagrass	*Torreyochloa pallida* var. *fernaldii*	G5T5Q	S1			A
Fernald's tick-trefoil	*Desmodium fernaldii*	G4	S1			A
Few-flowered tick-trefoil	*Hylodesmum pauciflorum*	G5	S2		E	B
Few-flowered witchgrass	*Dichanthelium oligosanthes* var. *oligosanthes*	G5T5?	S2S3			B
Fibrous bladderwort	*Utricularia striata*	G4G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Field sedge	*Carex conoidea*	G5	S1		E	A
Filmy angelica	*Angelica triquinata*	G4	S1		E	A
Flat-spiked sedge	*Carex planispicata*	G4Q	S1S2			A
Flat-stem spikerush	*Eleocharis compressa* var. *compressa*	G5T5	S1		E	A
Flatleaf bladderwort	*Utricularia intermedia*	G5	S1			A
Flatsedge	*Cyperus hystricinus*	G4	S2			B
Flatstem pondweed	*Potamogeton zosteriformis*	G5	S1		E	A
Flattened pipewort	*Eriocaulon compressum*	G5	S2			B
Fly-poison	*Amianthium muscitoxicum*	G4G5	S2			B
Fowl bluegrass	*Poa palustris*	G5	S1			A
Fraser's sedge	*Carex fraseriana*	G4	S1		E	A
Fringe-top bottle gentian	*Gentiana andrewsii*	G5	S2		T	B
Fringed gentian	*Gentianopsis crinita*	G5	S1		E	A
Fringed yellow-eyed-grass	*Xyris fimbriata*	G5	S1		E	A
Giant-seed goosefoot	*Chenopodiastr-um simplex*	G5	S2		T	B
Gibbous panic-grass	*Sacciolepis striata*	G5	S1		E	A
Glade fern	*Homalosorus pycnocarpos*	G5	S2		T	B
Glade mallow	*Napaea dioica*	G4	S1		E	A
Glade spurge	*Euphorbia purpurea*	G3	S1		E	A
Globe beakrush	*Rhynchospora globularis*	G5?	S1		E	A
Golden heather	*Hudsonia ericoides*	G4	S1		E	A
Golden-seal	*Hydrastis canadensis*	G3G4	S2		T	A
Goldie's fern	*Dryopteris goldieana*	G4G5	S2			B
Goldthread	*Coptis trifolia*	G5	S1		E	A
Goosefoot cornsalad	*Valerianella chenopodiifolia*	G4	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Green adder's-mouth orchid	*Malaxis unifolia*	G5	S2			B
Gritty hedge-nettle	*Stachys aspera*	G4?	S1		E	A
Grooved yellow flax	*Linum sulcatum*	G5	S1		E	A
Grove sandwort	*Moehringia lateriflora*	G5	S1		E	A
Hair-awn muhly	*Muhlenbergia capillaris*	G5	S1		E	A
Hairy false gromwell	*Lithospermum parviflorum*	G4G5T4	S1		E	A
Hairy lettuce	*Lactuca hirsuta*	G5?	S1			A
Hairy ludwigia	*Ludwigia hirtella*	G5	S1		E	A
Hairy needle-leaved witchgrass	*Dichanthelium filiramum*	GNR	S2			B
Hairy rockcress	*Arabis adpressipilis*	G4	S1S2			A
Hairy snoutbean	*Rhynchosia tomentosa*	G5	S2		T	B
Hairy wild petunia	*Ruellia humilis*	G5	S1		E	A
Hairy woodmint	*Blephilia hirsuta*	G5	S1S2			A
Hairy-fruited sedge	*Carex trichocarpa*	G4	S2			B
Harned's clintonia	*Clintonia alleghaniensis*	G1Q	S1			A
Harper's fimbristylis	*Fimbristylis perpusilla*	G2	S2		E	A
Harperella	*Harperella nodosa*	G2	S1	E	E	A
Hazel dodder	*Cuscuta coryli*	G4	S1			A
Highland rush	*Oreojuncus trifidus*	G5	S1		E	A
Hitchcock's sedge	*Carex hitchcockiana*	G5	S1		E	A
Hooded skullcap	*Scutellaria galericulata*	G5	S2			B
Horned bladderwort	*Utricularia cornuta*	G5	S1			A
Horse-tail paspalum	*Paspalum fluitans*	G5	S2		T	B
Horsetail spikerush	*Eleocharis equisetoides*	G4	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Houghton's umbrella-sedge	*Cyperus houghtonii*	G4?	S1			A
Hyssopleaf hedge-nettle	*Stachys hyssopifolia*	G4G5	S1			A
Illinois pondweed	*Potamogeton illinoensis*	G5	S2			B
Inflated sedge	*Carex vesicaria*	G5	S1		T	A
Inland sedge	*Carex interior*	G5	S1			A
Jointed rush	*Juncus articulatus*	G5	S1			A
Kate's Mountain clover	*Trifolium virginicum*	G3	S2S3		T	A
Kidneyleaf grass-of-parnassus	*Parnassia asarifolia*	G4	S1		E	A
Kidneyleaf twayblade	*Neottia smallii*	G4	S1		E	A
Koehne ammannia	*Ammannia latifolia*	G5	S2			B
Lake-bank sedge	*Carex lacustris*	G5	S2			B
Lake-cress	*Armoracia lacustris*	G4?	S1		E	A
Lanceleaf grapefern	*Botrychium angustisegment-um*	G4	S1		X	A
Large purple fringed orchid	*Platanthera grandiflora*	G5	S2		T	B
Large-flower bellwort	*Uvularia grandiflora*	G5	S1			A
Large-leaf waterleaf	*Hydrophyllum macrophyllum*	G5	S2		T	B
Large-leaved pondweed	*Potamogeton amplifolius*	G5	S1S2			A
Late goldenrod	*Solidago tarda*	G4?Q	S1			A
Leafy pondweed	*Potamogeton foliosus*	G5	S2			B
Leatherleaf	*Chamaedaphne calyculata*	G5	S1		T	A
Leopard's-bane	*Arnica acaulis*	G4	S1		E	A
Lesser panicled sedge	*Carex diandra*	G5	S1		E	A
Limestone wild petunia	*Ruellia strepens*	G4G5	S2S3			B
Linear-leaf willowherb	*Epilobium leptophyllum*	G5	S2S3			B
Little floatingheart	*Nymphoides cordata*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Little-head nutrush	*Scleria oligantha*	G5	S1			A
Lobed spleenwort	*Asplenium pinnatifidum*	G4	S1		E	A
Loesel's twayblade	*Liparis loeselii*	G5	S1S2			A
Long-beaked baldrush	*Rhynchospora scirpoides*	G4	S2		T	B
Long-bract green orchis	*Dactylorhiza viridis*	G5	S1		E	A
Long-bristle Indian grass	*Sorghastrum elliottii*	G5	S1		E	A
Long-stalk greenbrier	*Smilax pseudochina*	G4G5	S2		T	B
Long-stalked crowfoot	*Ranunculus hederaceus*	G5	S1		E	A
Long-stalked sedge	*Carex pedunculata*	G5	S1		E	A
Long's bittercress	*Cardamine longii*	G3?	S2		E	A
Long's rush	*Juncus longii*	G3Q	S1		E	A
Low bindweed	*Convolvulus spithamaeus*	G5T4	S2			B
Low nutrush	*Scleria verticillata*	G5	S1		E	A
Low rough aster	*Eurybia radula*	G5	S1		E	A
Low showy aster	*Eurybia spectabilis*	G5	S1		E	A
Lowland loosestrife	*Steironema hybridum*	G5	S2		T	B
Many-flowered umbrella-sedge	*Cyperus lancastriensis*	G5	S2S3			B
Marsh fleabane	*Pluchea camphorata*	G5	S2		T	B
Marsh speedwell	*Veronica scutellata*	G5	S1		E	A
Maryland bur-marigold	*Bidens bidentoides*	G3G4	S3.1			B
Matted spikerush	*Eleocharis intermedia*	G5	S1		E	A
McDowell's sunflower	*Helianthus occidentalis*	G5	S1		T	A
Mead's sedge	*Carex meadii*	G4G5	S1		E	A
Michaux's stitchwort	*Sabulina michauxii*	G5	S2		T	B
Mid-Atlantic beakrush	*Rhynchospora mesoatlantica*	G1	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Mississippi buttercup	*Ranunculus laxicaulis*	G5?	S1		E	A
Missouri rockcress	*Borodinia missouriensis*	G5	S1		E	A
Mitchell's sedge	*Carex mitchelliana*	G4	S2			B
Mountain parsley	*Taenidia montana*	G3	S2		T	A
Mountain woodfern	*Dryopteris campyloptera*	G5	S1		E	A
Mountain-ricegrass	*Patis racemosa*	G5	S2S3			B
Mudwort	*Limosella australis*	G5	S2		E	B
Muehlenberg's nutrush	*Scleria muehlenbergii*	G5	S1S2			A
Nannyberry	*Viburnum lentago*	G5	S1			A
Nantucket shadbush	*Amelanchier nantucketensis*	G3Q	S1		T	A
Narrow-panicle rush	*Juncus tweedyi*	G5	S2			B
Narrowleaf bluecurls	*Trichostema setaceum*	G5	S1			A
Narrowleaf willow	*Salix interior*	G5	S1		E	A
Necklace sedge	*Carex projecta*	G5	S2			B
New Jersey rush	*Juncus caesariensis*	G2G3	S1		E	A
Nodding pogonia	*Triphora trianthophoros*	G4?	S1		E	A
Nodding trillium	*Trillium flexipes*	G5	S1		E	A
Northeastern bladderwort	*Utricularia resupinata*	G4	S1		E	A
Northeastern bulrush	*Scirpus ancistrochaetus*	G3	S1	E (PD)	E	A
Northeastern white water-crowfoot	*Ranunculus trichophyllus*	G5	S1		E	A
Northern bedstraw	*Galium boreale*	G5	S1		E	A
Northern beechfern	*Phegopteris connectilis*	G5	S2			B
Northern dropseed	*Sporobolus heterolepis*	G5	S1		E	A
Northern oak fern	*Gymnocarpium dryopteris*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Northern pitcherplant	*Sarracenia purpurea*	G5	S2		T	B
Northern prickly-ash	*Zanthoxylum americanum*	G5	S1S2		E	A
Northern white-cedar	*Thuja occidentalis*	G5	S1		T	A
Octoraro Creek chickweed	*Cerastium velutinum* var. *villosissimum*	G5T1	S1			A
One-flower sclerolepis	*Sclerolepis uniflora*	G3	S2		T	A
Ostrich fern	*Matteuccia struthiopteris*	G5	S2S3			B
Ozark milkvetch	*Astragalus distortus*	G5	S2		T	B
Pale beardtongue	*Penstemon pallidus*	G5	S1			A
Pale false foxglove	*Agalinis skinneriana*	G3G4	S1		E	A
Pale green orchid	*Platanthera flava*	G4?	S2S3			B
Parker's pipewort	*Eriocaulon parkeri*	G3	S2		T	A
Partridge pea	*Chamaecrista fasciculata* var. *macrosperma*	G5T3	S1		E	A
Pineland tick-trefoil	*Desmodium strictum*	G4	S1		E	A
Pink milkwort	*Senega incarnata*	G5	S2S3			B
Pink sundew	*Drosera capillaris*	G5	S1		E	A
Pipevine	*Isotrema macrophyllum*	G5	S2		T	B
Plains frostweed	*Crocanthemum bicknellii*	G5	S1		E	A
Plukenet's flatsedge	*Cyperus plukenetii*	G5	S1		E	A
Pondspice	*Litsea aestivalis*	G3?	S1		E	A
Porcupine sedge	*Carex hystericina*	G5	S1		E	A
Potato dwarf-dandelion	*Krigia dandelion*	G5	S2S3			B
Prairie blazing star	*Liatris spicata*	G5	S1			A
Prairie goldenrod	*Solidago rigida*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Primrose-willow	*Ludwigia decurrens*	G5	S2S3			B
Puerto Rico sea-purslane	*Sesuvium maritimum*	G5	S1		E	A
Purple bladderwort	*Utricularia purpurea*	G5	S1		T	A
Purple clematis	*Clematis occidentalis*	G5	S1		E	A
Purple fringeless orchid	*Platanthera peramoena*	G5	S1S2		T	A
Purple giant-hyssop	*Agastache scrophulariifolia*	G4	S1S2		T	A
Purple meadow-parsnip	*Thaspium trifoliatum*	G5	S1		E	A
Purple mecardonia	*Mecardonia acuminata*	G5	S2		E	B
Purple milkweed	*Asclepias purpurascens*	G4G5	S2			B
Purple oat	*Schizachne purpurascens*	G5	S1		E	A
Pursh's wild petunia	*Ruellia purshiana*	G3	S1		E	A
Queen-of-the-prairie	*Filipendula rubra*	G4G5	S1		E	A
Racemed milkwort	*Senega polygama*	G5	S1		T	A
Racemose goldenrod	*Solidago racemosa*	G5T3?	S1		T	A
Ravenel's witchgrass	*Dichanthelium ravenelii*	G5	S1			A
Red bay	*Tamala palustris*	G5	S1		E	A
Red milkweed	*Asclepias rubra*	G4G5	S1		E	A
Red root	*Lachnanthes caroliniana*	G4	S1		E	A
Red turtlehead	*Chelone obliqua*	G4	S2		T	B
Reticulated nutrush	*Scleria reticularis*	G4	S2S3			B
Richardson's sedge	*Carex richardsonii*	G5	S1		E	A
Rigid sedge	*Carex tetanica* var. *canbyi*	G4G5T1T2Q	S1		E	A
Ringed witchgrass	*Dichanthelium annulum*	G4	S1			A
Robbins' spikerush	*Eleocharis robbinsii*	G4G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Rock goldenrod	*Solidago rupestris*	G4?	S1			A
Rock grape	*Vitis rupestris*	G3	S1			A
Rock skullcap	*Scutellaria saxatilis*	G3G4	S1		E	A
Rose coreopsis	*Coreopsis rosea*	G3	S1		E	A
Rosy twisted-stalk	*Streptopus lanceolatus*	G5	S1S2		T	A
Rough dropseed	*Sporobolus clandestinus*	G4G5	S2			B
Rough flatsedge	*Cyperus retrofractus*	G5	S2			B
Roughleaf ricegrass	*Oryzopsis asperifolia*	G5	S2		T	B
Roundleaf dogwood	*Swida rugosa*	G5	S1		E	A
Roundleaf fameflower	*Phemeranthus teretifolius*	G4	S2		T	B
Roundleaf serviceberry	*Amelanchier sanguinea*	G5	S1		E	A
Running serviceberry	*Amelanchier spicata*	G5	S2			B
Running shadbush	*Amelanchier humilis*	G5	S1		T	A
Rusty woodsia	*Woodsia ilvensis*	G5	S2		T	B
Salad violet	*Viola esculenta (edulis)*	G4G5	S2			B
Saltmarsh bulrush	*Bolboschoenus novae-angliae*	G3	S2			A
Saltmarsh spikerush	*Eleocharis halophila*	G4Q	S1		E	A
Sandplain flax	*Linum intercursum*	G4	S2		T	B
Sandplain gerardia	*Agalinis decemloba (acuta)*	G3G4	S1	E*	E	A
Sandyland blue-eyed grass	*Sisyrinchium arenicola*	GNR	S1		E	A
Scaly gayfeather	*Liatris squarrosa*	G5	S1		E	A
Scarlet Indian-paintbrush	*Castilleja coccinea*	G5	S1		E	A
Scribner's witchgrass	*Dichanthelium oligosanthes* var. *scribnerianum*	G5T5	S2			B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Sea chickweed	*Honckenya peploides*	G5	S1		E	A
Seabeach amaranth	*Amaranthus pumilus*	G2	S1	T	E	A
Seabeach knotweed	*Polygonum glaucum*	G3	S1		E	A
Seabeach orach	*Atriplex mucronata*	G3G4	S1S2			A
Seabeach sedge	*Carex silicea*	G5	S1		E	A
Seaside alder	*Alnus maritima*	G3	S3.1			B
Seneca snakeroot	*Senega officinalis*	G4G5	S2		T	B
Sensitive joint-vetch	*Aeschynomene virginica*	G2	S1	T	E	A
Serpentine aster	*Symphyotrichum depauperatum*	G2	S1		E	A
Sessile-fruit arrowhead	*Sagittaria rigida*	G5	S1		E	A
Sessile-leaf bugleweed	*Lycopus amplectens*	G5	S1		E	A
Seven-angle pipewort	*Eriocaulon aquaticum*	G5	S1		E	A
Shale barren skullcap	*Scutellaria leonardii*	G5	S2		T	B
Sharp-scaled mannagrass	*Glyceria acutiflora*	G5	S1		E	A
Sharpscale sedge	*Carex oxylepis*	G5?	S1			A
Shining ladies'-tresses	*Spiranthes lucida*	G4	S1		E	A
Shoreline sedge	*Carex hyalinolepis*	G4G5	S2S3			B
Short-beaked baldrush	*Rhynchospora nitens*	G4	S1		E	A
Short's hedge-hyssop	*Gratiola viscidula*	G4G5	S1		E	A
Shortleaf beardgrass	*Gymnopogon brevifolius*	G5	S1		E	A
Showy goldenrod	*Solidago speciosa*	G5	S2		T	B
Shriver's frilly orchid	*Platanthera shriveri*	G1	S1			A
Shumard oak	*Quercus shumardii*	G5	S2		T	B
Side-oats grama	*Bouteloua curtipendula*	G5	S2			B
Single-head pussytoes	*Antennaria solitaria*	G5	S2		T	B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Slender blueflag	*Iris prismatica*	G4G5	S2		E	B
Slender cottongrass	*Eriophorum gracile*	G5	S1		E	A
Slender marsh pink	*Sabatia campanulata*	G4	S1		E	A
Slender nutrush	*Scleria minor*	G4	S1		E	A
Slender plume grass	*Erianthus strictus*	G5	S1		E	A
Slender rattlesnake-root	*Nabalus autumnalis*	G4G5	S1		E	A
Slender sedge	*Carex lasiocarpa*	G5	S1		E	A
Slender-leaved bluets	*Houstonia tenuifolia*	G5T4T5	S1			A
Small cranberry	*Vaccinium oxycoccos*	G5	S2		T	B
Small purple fringed orchid	*Platanthera psycodes*	G5	S1		X	A
Small white lady's-slipper	*Cypripedium candidum*	G4	S1		E	A
Small-flower baby-blue-eyes	*Nemophila aphylla*	G5	S2			B
Small-headed beakrush	*Rhynchospora microcephala*	G5T5	S2			B
Small's yellow-eyed-grass	*Xyris smalliana*	G4G5	S1		E	A
Smartweed dodder	*Cuscuta polygonorum*	G4G5	S1		E	A
Smooth cliffbrake	*Pellaea glabella*	G5	S1		E	A
Smooth false buttonweed	*Spermacoce glabra*	G4G5	S1		E	A
Smooth orange milkweed	*Asclepias lanceolata*	G5	S1			A
Smooth phlox	*Phlox glaberrima*	G5	S1		E	A
Smooth rose	*Rosa blanda*	G5	S1		E	A
Smooth sunflower	*Helianthus laevigatus*	G4	S1		E	A
Snow trillium	*Trillium nivale*	G4	S1		E	A
Snowy campion	*Silene nivea*	G4?	S1		E	A
Sourwood	*Oxydendrum arboreum*	G5	S1		E	A
Southern waxy sedge	*Carex glaucescens*	G4	S1		E	A
Southern wild rice	*Zizaniopsis miliacea*	G5	S1		E	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Spiked hoary-pea	*Tephrosia spicata*	G4G5	S1S2		T	A
Spongy arrowhead	*Sagittaria spatulata*	G5T4	S2			B
Spreading pogonia	*Cleistesiopsis divaricata*	G4	S1		E	A
Spreading rockcress	*Arabis patens*	G3	S2			A
Spring coralroot	*Corallorhiza wisteriana*	G5	S1		E	A
Standley's goosefoot	*Chenopodium standleyanum*	G5	S2S3			B
Star duckweed	*Lemna trisulca*	G5	S1		E	A
Starflower Solomon’s-plume	*Maianthemum stellatum*	G5	S2		E	B
Stiff gentian	*Gentianella quinquefolia*	G5	S1		E	A
Stiff tick-trefoil	*Desmodium obtusum*	G4G5	S1		E	A
Stiff-hair sunflower	*Helianthus hirsutus*	G5	S1			A
Striped gentian	*Gentiana villosa*	G4	S1		E	A
Summer sedge	*Carex aestivalis*	G4	S1		E	A
Sundial lupine	*Lupinus perennis*	G5	S2		T	B
Susquehanna doll's-daisy	*Boltonia asteroides* var. *asteroides*	G5TNR	S1			A
Swamp lousewort	*Pedicularis lanceolata*	G4	S1		E	A
Swamp pink	*Helonias bullata*	G3	S2	T	E	A
Swamp wedgescale	*Sphenopholis pensylvanica*	G4	S2		T	B
Sweet pinesap	*Monotropsis odorata*	G3	S1		E	A
Sweet-scented Indian-plantain	*Hasteola suaveolens*	G4	S1		E	A
Switch cane	*Arundinaria tecta*	G5	S2			B
Swollen bladderwort	*Utricularia inflata*	G5	S2			B
Tall dock	*Rumex altissimus*	G5	S1		E	A
Tall larkspur	*Delphinium exaltatum*	G3	S1		E	A
Tall swamp witchgrass	*Dichanthelium scabriusculum*	G4	S1		T	A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Tall tickseed	*Coreopsis tripteris*	G5	S1		E	A
Ten-angle pipewort	*Eriocaulon decangulare*	G5	S1			A
Tennessee bladderfern	*Cystopteris tennesseensis*	G5	S1			A
Threadleaf gerardia	*Agalinis setacea*	G5?	S2		E	B
Three-angle spikerush	*Eleocharis tricostata*	G4	S1		E	A
Three-flower melicgrass	*Melica nitens*	G5	S2		T	B
Three-ribbed arrow-grass	*Triglochin striata*	G5	S1S2		E	A
Tobaccoweed	*Elephantopus tomentosus*	G5	S2		T	B
Toothed tick-trefoil	*Desmodium cuspidatum*	G5	S1			A
Torrey's beakrush	*Rhynchospora torreyana*	G4	S2		T	B
Torrey's bulrush	*Schoenoplectus torreyi*	G4	S1			A
Torrey's dropseed	*Muhlenbergia torreyana*	G3	S1		E	A
Torrey's mountainmint	*Pycnanthemum torreyi*	G2	S1		E	A
Trailing stitchwort	*Stellaria alsine*	G5	S1		E	A
Tuberous grass-pink	*Calopogon tuberosus*	G5	S1		E	A
Tuckerman's sedge	*Carex tuckermanii*	G5	S1		E	A
Tufted hairgrass	*Deschampsia cespitosa*	G5	S1		E	A
Two-formed pink	*Sabatia difformis*	G4G5	S1		E	A
Umbrella flats flatsedge	*Cyperus diandrus*	G5?	S1			A
Upland dwarf iris	*Iris verna* var. *smalliana*	G5T4T5	S1			A
Valerian	*Valeriana pauciflora*	G4	S1		E	A
Vanilla grass	*Hierochloe hirta*	G5	S1		E	A
Vasey's goldenrod	*Solidago vaseyi*	G4	S1			A
Veined skullcap	*Scutellaria nervosa*	G5	S1S2		T	A
Velvety sedge	*Carex vestita*	G5	S2		T	B

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Vetchling peavine	*Lathyrus palustris*	G5	S1		E	A
Virginia false gromwell	*Lithospermum virginianum*	G4	S1		E	A
Virginia heartleaf	*Hexastylis virginica*	G4	S1		E	A
Virginia least trillium	*Trillium pusillum* var. *virginianum*	G4T3	S2		T	A
Virginia mallow	*Ripariosida hermaphrodita*	G3	S1		E	A
Virginia mountainmint	*Pycnanthemum virginianum*	G5	S2			B
Walter's paspalum	*Paspalum dissectum*	G4?	S2		T	B
Wand-like three-awn grass	*Aristida virgata*	G4G5	S2		T	B
Warty spurge	*Euphorbia spathulata*	G5	S1		E	A
Water bulrush	*Schoenoplectus subterminalis*	G5	S1		E	A
Water horsetail	*Equisetum fluviatile*	G5	S1		E	A
Water loosestrife	*Lysimachia thyrsiflora*	G5	S1		E	A
Water pygmyweed	*Crassula aquatica*	G5	S1		E	A
Water-plantain spearwort	*Ranunculus ambigens*	G4	S1			A
Western hairy rockcress	*Arabis pycnocarpa*	G5	S1			A
White doll's-daisy	*Boltonia asteroides var. glastifolia*	G5TNR	S1		E	A
White fringed orchid	*Platanthera blephariglottis*	G4G5	S2		T	B
White spikerush	*Eleocharis albida*	G4G5	S2S3			B
White trout lily	*Erythronium albidum*	G5	S2		T	B
White-bracted boneset	*Eupatorium leucolepis*	G5	S2S3		T	B
White-edged witchgrass	*Dichanthelium tenue*	GNR	S1			A
Whorled mountainmint	*Pycnanthemum verticillatum*	G5	S2		T	B
Whorled water-milfoil	*Myriophyllum verticillatum*	G5	S1			A

Common Name	Scientific Name	G-Rank[1]	S-Rank[1]	Federally listed[2]	State-listed[2]	Conservation status group[3]
Wild black currant	*Ribes americanum*	G5	S1		X	A
Wild bleedinghearts	*Dicentra eximia*	G4	S2		T	B
Wild calla	*Calla palustris*	G5	S1		E	A
Willow aster	*Symphyotrichum praealtum*	G5	S1			A
Winged loosestrife	*Lythrum alatum*	G5	S1		E	A
Wiry witch grass	*Panicum flexile*	G5	S1		E	A
Woodland agrimony	*Agrimonia striata*	G5	S1		E	A
Woodland horsetail	*Equisetum sylvaticum*	G5	S1		E	A
Woolly three-awn	*Aristida lanosa*	G5	S1		E	A
Wright's witchgrass	*Dichanthelium wrightianum*	G4	S1		E	A
Wrinkled joingrass	*Mnesithea rugosa*	G5	S1		E	A
Yellow avens	*Geum aleppicum*	G5	S1		E	A
Yellow fringed orchid	*Platanthera ciliaris*	G5	S2		T	B
Yellow nailwort	*Paronychia virginica*	G4	S1		E	A
Yellow nodding ladies' tresses	*Spiranthes ochroleuca*	G4	S1		E	A
Yellow water-crowfoot	*Ranunculus flabellaris*	G5	S1		E	A
Yellowleaf tinker's-weed	*Triosteum angustifolium*	G5	S1		E	A

[1] = See Table 3,5 for S-rank and G-rank definitions
[2] = T (Threatened); E (Endangered); X (Endangered Extirpated); PD (Proposed for Delisting)
[3] = See Table 3.7 for Conservation Status definitions
* = a qualifier denoting the species is listed in a limited geographic area only

Using the best available current information, this chapter summarized the full array of species found in Maryland and identified Species of Greatest Conservation Need (SGCN) in each taxonomic group (addressing **Element #1**). The next chapter will provide detailed information about the distribution and condition of the identified Key Wildlife Habitats (KWHs), including their associated SGCN and natural communities (addressing **Element #2**).

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Chapter 4

Maryland’s Key Wildlife Habitats

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Introduction

The 2025 State Wildlife Action Plan (SWAP or Plan) identifies nearly one thousand animal and plant species as Species of Greatest Conservation Need (SGCN) (Chapter 3). This includes federally and state-listed Threatened or Endangered species, rare species, endemic species, declining species, and responsibility species for which Maryland harbors a significant portion of the overall population. The distribution and abundance of SGCN and other Maryland flora and fauna are directly related to the condition, extent, and location of their habitats.

While some species can be found in a variety of habitats, many are less adaptive and are restricted to one or relatively few habitats. This especially holds true for plants, which cannot migrate to other areas or habitats as most animals can. These specific habitats often exhibit restricted distribution in Maryland. This distribution is influenced by the diversity of Maryland's six major physiographic provinces: Lower Coastal Plain, Upper Coastal Plain, Piedmont, Blue Ridge, Ridge and Valley, and Appalachian Plateau (Chapter 2, Figure 2.1). Maryland's latitude also supports an overlap of habitat ranges; it harbors species that typically occur in more northern latitudes as well as those that occupy the southeastern United States. Aquatic habitats similarly exhibit a wide range, from saline Atlantic Ocean and Coastal Bays, to brackish Chesapeake Bay estuary, to freshwater streams and rivers. While this greatly adds to Maryland's ecological diversity, it also influences the somewhat limited distribution of certain wildlife species and their habitats (Lawrence 1984; Lawrence & Gross 1984; Fergus 2003). Because of the strong tie between species and habitats, it is critical to identify habitats that support SGCN in order to conserve them. For purposes of the 2025 SWAP revision, habitats that support SGCN are referred to as Key Wildlife Habitats (KWHs).

Furthermore, conservation of uncommon and rare habitats can serve as protective umbrellas for conserving lesser-known species. There are thousands of understudied, poorly understood, and/or new species in Maryland whose needs and habitat associations biologists do not yet understand. This is reflected in Maryland's new State Assessment Priority Species (SAPS) list (Appendix 3b). Though we do not yet know enough about these species to associate them with specific KWHs, the identification and protection of vulnerable habitats mean these lesser-known species are protected by proxy.

This chapter focuses on Maryland's KWHs. It begins with a definition of KWHs, lists the KWHs for the 2025 SWAP revision, provides reasoning for their selection, and ends with detailed descriptions of every KWH. The best available current information regarding the description, condition, and distribution of KWHs (directly addressing **Element #2**) is provided and then associated with SGCN found in those habitats (addressing **Element #1**). Each KWH also lists county distributions, examples of public lands to visit, and associated state rare natural communities. For KWH–species associations, species are referenced by common name, although for certain groups wherein common names are not widely agreed upon—most notably plants—as well as some insect species, scientific names are included as well. For a complete list of SGCN scientific names and KWH associations, please see Appendix 3a.

What are Key Wildlife Habitats?

In general, the term "habitat" is described as the physical and biological environment that provides the necessary food, shelter, and other needs of a particular animal, plant, or other organism. Key Wildlife Habitats, or KWHs, are no different in concept, with the exception that many species dependent upon those habitats are considered SGCN. While SGCN may occupy many habitats, the ones attributed as "key" for that species are considered important for the presence and persistence of that species in Maryland. Likewise, KWHs serve as critical foundations and support networks not only for SGCN but for all species in Maryland. Together, KWHs represent a patchwork mosaic of habitats in which the spectrum of Maryland's natural diversity can be understood, identified, and mapped.

Because vegetation typically reflects biological and ecological patterns across the landscape, most terrestrial KWHs are structured as ecological cover types based primarily on vegetation. They are organized into a simple classification scheme which is scalable, allowing for compatibility with other ecological classifications. At the local level, this classification scheme is closely related to the natural community classification used by the Maryland Department of Natural Resources (MD DNR) Natural Heritage Program (NHP). This classification is a relatively fine-scale classification system that uses an ecologically based hierarchy and grouping of vegetation associations from the U.S. National Vegetation System (Federal Geographic Data Committee 2008) as the foundation.

Natural communities can be defined as "recurring assemblages of plants and animals found in particular physical environments" (MD DNR 2026a). Restricted or vulnerable associations that support the unique assemblages of plant and animal species are referred to as "rare natural communities." A natural community may be considered rare for a number of reasons: it might represent a habitat on the northern or southern extent of its range, be particularly sensitive to anthropogenic threats, or be especially vulnerable to a rapidly changing climate. MD DNR NHP tracks rare natural communities—as well as rare plant and animal species—throughout the state.

Many KWHs have a direct ecological relationship with and are equivalent to certain levels in the Maryland natural community classification (e.g., Basic Mesic Forest, Shale Barren). Others may represent habitats slightly broader in scope that are the result of collapsing several natural community types into one KWH. Still others may not relate to any natural community types; anthropogenic or artificial habitats, not being "natural," have no associated natural communities. Many aquatic habitats are also not associated with any natural communities, as Maryland's classification system focuses mainly on terrestrial and wetland habitats.

This relationship to finer-scaled classifications may be useful in driving local land management decisions or identifying rare natural communities, although it is not practical in facilitating regional approaches to wildlife conservation. For the previous SWAP revision a decade ago, Maryland therefore based its KWHs on NatureServe's ecological systems, which in turn formed the basic classification scale of the Northeastern Terrestrial Wildlife Habitat Classification System (NETWHCS) (Gawler 2008) and the Northeastern Aquatic Habitat Classification System (NEAHCS) (Olivero & Anderson 2008). Many of these KWHs were kept relatively intact for the 2025 SWAP revision. Major changes include the consolidation of similar KWHs, the addition of three new KWHs, and the overhaul of bay and ocean KWHs. For a complete list of KWH changes in 2025, see Appendix 4a. For further explanation of NETWHCS and NEAHCS, please refer to the equivalent of this chapter in Maryland's 2015 SWAP revision (MD DNR 2016a).

The three new KWHs in 2025—Urban and Suburban Environment, Small Coastal Plain Island, and Artificial Barren—were added in order to emphasize the importance of human-created or human-impacted habitats for particular groups of SGCN. Urban and Suburban Environments, for example, can serve as important stopover habitat for migratory bird populations. Maryland's rapidly disappearing Small Coastal Plain Islands are some of the only breeding grounds left for Maryland's colonial waterbird SGCN. Artificial Barrens encompass unvegetated, uncapped, and undeveloped gravel and sand pits that support insect SGCN. These species historically relied upon natural barrens, but with the decline of that habitat type in Maryland, they now rely upon human-made habitats as well.

Bay and ocean KWHs have been simplified based on Maryland's three major saline or brackish bodies of water: the Chesapeake Bay, Coastal Bays, and Atlantic Ocean. During the 2025 SWAP revision process, reviewers found the 2015 SWAP revision's splitting of the estuarine and marine habitat features to be conceptually confusing. These three new KWHs are easier to conceptualize, geographically distinct, and allow for clearer SGCN–KWH associations. The bay and ocean KWHs from the 2015 SWAP revision have been consolidated into these new descriptions. The Small Coastal Plain Island KWH is also considered a bay or ocean habitat for the sake of categorization.

A total of 57 KWHs have been identified for the 2025 SWAP revision (Table 4.1). Together they represent a diverse portfolio of ecological systems, each bound by similar physiography, geology, hydrology, climate, soil composition, flora, or other significant characteristics.

Table 4.1 Maryland's 57 Key Wildlife Habitats

KEY WILDLIFE HABITAT	**PHYSIOGRAPHIC PROVINCE OF OCCURRENCE**					
Upland Habitats	**AP**	**RV**	**BR**	**PD**	**UCP**	**LCP**
High Elevation Ridge Forest	X					
Hemlock-Northern Hardwood Forest	X	X	X	X		
Cove Forest	X	X	X			
Montane-Piedmont Oak-Pine Forest	X	X	X	X		
Oak-Hickory Forest	X	X	X	X		
**Managed Montane Conifer Forest*	X					
Mesic Mixed Hardwood Forest		X	X	X	X	X
Coastal Plain Oak-Pine Forest					X	X
Maritime Forest and Shrubland						X
Serpentine Barren				X		
Shale Barren		X				
Acidic Glade and Barren	X	X	X	X		
Basic Glade and Barren		X	X	X		
**Artificial Barrens*					X	X
Cliff and Rock Outcrop	X	X	X	X		
Coastal Bluff					X	X
Coastal Beach					X	X
Maritime Dune and Grassland						X

Wetland Habitats	**AP**	**RV**	**BR**	**PD**	**UCP**	**LCP**
Montane-Piedmont Floodplain	X	X	X	X		
Coastal Plain Floodplain					X	X
Montane Acidic Fen	X					
Montane-Piedmont Seepage Swamp	X	X	X			
Piedmont Seepage Wetland				X		
Piedmont Upland Depression Swamp				X		
Coastal Plain Flatwood and Depression Swamp					X	X
Coastal Plain Seepage Swamp					X	X
Coastal Plain Seepage Acidic Fen					X	X
Delmarva Bay						X
Maritime Swamp						X
Vernal Pool	X	X	X	X	X	X
Spring	X	X	X	X	X	
Tidal Forest					X	X
Tidal Freshwater Marsh and Shrubland					X	X
Tidal Brackish Marsh and Shrubland					X	X
Tidal Salt Marsh and Shrubland					X	X
Intertidal Mudflat and Sand Flat					X	X
**Artificial Impoundment and Artificial Wetland*	X	X	X	X	X	X
Aquatic Habitats	**AP**	**RV**	**BR**	**PD**	**UCP**	**LCP**
Coldwater Stream	X	X	X	X		
Limestone Stream		X	X			
Highland Stream	X	X	X			
Piedmont Stream				X		
Coastal Plain Stream					X	X
Blackwater Stream					X	X
Highland River	X	X	X			
Piedmont River				X		
Coastal Plain River					X	X
Chesapeake Bay					X	X
Coastal Bays						X
Atlantic Ocean						X
Small Coastal Plain Island					X	X
Subterranean Habitats	**AP**	**RV**	**BR**	**PD**	**UCP**	**LCP**
Cave and Karst	X	X	X	X		
**Artificial Structure: Mine and Tunnel*	X	X	X	X		
Other Habitats	**AP**	**RV**	**BR**	**PD**	**UCP**	**LCP**
**Managed Successional Forest*	X	X	X	X	X	X
**Managed Grassland*	X	X	X	X	X	X
**Roadside and Utility Right-of-Way*	X	X	X	X	X	X
**Artificial Structure: Buildings and Other Structures*	X	X	X	X	X	X
**Urban and Suburban Environment*	X	X	X	X	X	X

Key: AP = Appalachian Plateau; RV = Ridge and Valley; BR = Blue Ridge; PD = Piedmont; UCP = Upper Coastal Plain and LCP = Lower Coastal Plain
**Habitat* = Human-made Key Wildlife Habitat

Key Wildlife Habitat Classification

Maryland's KWHs are nested within a hierarchical classification system split into five broad divisions: 1) Upland Habitats, 2) Wetland Habitats, 3) Aquatic Habitats, 4) Subterranean Habitats, and 5) Other Habitats (see Table 4.1). These upper-level divisions are generally thought of as systems (*sensu* Cowardin et al. 1979) and are based primarily on gross hydrologic regime. For purposes of organization and for grouping threats and actions (Appendix 6b), four of the five divisions are further divided into finer groups based on similarities of hydrology (e.g., Tidal Wetlands), physiognomic structure (e.g., Forests), geomorphology (e.g., Coastal Beaches and Dunes), or other characteristics. For a full list of KWHs and their associated groupings, please see Appendix 4a.

Upland habitats are all terrestrial, non-wetland habitats that typically have dry to mesic well-drained soils. The 18 different upland habitats are divided into three groups: the forest group; the glade, barren, and cliff group; and the coastal beach and dune group. Unlike in the 2015 SWAP revision, the 2025 SWAP revision includes some anthropogenic habitats in this broad habitat group; Managed Montane Conifer Forest was added to the forest group and Artificial Barren to the glades, barrens, and cliff group. This is because these KWHs have similar properties regardless of whether they are natural or human made.

Wetland habitats are often the interface between upland and aquatic habitats. They include all non-tidal and tidal wetland habitats dominated by woody plants, herbaceous emergent plants, and floating aquatic plants. These 19 wetland habitats are divided into four groups: the floodplain wetland group, the groundwater wetland group, the tidal wetland group, and the artificial wetland group. The artificial wetland group contains only one KWH—Artificial Impoundment and Artificial Wetland—which was added to this group in the 2025 SWAP revision for the same reasons articulated above.

Aquatic habitats represent Maryland's streams, rivers, and large marine and estuarine water bodies. The 13 different aquatic habitats are further divided into two groups: the stream and river group, and the bay and ocean group. The Small Coastal Plain Island KWH is included in the bay and ocean group because of where these islands are found (i.e., in the Coastal Bays and Chesapeake Bay).

Regarding the stream and river group—though there is not necessarily a clear, widely accepted definition that distinguishes streams from rivers—there are some key differences between the stream and river KWHs that are important to consider. Streams are typically smaller than rivers, with narrower channel width, lower water volume, and lower flow. Streams tend to function as tributaries to other streams or rivers, whereas rivers drain into larger water bodies such as estuaries or oceans. Streams also tend to support lower species richness than rivers and are dominated by species evolved to tolerate instability in flow and habitat conditions. Conversely, rivers support higher species richness and are dominated by species adapted to more stable habitat conditions, typically with larger body size and different functional feeding traits than headwater stream species. Food chains differ as well: stream food chains are usually dominated by inputs from terrestrial sources (i.e., plant material such as leaves and woody debris), whereas river food chains rely upon aquatic food sources such as phytoplankton and aquatic vegetation.

Subterranean habitats include cave habitats and significant associated karst features. The Artificial Structure: Mine and Tunnel KWH was also added to this group for the 2025 SWAP revision for the same reasons articulated in the upland and wetland habitat summaries above.

Finally, the fifth broad habitat category is entitled “other habitats.” These are certain human-made habitats that resemble and provide some function as natural wildlife habitats because of their structure, hydrology, vegetative composition, or other characteristics. This category includes habitats created as unintended outcomes as well as habitats that are specifically designed and built to serve as wildlife habitat, such as warm season grass plantings. The five “other” habitats are further divided into two groups: Working Lands and (Sub)urban. It is also worth noting that Managed Montane Conifer Forest, Artificial Impoundment and Artificial Wetland, and Artificial Structure: Mine and Tunnel were in this habitat category in the 2015 SWAP revision; Artificial Barren would have been as well, were it not a new KWH in 2025.

Although these five KWHs (as well as the four additional anthropogenic habitats marked with an asterisk in Table 4.1) have microclimates or other features that render them as important surrogate habitats for SGCN, their importance for maintaining wildlife populations varies on a case-by-case basis from suitable habitat to critical. For example, chimney swifts *(Chaetura pelagica)* lost the majority of their original nesting and roosting habitat long ago, as colonizing Europeans and growing populations vastly reduced the number of large, hollow trees. The primary habitats remaining are structures (i.e., chimneys) created and maintained by people. On the other hand, it is important to remember that not every building will support SGCN or provide a benefit equivalent to natural habitats. Maryland does not necessarily advocate for more of these artificial habitats; rather, in the absence of natural habitat equivalents, instances of these KWHs that serve as important SGCN habitat should be kept as they are and minimally disturbed.

In certain cases, artificial or human-made habitat can benefit humans, wildlife, and the ecosystem at large. This is possible through careful design and stewardship, based largely on the knowledge and practices of the indigenous peoples of Maryland. One example of this is the increasingly popular “food forest” phenomenon, which can provide food for people, food for animals, and habitat for a variety of native species. A case study is included below to highlight this practice and the benefits it brings to Maryland’s people, plants, and animals,

Case Study: Food Forests and Indigenous-Based Knowledge

The woods and wildlife go hand in hand. Our forests, from leaf litter to the treetops, can provide a home and a meal for many species.

Forest stewardship involves managing those woodlands for improved health of the trees, shrubs, and land overall. Depending on landowner objectives, it can also mean building a higher quality habitat for our wildlife by boosting overall plant diversity to provide food sources at varying points of the season. Whether it’s a Wildlife Management Area or a forest stand on private property, MD DNR’s Wildlife and Heritage Service (WHS) and Forest Service (MFS) are always looking to maximize the benefits of our woods and all the resources the forest provides for animals and people alike.

What indigenous communities understood—the original stewards of this land before the word "stewardship" existed—was that our forests are also food stores and a pharmacy for our very own species. Agroforestry, the science of integrating trees and shrubs into agricultural settings, views our landscape through this multifunctional layered lens.

In recent years, there has been a tremendous increase in knowledge exchange within the world of agroforestry, resulting in several best practices, one which has been thoroughly embraced in municipalities and public spaces: food forests. Although these are more built systems by human design versus the more symbiotic ancestral relationship of Native Americans and our forests prior to European settlement, the species that are involved in this practice are inspired by and rooted in indigenous knowledge and the first "foragers" of the land. From American persimmon *(Diospyros virginiana)* to pawpaw *(Asimina triloba)* to hazelnut *(Corylus americana)*, there are layers of untapped potential in our landscape that our native wildlife knew and thrived with well before we were here. The following paragraphs describe the "edible understory" of Maryland's food forests as well the benefits they provide to Maryland's people and wildlife.

We'll begin at the top of the food forest canopy with the persimmon tree. Late season blooms and the fruit that follows on persimmon provide a well-timed meal for pollinators and wildlife. Persimmons also serve as the larval home for one of our state's largest and most beautiful moth species, the luna moth. The pileated woodpecker, the largest woodpecker in the United States, is known to feast on the fruit as it lingers on the stem late into the season before dropping to the forest floor. Northern bobwhite *(Colinus virginianus)*—a gamebird we are actively working to restore habitat for, as well as an SGCN—are also known to include persimmon on their avian menu.

Francis Smith, MD DNR, with a persimmon tree at White Marsh Park Edible Trail (Joe Zimmermann, MD DNR)

Though persimmon can stand the tallest in a food forest, the "Indiana banana" or pawpaw rises above all in terms of popularity and is the most well-known of this tree and shrub bunch. Our largest native tree fruit is food for a wide variety of native species, including wild turkey, black bear, Virginia opossum, and various fox species. As a shaded edge, bottomland species that can frequent wooded corridors along waterways, pawpaw are also utilized by beavers, who are known to eat its bark. The infamous "hillbilly mango" is also a larval host for a specialist insect species, the zebra swallowtail, that relies solely on this understory treat to begin its life journey.

Another food forest native that can sometimes be found on the shaded edges of our landscapes is the serviceberry, two species of which are SGCN. There is no higher value tree among our feathered friends, with over 30 bird species being supported by this plant. This includes many declining migratory and gamebird species that need habitat and food sources now more than ever, many of which are also SGCN: ruffed grouse *(Bonasa umbellus)*, northern bobwhite, wood thrush *(Hylocichla mustelina)*, scarlet tanager *(Piranga olivacea)*, and veery *(Catharus fuscescens)*, among others. Serviceberry's early-season white blooms provide nectar to many of our native bees as well, which are also under threat and in increasing need of habitat. Mason, mining, cuckoo, and bumblebees all dine on the "shadbush" flowers, so called because, when in bloom, these flowers signaled to indigenous peoples that the shad fish were running, and it was time to go fishing.

Wild American plum (Prunus americana)
(Joe Zimmermann, MD DNR)

The Prunus family supports more caterpillar species (400+) than any other trees in Maryland, other than our mighty oaks. Wild American plum *(Prunus americana)* is one of those family members that can be a jam-jelly fruit and potentially more adult crop of a cocktail flavor additive among our agroforestry natives. Maryland's gamebird gang of turkey, grouse, and quail are all quite comfortable in the thickets of a spreading American plum patch, as they can provide both food and safe cover from predators. Native bees, wasps, and mammals may also rely on this fruit as it lingers late into the season.

Hazelnut is a shrub that adds desirable stratification to any native forest stand. It is another multi-stem home for gamebirds that can huddle beneath it for shelter. Additionally, hazelnut supports two of Maryland's most unique insects: the aforementioned luna moth, which uses hazelnut as a larval home, and the alien-looking walking stick. The walking stick has been known to eat the leaves of hazelnut, although one must look closely to spot this invertebrate in action. Like the pawpaw, beavers also enjoy munching on the bark of this native nut shrub. Not to be outdone, gray squirrels will also devour a hazelnut bush when it is in production and leave nothing but scattered shells in their wake.

Mother Nature's cold medicine, the elderberry, both helps human health and has immense value to our wildlife cohabitants. One of the most important contributions this sprawling shrub can provide is hollow-stem habitat for native mason and mining bees. The largest native moth in the U.S., the cecropia moth, also begins its life in larval stages hosted by elderberry. Similar to serviceberry, there are at least 20 bird species that will dine among the elders, including the rose-breasted grosbeak, kinglet species, and the always-popular eastern bluebird. On the same shaded, moist edges of woodlands as the pawpaw, elderberry can also provide respite and cover for ruffed grouse and ring-necked pheasant.

A bit closer to the forest floor is the little-known native shrub, the black chokeberry *(Aronia melanocarpa)*, more often referred to by its lovelier-sounding Latin name, Aronia. Multiple larval forms of insects call this shrub home, including the coral hairstreak and bluish spring moth. Beyond serving as habitat for these insects, the numerous flowers of black chokeberry are a nectar source for one of the most sought-after, high-speed migratory species, the hummingbird.

Though its fruit can seem too tart to humans, when food supply is low heading into winter months, cedar waxwing and other winter migrants can nibble on this native fruit. The iconic Delmarva fox squirrel's *(Sciurus niger cinereus)* habitat is often cited as overlapping black chokeberry, as it was known to be a part of this Endangered-turned-recovered species' diet.

Veery (Catharus fuscescens) (Dan Sudia, USFWS)

Last—though certainly not least—is highbush blueberry *(Vaccinium corymbosum).* Maryland is home to both lowbush and highbush blueberry, but with its larger berries, the highbush is often the favored choice of humans and wildlife alike. The brown elfin butterfly larval form is supported by blueberry, and honeybees, bumblebees, and mining bees can be found buzzing around its flowers. As with the other listed berries, from towhees to tanagers, this plant's berries are a favorite of dozens of bird species. Veery, a long-distance migrant, has experienced population declines and is even more so benefitted by this well-known berry species. Just about every mammal in Maryland is also quite fond of a blueberry understory.

What is most exciting about the planting of all of these species and food forests is that, even if humans cannot keep these systems in perfectly straight, aesthetically pleasing rows—and if we cannot harvest fruits and nuts in time—then these areas simply become multi-layered, multifunctional buffets and homes for an endless number of species.

In a broader sense, the resulting stratification and diversification of our native understory through this approach only helps to build a more resilient woodland system in the face of increasing cases of weather whiplash, as climate change and other factors cause quick changes from flash flood-level precipitation to bone-dry conditions, seesaw temperature swings, and more. A well-designed food forest can provide more sustainable systems for our lands and wildlife for generations to come.

Key Wildlife Habitat Classification: Regional Context

The Northeast Association of Fish and Wildlife Agencies (NEAFWA) encourages all northeast states to standardize their habitat types in order to promote streamlined collaboration between states. Chapter 2 of the Northeast Regional Conservation Synthesis for 2025 State Wildlife Action Plans (TCI & NEFWDTC 2023) lists 24 regional habitat types for states to use. While Maryland does not use this classification, all 57 KWHs have been cross referenced with the 24 regional habitat types to better facilitate cross-state collaboration. Each KWH description includes which regional habitat type it matches. For a comprehensive list of Maryland KWHs and regional habitat types, see Appendix 4a.

Structural Conditions of Key Wildlife Habitats

The relationship of SGCN to KWHs is a complex one in which a combination of environmental conditions must exist in order to provide the necessities of life that allow a species to survive and reproduce. Healthy and viable wildlife populations seek out and use particular habitat types (e.g., cover types), structural conditions (e.g., stand attributes), and habitat elements (i.e., finer-scaled site-specific attributes). Together, these conditions form the core of the wildlife habitat concept and are used here to illustrate the multidimensional relationships of wildlife and habitat.

The structural condition of a KWH is a vital component of a species' overall habitat. Structural conditions for vegetated upland and wetland habitats are known to vary through time in a predictable way as they follow plant successional series in a given habitat. These series, also known as seral stages, are the temporal phases of plant community development towards its climax and are classified based on age, structure of plant species, and evidence of natural or human-caused disturbance. All seral stages serve a purpose and are important to maintain in the landscape. Forests in particular support a wide variety of species depending on the structural condition or seral stage present at a given time. Furthermore, the forested habitat types represented at either end of this development are some of the most vulnerable yet important habitat types in Maryland.

Old growth forest
(Ed Thompson, MD DNR)

Old growth forests are considered the latest stage of a forest community's development. They are extremely important for a wide diversity of SGCN and are the rarest of forest seral stages in Maryland. The structural complexity that is characteristic of older forests with multiaged tree strata and significant standing dead and down trees provides greater niche and functional potential for unique biological diversity in forested systems, which is why this seral stage is so important for SGCN. Old growth forests historically occurred throughout Maryland, representing a broad range of forest types. Today, only scattered remnants remain in the state and elsewhere in the northeastern United States. These remnant patches were most likely left behind on sites that were not easily accessible for logging or where surveying errors led to uncertainty about forest ownership (McCarthy 1995). This rarity—not only in Maryland, but the majority of the U.S.—is the reason for highlighting this seral stage, in the hopes that more forest acreage in varying forest types will be allowed to reach old growth status. In a human-dominated environment, this is only possible through sound forest stewardship on both public and private lands.

One way that old growth forest status can be achieved is through Maryland's Wildlands Preservation System, the state equivalent to the federal Wilderness Preservation System. By designating certain state-owned properties as Wildlands, the state protects stretches of important habitat from all activities except passive recreation (e.g., hiking, fishing) (MD DNR 2026b). Due to this moratorium on timber harvest and associated activities, forests that receive this designation are therefore allowed to reach old growth status with minimal disturbance. One example of this can be found at Dans Mountain Wildlife Management Area (WMA), which includes the largest contiguous state-owned forest in Maryland (MD DNR 2026c). In 2015, 4,047 acres of its total 9,783 acreage were given the Wildland designation (MD DNR 2016b). This means that, although little of the WMA is currently considered old growth, many more acres of forest will be allowed to reach old growth status in the future.

In 2007, MD DNR led an effort to map and characterize extant old growth forest on public lands throughout the state (MD DNR 2007). Although these estimates are nearly twenty years old, there has not been such a comprehensive inventory of Maryland's old growth forest in the years since. As such, for certain KWH descriptions in this chapter, estimates of old growth forest on state lands are included based on this inventory effort.

Natural processes such as fire, floods, storm damage, tree aging, and beaver activity can re-set the clock on a mature forest community to an earlier seral stage on a large or small scale, providing suitable habitat for a different set of species until the forest once again reaches maturity. Human activities can also create changes in natural forest communities that mimic the impacts of natural disturbances to some extent. These processes and activities can bring about the other end of a forest community's development: early successional forest habitat. Early successional forests are upland areas dominated by shrubs and small trees (< 8 m tall) and include recently logged forests, succeeding non-forested land, temporary natural forest openings, shrub-dominated natural communities, and forest edges. The Managed Successional Forest KWH is the best example of this habitat type in the 2025 SWAP revision.

Early successional forests are critical to many bird, small mammal, and reptile SGCN that rely on this sometimes human-made habitat type in place of what was once more abundant, natural shrubland habitat. This habitat type is particularly at risk of redevelopment and is sensitive to suppression of natural disturbances (e.g., fire and beaver activity), as its existence relies upon these sorts of disturbances. Groups like the Maryland Prescribed Fire Council (Maryland Prescribed Fire Council 2026) work to mimic historic fire regimes through prescribed burning, which can "reset" forests back to this early successional forest habitat type.

Beyond using these two habitat types as examples of different structural conditions for the same overarching habitat group, these habitat types were chosen in order to highlight the importance of applying different management techniques to different habitats. The main need of old growth forests is to be preserved and protected; the main needs of early successional forests, on the other hand, are to reestablish natural disturbance patterns and support a network of always-changing forested habitat. This Plan looks to balance more "traditional" conservation techniques (i.e., preservation and protection) with the reality that some SGCN and habitats rely upon a changing, diverse landscape, and applies both approaches where and when appropriate.

Mapping Maryland's Key Wildlife Habitats

Once the list of Key Wildlife Habitats was compiled, the need for geographic information system (GIS) map data addressing the distribution of the habitats was determined. The current scientific inventory and geospatial databases were not sufficient to produce accurate distribution maps for all of the SGCN, their associated KWHs, or vegetative associations identified during the SWAP update process. Since coarse-level habitat information and accurate habitat distribution models are critical as a range indicator for some of the SGCN lacking adequate distribution and abundance data, the field inventories and analyses required to create these products remain a priority.

Distribution maps of Maryland's KWHs are included in this chapter, within each habitat section, for 55 of the 57 habitats. Although some location information is available, insufficient Maryland data exist to create meaningful distribution maps for two habitats: Roadside and Utility Right-of-Way and Artificial Structure: Buildings and Other Structures. For the remainder, GIS data layers were reviewed and compiled for the purpose of generating a graphical representation of the general distribution of the KWHs at a statewide scale. Because of this scale, many of the smaller habitat patches have been buffered to increase their visibility on the map, especially for habitats that are not densely distributed. However, the smallest patches may still be too small to be seen at this scale; some KWHs, such as Spring and Small Coastal Plain Island, are displayed as points rather than as polygons as a way to handle this issue. Many maps represent known and potential habitat, especially those of the more common and widely distributed habitats. Many, if not most, of the KWH maps used the same data sources and GIS layers as were used in the 2015 SWAP.

These maps were compiled using numerous existing data sources, such as U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory data; U.S. Geological Survey (USGS) National Hydrography Dataset, National Land Cover Data and Geographic Names Information System; U.S. Department of Agriculture (USDA) Soil Conservation Service generalized soils data; Federal Emergency Management Agency (FEMA) Q3 Floodplain data; MD Department of Planning's (MDP) Land Use/Land Cover data; University of Maryland Center for Environmental Science (UMCES) Appalachian Lab deep mines dataset; MD DNR Maryland Biological Stream Survey (MBSS) and Versar Inc. streams data (MBSS100k); and other MD DNR data developed by various sources, including Maryland Geological Survey (MGS), MD DNR Resource Assessment Service (RAS), and MD DNR Natural Heritage Program (NHP). The Northeast Terrestrial Habitat Map, developed by The Nature Conservancy (2011), was also a major source of data. Data sources for each map are listed in the accompanying caption.

The accuracy of MD DNR's KWH GIS data layers varies greatly, ranging from field-verified locations to predictive models, and many will need additional ground-truthing and other quality control measures and refinements before they should be considered accurate enough to use for most other purposes, especially at a local level. Even the maps that display known point location data are to some extent incomplete; therefore, these maps only should be viewed as generalized range maps, rather than depicting the full and complete distribution of habitats.

In addition to displaying the general location of KWHs in Maryland, these maps can be used as a tool to help direct distribution and abundance surveys of SGCN and associated vegetative communities within these habitats. The maps may also support the development of conservation strategies for specific KWHs on state and private lands designed to benefit all wildlife. Further mapping of "ecological landscapes" and natural communities will identify and delineate land areas with similar topography, bedrock type, soils, surface hydrology, vegetation, and land use. This will allow improved analyses and prediction of the distribution of species and habitats of greatest conservation need within their ecological context and provide an important tool to assist in the conservation of unique habitats within the framework of natural biological systems.

Upland Habitats
Forests

High Elevation Ridge Forest

Region(s): *Western*
Habitat Group*: Forests*
NEAFWA: *High Elevation Forests*

Jason Harrison, MD DNR

The High Elevation Ridge Forest Key Wildlife Habitat is characterized by rocky forests and woodlands that developed on Maryland's highest mountain ridges at or above 2,500 feet, such as those found on Backbone, Big Savage, Negro, Meadow, and Dans Mountains. The ecological communities within this habitat represent the uppermost elevational limits of oak-heath forests found throughout the western Piedmont and mountain regions, occupying some of the most inhospitable habitats in Maryland, situated on very exposed sites that are frequently subjected to high winds throughout the year and ice storms during the winter months. Trees are often stunted, have wind-pruned branches, and generally have a much different appearance than trees downslope at lower elevations.

Overall species diversity is low, with chestnut oak *(Quercus montana)* most prominent in the canopy. Other canopy species may include northern red oak *(Quercus rubra)*, white oak *(Quercus alba)*, pitch pine (*Pinus rigida*), eastern white pine (*Pinus strobus*), bear oak *(Quercus ilicifolia)*, sweet birch (*Betula lenta*), yellow birch *(Betula alleghaniensis)*, black cherry *(Prunus serotina)*, and occasionally red spruce *(Picea rubens)*. Shrubs may include thickets of young bear oak, mountain laurel *(Kalmia latifolia)*, blueberries (*Vaccinium* spp.), and black huckleberry *(Gaylussacia baccata*). Depending on the density of shrub cover, the herbaceous layer has sparse to moderate cover, and common species include Pennsylvania sedge (*Carex pensylvanica*), spotted wintergreen (*Chimaphila maculata*), false toadflax (*Comandra umbellata*), pink lady's slipper (*Cypripedium acaule*), poverty oatgrass (*Danthonia spicata*), trailing arbutus (*Epigaea repens*), rattlesnake-weed (*Hieracium venosum*), Indian cucumber (*Medeola virginiana*), ghost pipe (*Monotropa uniflora*), and bracken fern (*Pteridium aquilinum*).

These habitats are prone to spongy moth infestations, which can cause significant tree mortality in oak-dominated forests. Prior to the chestnut blight of the 1940s, American chestnut *(Castanea dentata)* was a major component of this habitat. In 2007, the Maryland Department of Natural Resources identified approximately 220 acres of High Elevation Ridge Forests as old growth forests on state lands (MD DNR 2007).

County Distribution: Allegany, Garrett

Places to Visit: Potomac-Garrett State Forest, Savage River State Forest, Dans Mountain Wildlife Management Area

State Rare Natural Communities: Lower New England High Slope Chestnut Oak Forest

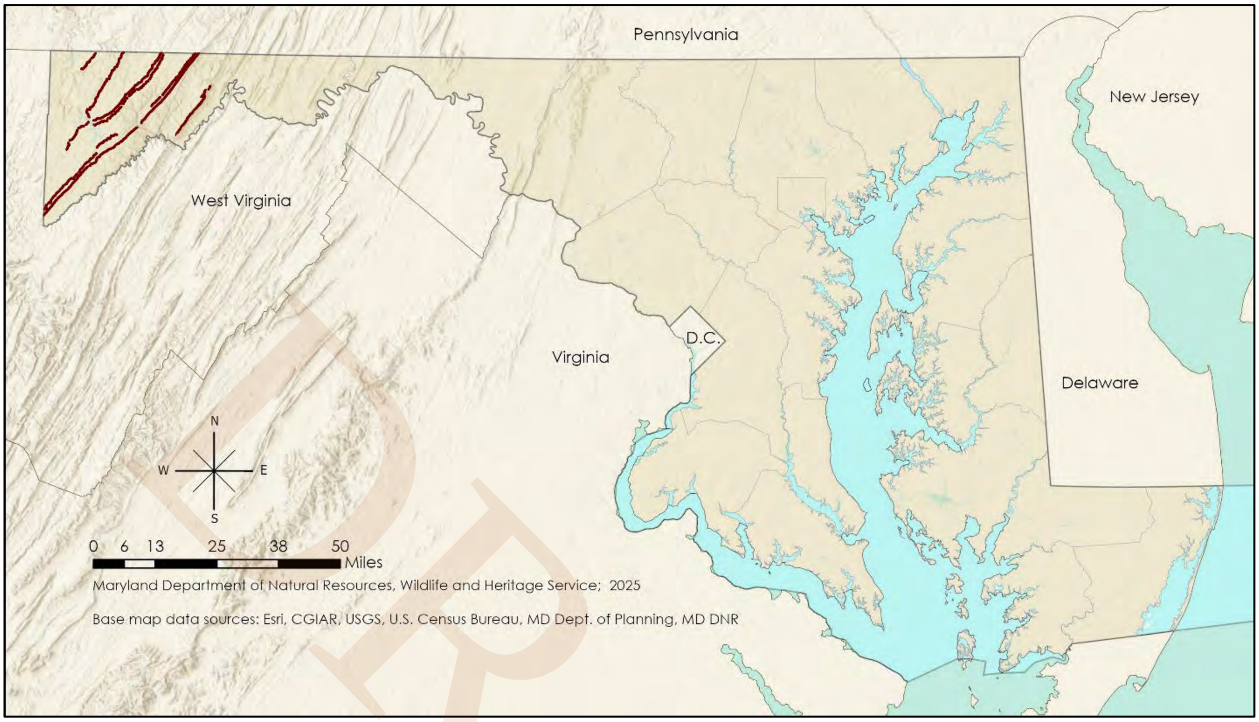


Figure 4.1 Location of High Elevation Ridge Forests in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with High Elevation Ridge Forests:

Birds
Acadian flycatcher
Black-and-white warbler
Black-throated blue warbler
Black-throated green warbler
Broad-winged hawk
Brown creeper
Canada warbler
Dark-eyed junco
Eastern whip-poor-will
Golden eagle
Golden-winged warbler
Magnolia warbler
Mourning warbler
Ovenbird
Ruffed grouse
Scarlet tanager
Winter wren
Wood thrush
Worm-eating warbler

Reptiles
Copperhead
Eastern box turtle
Timber rattlesnake

Amphibians
Jefferson salamander
Wehrle's salamander

Mammals
Allegheny woodrat
Appalachian cottontail
Bobcat
Eastern red bat
Eastern small-footed bat
Eastern spotted skunk
Hoary bat
Indiana bat
Least weasel
Little brown bat
Long-tailed shrew
Northern long-eared bat
Silver-haired bat

Mammals (continued)
Smoky shrew
Tricolored bat

Invertebrates (Snails)
Angular disc snail

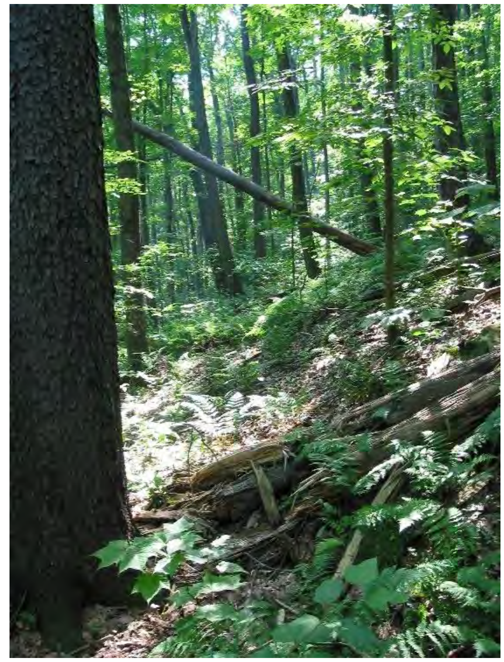
Insects (Lepidoptera)
Barred angle moth *(Macaria subcessaria)*
Gray comma

Insects (Coleoptera)
Common claybank tiger beetle
Cow path tiger beetle
Northern barrens tiger beetle
Splendid tiger beetle

Plants
Climbing fumitory *(Adlumia fungosa)*
Giant-seed goosefoot *(Chenopodiastrum simplex)*
Beaked dodder *(Cuscuta rostrata)*
Mountain woodfern *(Dryopteris campyloptera)*

Hemlock-Northern Hardwood Forest

Region(s): *Central, Western*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands*



Jason Harrison, MD DNR

The Hemlock-Northern Hardwood Forest Key Wildlife Habitat is characterized by cool, mesic forests of low mountain slopes and valleys in Maryland. These forests are most abundant at higher elevations on the Appalachian Plateau but also occur in pockets along north-facing mountain slopes of the Ridge and Valley and Blue Ridge, with disjunct and isolated stands that occur in portions of the Piedmont and coastal plain regions that represent relict stands of a once more widespread forest of the late Pleistocene age. As the post-glacial climate warmed, these forests retreated to higher elevations within the state.

The composition of Hemlock-Northern Hardwood Forests in Maryland varies with site conditions and was heavily influenced by destructive fires and extensive logging of eastern hemlock *(Tsuga canadensis)*, red spruce *(Picea rubens)*, white pine *(Pinus strobus)*, and hardwoods in the early 1900s. Approximately 400 acres of Hemlock-Northern Hardwood Forests have been identified as old growth on state lands in western Maryland (MD DNR 2007). Today's stands are typically dominated by northern hardwoods such as sugar maple *(Acer saccharum)*, American beech *(Fagus grandifolia)*, black cherry *(Prunus serotina)*, and yellow birch *(Betula alleghaniensis)*, with mixtures of eastern hemlock. Other tree associates may include northern red oak *(Quercus rubra)*, white oak *(Quercus alba)*, white pine, sweet birch *(Betula lenta)*, red spruce, white ash *(Fraxinus americana)*, basswood *(Tilia americana)*, and red maple *(Acer rubrum)*. The understory of Hemlock-Northern Hardwood Forests may include species such as striped maple *(Acer pensylvanicum)*, witch-hazel *(Hamamelis virginiana)*, maple-leaf viburnum *(Viburnum acerifolium)*, and dense patches of great laurel *(Rhododendron maximum)* and mountain laurel *(Kalmia latifolia)*. It is not uncommon to discover the herbaceous layers in some stands entirely dominated by patches of hay-scented fern *(Dennstaedtia punctilobula)* or New York fern *(Amauropelta noveboracensis)*. Other characteristic herbs include Indian cucumber-root *(Medeola virginiana)*, whorled aster *(Oclemena acuminata)*, Canada mayflower *(Maianthemum canadense)*, bellworts *(Uvularia* spp.), violets *(Viola* spp.*)*, and wood ferns *(Dryopteris* spp.*)*.

Forests where eastern hemlock is an important canopy component are threatened by the hemlock woolly adelgid, a non-native and destructive insect from Asia that infests hemlock trees, ultimately resulting in mortality.

County Distribution: Allegany, Baltimore, Caroline, Carroll, Cecil, **Frederick**, **Garrett**, Harford, Howard, Kent, Montgomery, Talbot, **Washington**

Places to Visit: Savage River State Forest, Swallows Falls State Park

State Rare Natural Communities: Eastern Hemlock-Hardwood Forest, Northern Hardwood Forest

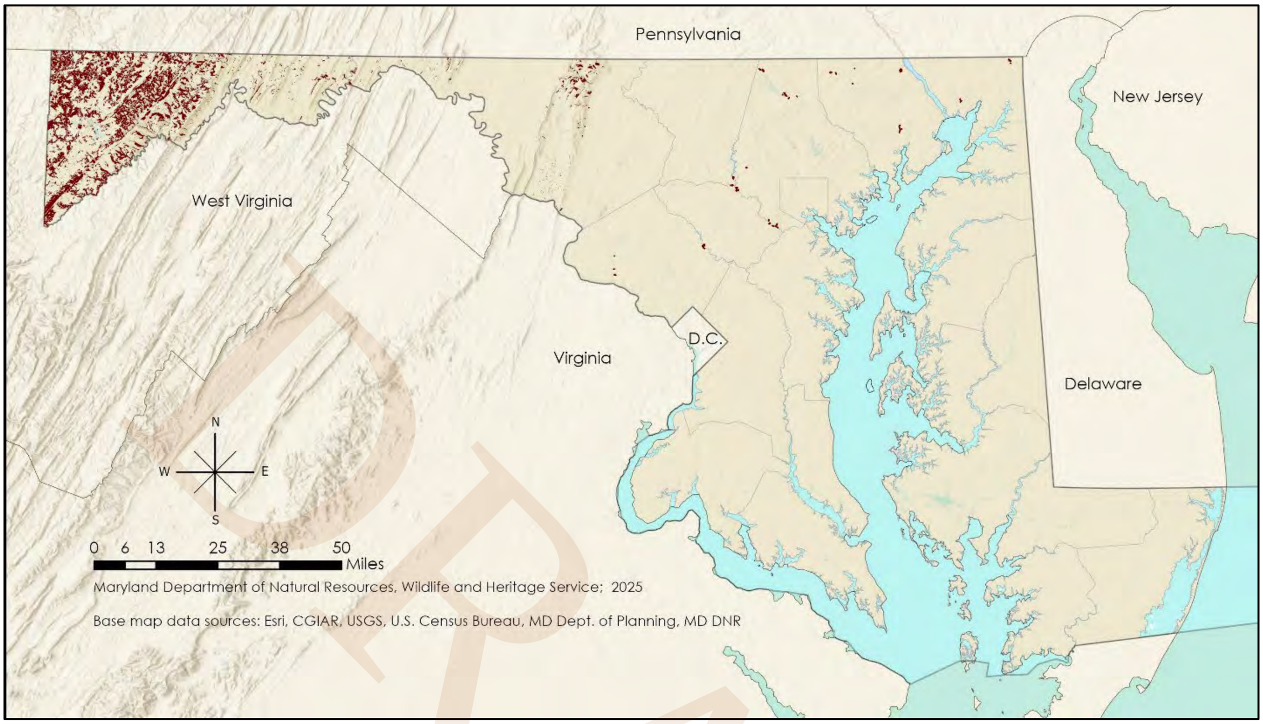


Figure 4.2 Location of Hemlock-Northern Hardwood Forests in Maryland. Sources: MD DNR, Delaware Department of Natural Resources and Environmental Control.

Species of Greatest Conservation Need Associated with Hemlock-Northern Hardwood Forests:

Birds

Acadian flycatcher
American goshawk
American redstart
American woodcock
Bald eagle
Black-and-white warbler
Black-throated blue warbler
Black-throated green warbler
Blackburnian warbler
Broad-winged hawk
Brown creeper
Canada warbler
Dark-eyed junco
Eastern whip-poor-will
Golden eagle
Golden-crowned kinglet
Golden-winged warbler
Hooded warbler
Kentucky warbler
Least flycatcher

Reptiles

Copperhead
Eastern box turtle
Smooth greensnake
Timber rattlesnake
Wood turtle

Amphibians

Green salamander
Jefferson salamander
Mountain chorus frog
Valley and Ridge salamander
Wehrle's salamander

Mammals

Allegheny woodrat
American mink
Appalachian cottontail
Bobcat
Eastern red bat
Eastern small-footed bat

Insects (Lepidoptera)

Barred angle moth *(Macaria subcessaria)*
Comstock's sallow moth
Gray comma
West Virginia white

Insects (Coleoptera)

Common claybank tiger beetle
Cow path tiger beetle
Northern barrens tiger beetle
Splendid tiger beetle

Plants

Filmy angelica *(Angelica triquinata)*
Lanceleaf grapefern *(Botrychium angustisegmentum)*
Bunchberry *(Chamaepericlymenum canadense)*
Purple clematis *(Clematis occidentalis)*

Magnolia warbler
Mourning warbler
Northern parula
Northern saw-whet owl
Ovenbird
Pine siskin
Red-breasted nuthatch
Ruffed grouse
Scarlet tanager
Sharp-shinned hawk
Swainson's thrush
Veery
Winter wren
Wood thrush
Worm-eating warbler

Eastern spotted skunk
Gray fox
Hoary bat
Indiana bat
Least weasel
Little brown bat
Long-tailed shrew
Northern long-eared bat
Silver-haired bat
Smoky shrew
Southern bog lemming
Southern pygmy shrew
Southern rock vole
Southern water shrew
Tricolored bat

<u>Invertebrates (Snails)</u>

Angular disc snail
Spruce knob threetooth

Harned's clintonia *(Clintonia alleghaniensis)*
Clinton lily *(Clintonia borealis)*
Goldthread *(Coptis trifolia)*
Long-bract green orchis *(Dactylorhiza viridis)*
American fly-honeysuckle *(Lonicera canadensis)*
Bog clubmoss *(Lycopodiella inundata)*
Kidneyleaf twayblade *(Neottia smallii)*
Purple oat *(Schizachne purpurascens)*
Rosy twisted-stalk *(Streptopus lanceolatus)*
Canada yew *(Taxus canadensis)*
Large-flower bellwort *(Uvularia grandiflora)*

Cove Forest

Region(s): *Western*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands*

Edward Thompson, MD DNR

The Cove Forest Key Wildlife Habitat (KWH) is characterized by diverse, mesic forests of mountain slopes occupying sheltered landforms such as coves, ravines, and concave lower slopes, which provide shade protection from high winds, creating very moist soil conditions. Both rich and acidic Cove Forests are represented in this KWH and differentiated by soil fertility, species richness, and species composition.

Rich Cove Forests contain deep, nutrient-rich, moderately alkaline, fertile soils weathered from a variety of substrates that have higher levels of calcium, magnesium, and manganese, yielding some of the highest diversity of plant communities in the state, often supporting very diverse and lush herbaceous layers. However, greater soil nutrient availability also makes rich cove forests highly susceptible to invasion by non-native plant species. Forest canopies are most commonly dominated by combinations of sugar maple *(Acer saccharum)*, basswood *(Tilia americana)*, white ash *(Fraxinus americana)*, white oak *(Quercus alba)*, and northern red oak *(Quercus rubra)*. Other characteristic tree species include cucumber magnolia *(Magnolia acuminata)*, shagbark hickory *(Carya ovata)*, butternut *(Juglans cinerea)*, tulip poplar *(Liriodendron tulipifera)*, witch-hazel *(Hamamelis virginiana)*, eastern hop-hornbeam *(Ostrya virginiana)*, striped maple *(Acer pensylvanicum)*, and sweet birch *(Betula lenta)*. The herbaceous layer typically includes species such as Jack-in-the-pulpit *(Arisaema triphyllum)*, white snakeroot *(Ageratina altissima)*, aniseroot *(Osmorhiza longistylis)*, wood nettle *(Laportea canadensis)*, enchanter's nightshade *(Circaea lutetiana* ssp. *canadensis)*, Virginia waterleaf *(Hydrophyllum virginianum)*, wild ginger *(Asarum canadense)*, American ginseng *(Panax quinquefolius)*, wild columbine *(Aquilegia canadensis)*, yellow mandarin *(Prosartes lanuginosa)*, blue cohosh *(Caulophyllum thalictroides)*, foamflower *(Tiarella cordifolia)*, wood ferns *(Dryopteris* spp.*)*, trilliums *(Trillium* spp.*)*, and bellworts *(Uvularia* spp.).

Acidic Cove Forests occur on substrates underlain by acidic bedrock such as sandstone or quartzite. A mixture of eastern hemlock (*Tsuga canadensis*), white pine *(Pinus strobus)*, and hardwoods such as yellow birch, northern red oak, white oak, and dense patches of great laurel *(Rhododendron maximum)* or mountain laurel *(Kalmia latifolia)* distinguish these forests from rich Cove Forests. Other characteristic woody species include witch-hazel, spicebush *(Lindera benzoin)*, wild hydrangea *(Hydrangea arborescens)*, and maple-leaf viburnum *(Viburnum acerifolium)*. Herbaceous species are limited by dense shade and poor soils and are much sparser and less diverse than in rich cove forests. The herbaceous layer includes species suited to acidic soils, such as white wood aster *(Eurybia divaricata)*, Christmas fern *(Polystichum acrostichoides)*, hay-scented fern *(Dennstaedtia punctilobula)*, wild yam *(Dioscorea* spp.*)*, Canada mayflower *(Maianthemum canadense)*, rattlesnake fern *(Botrychium virginianum)*, and Solomon's plume *(Maianthemum racemosum* ssp. *racemosum)*.

The Cove Forest KWH is often transitional and adjacent to the Hemlock-Northern Hardwood Forest KWH. Approximately 500 acres of Cove Forest have been identified as old growth forests on state lands (MD DNR 2007). Cove Forests range-wide are threatened by logging and the invasion of shade-tolerant non-native weeds such as garlic mustard *(Alliaria petiolata)*. Furthermore, cove forests are threatened by two non-native insect species. Acidic Cove Forests, where eastern hemlock is an important canopy species, are threatened by the hemlock woolly adelgid, a non-native and destructive insect from Asia. Rich cove forests are threatened by mortality of white ash caused by emerald ash borer, also native to Asia.

County Distribution: Allegany, Frederick, Garrett, Washington

Places to Visit: Savage River State Forest, Potomac-Garrett State Forest

State Rare Natural Communities: Acidic Cove Forest, Rich Cove Forest

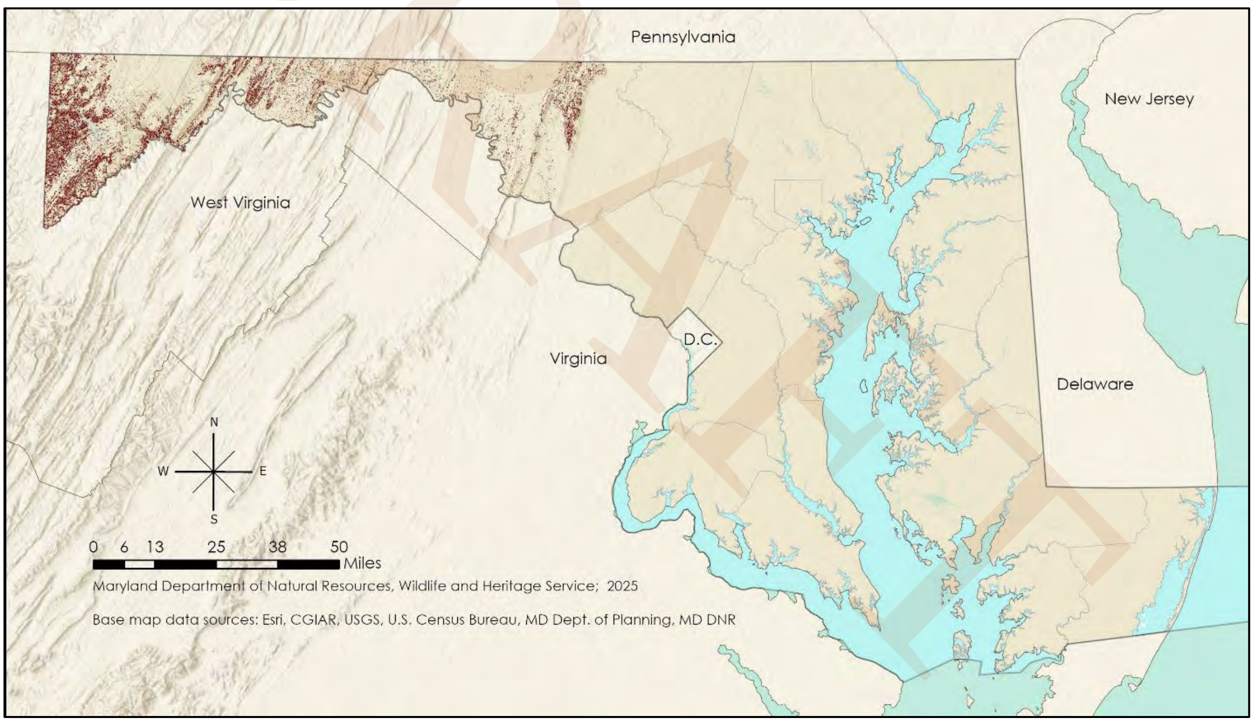


Figure 4.3 Location of Cove Forests in Maryland. Sources: MD DNR, Nature Serve's Terrestrial Ecological Systems of the U.S.

Species of Greatest Conservation Need Associated with Cove Forests:

Birds	Mammals	Amphibians
Acadian flycatcher	Allegheny woodrat	Green salamander
American redstart	American mink	Jefferson salamander
American woodcock	Appalachian cottontail	Mountain chorus frog
Baltimore oriole	Bobcat	Upland chorus frog

Black-and-white warbler
Black-throated blue warbler
Black-throated green warbler
Blackburnian warbler
Blue-winged warbler
Broad-winged hawk
Brown creeper
Canada warbler
Cerulean warbler
Dark-eyed junco
Eastern whip-poor-will
Golden eagle
Golden-winged warbler
Hooded warbler
Kentucky warbler
Least flycatcher
Northern parula
Northern saw-whet owl
Ovenbird
Prairie warbler
Ruffed grouse
Scarlet tanager
Sharp-shinned hawk
Veery
Winter wren
Wood thrush
Worm-eating warbler
Yellow-throated vireo

Eastern red bat
Eastern small-footed bat
Eastern spotted skunk
Gray fox
Hoary bat
Indiana bat
Least weasel
Little brown bat
Long-tailed shrew
Northern long-eared bat
Silver-haired bat
Smoky shrew
Southern bog lemming
Southern pygmy shrew
Southern water shrew
Tricolored bat

Reptiles

Copperhead
Eastern box turtle
Timber rattlesnake
Wood turtle

Valley and Ridge salamander
Wehrle's salamander

Insects (Lepidoptera)

Barred angle moth *(Macaria subcessaria)*
Comstock's sallow moth
Gray comma
West Virginia white

Plants

American bugbane *(Actaea podocarpa)*
Fraser's sedge *(Carex fraseriana)*
Northern oak fern *(Gymnocarpium dryopteris)*
Drooping bluegrass *(Poa saltuensis)*

Montane-Piedmont Oak-Pine Forest

Region(s): *Central, Western*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands*

Mark Hall, MD DNR

The Montane-Piedmont Oak-Pine Forest Key Wildlife Habitat (KWH) consists of dry-mesic oak and oak-pine dominated forests of low (< 2,500 feet) mountain slopes, ridge crests, and rolling Piedmont hills. This KWH develops over a variety of acidic substrates, including shale and sandstone in the mountains and metamorphic and igneous rocks in the Piedmont. These forests commonly include chestnut oak *(Quercus montana)*, white oak *(Quercus alba)*, scarlet oak *(Quercus coccinea)*, bear oak *(Quercus ilicifolia)*, black oak *(Quercus velutina)*, black gum *(Nyssa sylvatica)*, and white pine *(Pinus strobus)* in variable mixtures, although some stands may be entirely dominated by chestnut oak. Occasionally, stands may support abundant white pine, which may be more common in forests following logging or fire exclusion, while others may have Virginia pine *(Pinus virginiana)* and successional hardwoods such as red maple *(Acer rubrum)* present, indicative of past disturbances. Tall shrubs of mountain laurel *(Kalmia latifolia)*, wild azalea *(Rhododendron periclymenoides)*, and maple-leaf viburnum *(Viburnum acerifolium)* are typical as are dense patches of low heaths such as early lowbush blueberry *(Vaccinium pallidum)*, black huckleberry *(Gaylussacia baccata*), and deerberry *(Vaccinium stamineum)*. The herbaceous layer of these forests is generally sparse but may include poverty oatgrass *(Danthonia spicata)*, wavy hairgrass *(Deschampsia flexuosa* var. *flexuosa)*, and Pennsylvania sedge *(Carex pensylvanica)*. In 2007, the Maryland Department of Natural Resources identified about 730 acres of Montane-Piedmont Oak-Pine Forest as old growth forests on state lands (MD DNR 2007).

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Green Ridge State Forest, Savage River State Forest, South Mountain State Park, Dans Mountain Wildlife Management Area

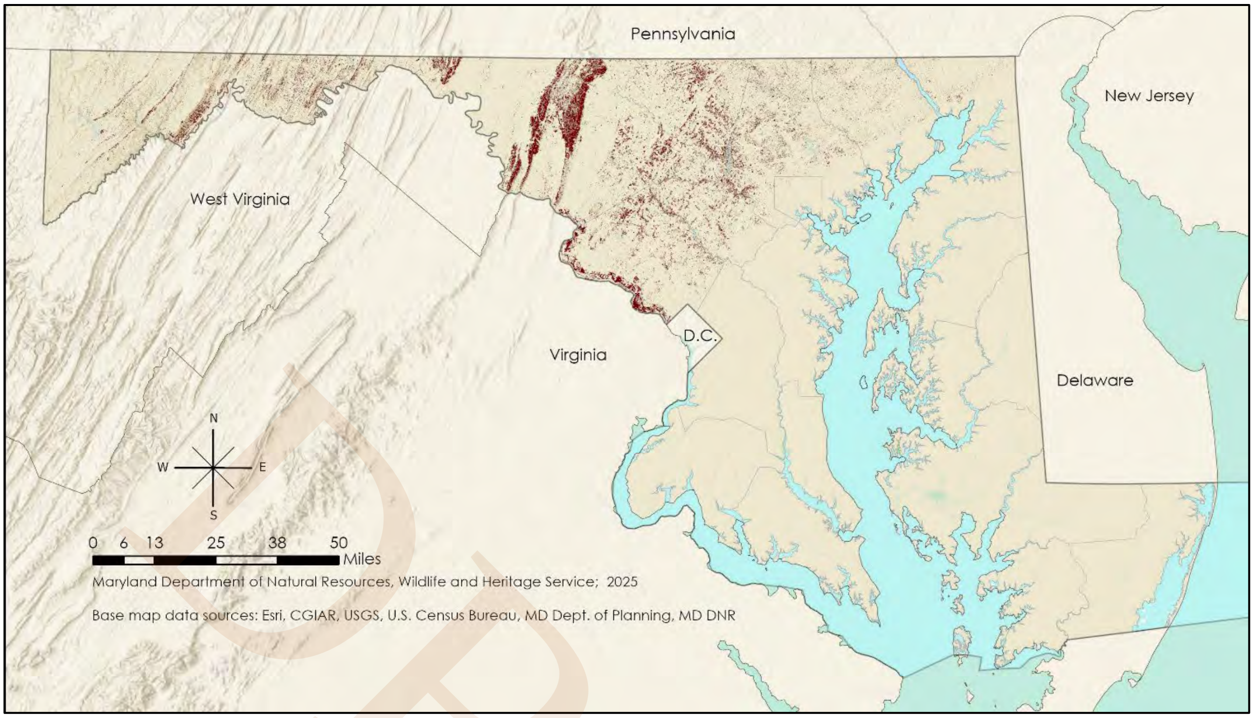


Figure 4.4 Location of Montane-Piedmont Oak-Pine Forests in Maryland. Sources: NatureServe's Terrestrial Ecological Systems of the U.S.

Species of Greatest Conservation Need Associated with Montane-Piedmont Oak-Pine Forests:

Birds

Acadian flycatcher
American woodcock
Bald eagle
Baltimore oriole
Black-and-white warbler
Black-billed cuckoo
Broad-winged hawk
Brown creeper
Eastern whip-poor-will
Golden eagle
Golden-winged warbler
Northern bobwhite
Northern saw-whet owl
Ovenbird
Prairie warbler
Ruffed grouse
Scarlet tanager
Sharp-shinned hawk
Wood thrush
Worm-eating warbler
Yellow-breasted chat
Yellow-throated vireo

Mammals

Allegheny woodrat
American mink
Appalachian cottontail
Bobcat
Eastern red bat
Eastern small-footed bat
Eastern spotted skunk
Gray fox
Hoary bat
Indiana bat
Least weasel
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians

Jefferson salamander
Mountain chorus frog
Upland chorus frog
Valley and Ridge salamander

Insects (Coleoptera)

Cow path tiger beetle
Northern barrens tiger beetle
Splendid tiger beetle

Insects (Hymenoptera)

A leafcutter bee *(Paranthidium jugatorium)*
Azalea mining bee *(Andrena cornelli)*
Half-black bumble bee *(Bombus vagans)*
Rusty-patch bumble bee *(Bombus affinis)*
Texas mason bee *(Osmia texana)*
Yellowbanded bumble bee *(Bombus terricola)*

Plants

Hairy woodmint *(Blephilia hirsuta)*
Summer sedge *(Carex aestivalis)*
Blue ridge sedge *(Carex lucorum)*
Ravenel's witchgrass *(Dichanthelium ravenelii)*
Hairy lettuce *(Lactuca hirsuta)*

Reptiles

Copperhead
Eastern box turtle
Mountain earthsnake
Northern coal skink
Red cornsnake
Six-lined racerunner
Smooth greensnake
Timber rattlesnake
Wood turtle

Insects (Lepidoptera)

Cobweb skipper
Edwards' hairstreak
Frosted elfin
Indian skipper
Leonard’s skipper
Melsheimer's sack-bearer
Northern metalmark
Northern oak hairstreak
Olympia marble
Pepper and salt skipper
Silvery blue

Sweet pinesap *(Monotropsis odorata)*
Mountain ricegrass *(Patis racemosa)*
Virginia mountainmint *(Pycnanthemum virginianum)*
Roundleaf dogwood *(Swida rugosa)*
Drummond’s aster *(Symphyotrichum drummondii)*

Oak-Hickory Forest

Region(s): *Central, Western*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands*

Richard Wiegand, MD DNR

The Oak-Hickory Forest Key Wildlife Habitat (KWH) is the most common forest type in the Piedmont and mountain regions of Maryland, historically covering thousands of acres throughout the Piedmont, Ridge and Valley, Blue Ridge, and Appalachian Plateau. They occupy a wide variety of low- to mid-elevation upland settings with variable soil moisture and fertility. Soils are predominantly acidic and nutrient-poor, but localized areas of basic (e.g., metabasalt, amphibolite, and gabbro) support a higher diversity of plants and are considered rare natural communities in the state. Soil moisture is dependent upon local site conditions but can vary from mesic on low to midslopes to dry on upper slopes, ridge crests and, occasionally, bedrock terraces along rivers.

Characteristic of this KWH is a well-developed, closed canopy of oaks such as white oak *(Quercus alba)*, northern red oak *(Quercus rubra)*, scarlet oak *(Quercus coccinea)*, black oak *(Quercus velutina)*, and occasionally chestnut oak *(Quercus prinus)*. American chestnut *(Castanea dentata)* was likely prominent in the canopy of oak-hickory forests prior to the chestnut blight of the 1940s, which essentially eliminated them from these forests. Hickory species are diagnostic and often abundant as understory trees, but may also reach into the canopy and commonly include pignut hickory *(Carya glabra)*, mockernut hickory *(Carya alba)*, red hickory (*Carya ovalis*), shagbark hickory *(Carya ovata)*, and bitternut hickory *(Carya cordiformis)*. White ash *(Fraxinus americana)*, eastern hop-hornbeam *(Ostrya virginiana)*, common hackberry *(Celtis occidentalis)*, and eastern redbud *(Cercis canadensis)* are characteristic of stands over basic substrates. With a long history of human habitation, logging, and agricultural conversion, many stands today are early to mid-successional and may be dominated by tulip poplar *(Liriodendron tulipifera)*, sugar maple *(Acer saccharum)*, white pine *(Pinus strobus)*, and Virginia pine *(Pinus virginiana)*. Only 100 acres of Oak-Hickory Forest were identified by the Maryland Department of Natural Resources as old growth on state lands (MD DNR 2007).

The understory of Oak-Hickory Forests is also variable and correlated with soil nutrient and moisture availability, grading from dense patches of deciduous shrubs on dry, acidic sites to lush herbaceous layers—sometimes with exceptionally high species diversity—on more mesic or nutrient-enriched sites. Forests with more acidic soils have understories that are typically shrub-dominated by ericads, including early lowbush blueberry *(Vaccinium pallidum)* and deerberry *(Vaccinium stamineum)*, and scattered individuals of maple-leaf viburnum *(Viburnum acerifolium)*, witch-hazel *(Hamamelis virginiana)*, and flowering dogwood *(Cornus florida)*. Historically, flowering dogwood was probably much more abundant, but today's stands are vulnerable to dogwood anthracnose, a fungal pathogen responsible for high mortality in dogwoods. On more enriched sites, the shrub layer is more open, with ericads and other shrubs having only patchy cover and less importance within the community.

The herbaceous layer grades from patchy with low diversity on acidic sites to dense with high diversity in stands over basic substrates. Native plants of basic Oak-Hickory Forests may include cut-leaf toothwort *(Cardamine concatenata)*, spring-beauty *(Claytonia* spp.), rue-anemone *(Thalictrum thalictroides)*, white wood aster *(Eurybia divaricata)*, bottlebrush grass *(Elymus hystrix* var. *hystrix)*, blue-stemmed goldenrod *(Solidago caesia)*, elm-leaf goldenrod *(Solidago ulmifolia* var. *ulmifolia)*, and Bosc's panic grass *(Dichanthelium boscii)*. Native plants of acidic Oak-Hickory Forests generally include species such as Indian cucumber-root *(Medeola virginiana)*, Solomon's-seal *(Polygonatum biflorum)*, rattlesnake-weed *(Hieracium venosum)*, plantain-leaved pussytoes *(Antennaria plantaginifolia)*, Pennsylvania sedge *(Carex pensylvanica)*, and poverty oatgrass *(Danthonia spicata)*. Unfortunately, excessive deer browse in these habitats has resulted in poor tree regeneration, and in some cases, invasion of non-native weeds such as garlic mustard *(Alliaria petiolata)* and Japanese honeysuckle *(Lonicera japonica)*.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Green Ridge State Forest, Monocacy Natural Resource Management Area, Patapsco Valley State Park, C&O Canal National Historical Park

State Rare Natural Community: Basic Oak-Hickory Forest

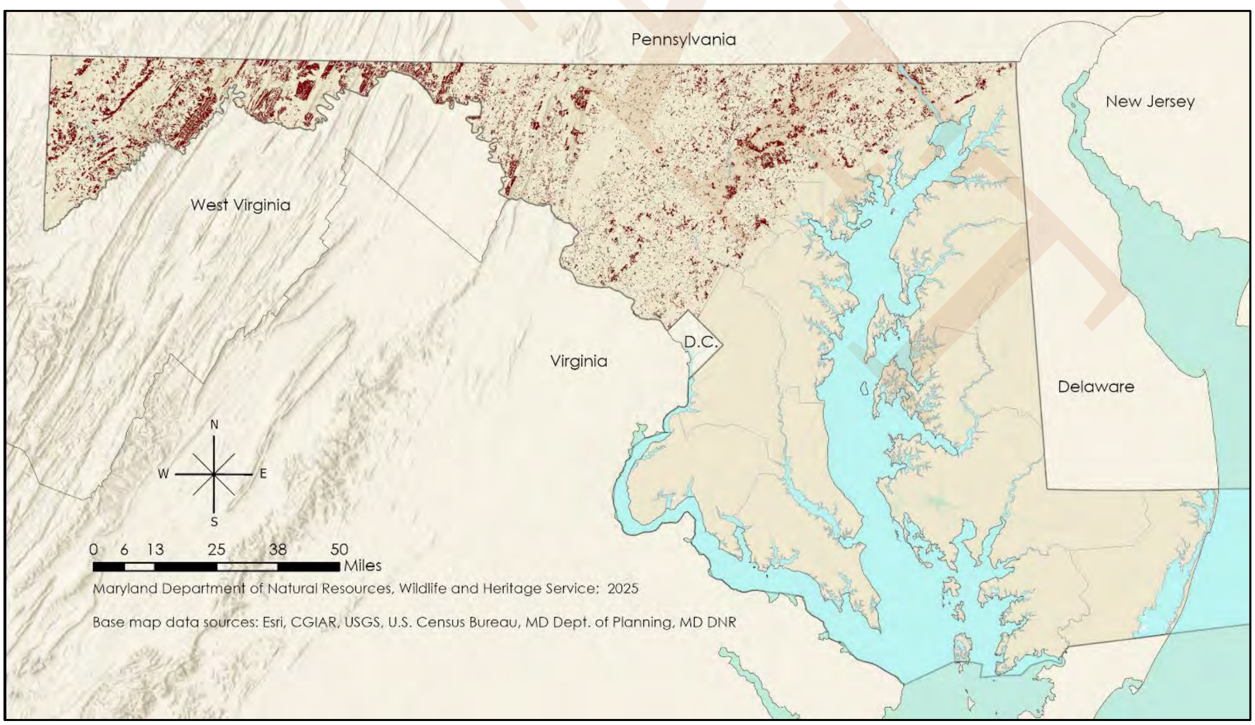


Figure 4.5 Location of Oak-Hickory Forests in Maryland. Source: The Nature Conservancy's (TNC) Northeastern Terrestrial Wildlife Habitat Classification System (NETWHCS).

Species of Greatest Conservation Need Associated with Oak-Hickory Forests:

Birds

Acadian flycatcher
American redstart
American woodcock
Bald eagle
Baltimore oriole
Black-and-white warbler
Black-billed cuckoo
Black-throated blue warbler
Black-throated green warbler
Blackburnian warbler
Blue-winged warbler
Broad-winged hawk
Brown creeper
Canada warbler
Cerulean warbler
Dark-eyed junco
Eastern whip-poor-will
Golden eagle
Golden-winged warbler
Hooded warbler
Kentucky warbler
Least flycatcher
Mourning warbler
Northern bobwhite
Northern parula
Ovenbird
Prairie warbler
Ruffed grouse
Scarlet tanager
Sharp-shinned hawk
Veery
Wood thrush
Worm-eating warbler
Yellow-breasted chat
Yellow-throated vireo

Mammals

Allegheny woodrat
American mink
Bobcat
Eastern red bat
Eastern small-footed bat
Eastern spotted skunk
Gray fox
Hoary bat
Indiana bat
Least weasel
Little brown bat
Northern long-eared bat
Silver-haired bat
Smoky shrew
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Amphibians

Green salamander
Jefferson salamander
Mountain chorus frog
Upland chorus frog
Valley and Ridge salamander

Reptiles

Copperhead
Eastern box turtle
Eastern kingsnake
Eastern mud turtle
Red cornsnake
Smooth greensnake
Spotted turtle
Timber rattlesnake
Wood turtle

Insects (Lepidoptera)

Barred angle moth *(Macaria subcessaria)*
Franck's sphinx
Gray comma
Northern oak hairstreak
Pepper and salt skipper

Insects (Hymenoptera)

A leafcutter bee *(Paranthidium jugatorium)*
Cranesbill miner bee *(Andrena distans)*
Half-black bumble bee *(Bombus vagans)*
Rusty-patch bumble bee *(Bombus affinis)*
Texas mason bee *(Osmia texana)*
Yellowbanded bumble bee *(Bombus terricola)*

Plants

Fly-poison *(Amianthium muscitoxicum)*
American chestnut *(Castanea dentata)*
Devil's-bit *(Chamaelirium luteum)*
Green adder's-mouth orchid *(Malaxis unifolia)*
Sourwood *(Oxydendrum arboreum)*
Bashful bulrush *(Trichophorum planifolium)*

Managed Montane Conifer Forest

Region(s): *Western*
Habitat Group*: Forests*
NEAFWA: *Agriculture: Plantations/Orchards*
Additional Notes: *An artificial or human-made habitat*

Dave Brinker, MD DNR

This habitat consists of pure or nearly pure conifer stands that have been planted, usually as monocultures. Many contain non-native conifers (e.g., Norway spruce [*Picea abies*], black spruce [*Picea glauca*], Scotch pine [*Pinus sylvestris*]), but some include native species such as eastern white pine *(Pinus strobus)*. Numerous conifer forest stands in western Maryland were established during the 1930s by Civilian Conservation Corps work crews. Today, these plantings can still be found on DNR lands (e.g., Savage River State Forest, New Germany State Park) and elsewhere as dense, heavily shaded, mature conifer stands. In a region where most natural forests dominated by northern conifers were eliminated by nineteenth and early twentieth century logging, montane conifer plantations provide surrogate nesting habitat for some sub-boreal and boreal bird species of conservation need that reach the southern periphery of their breeding range in the central and southern Appalachians. Species such as red-breasted nuthatch *(Sitta canadensis)* and golden-crowned kinglet *(Regulus satrapa)* can be found in other forested habitats, such as Hemlock-Northern Hardwood Forests, but the density and age of conifers in these stands provide optimal conditions for species with northern affinities.

County Distribution: Allegany, Garrett

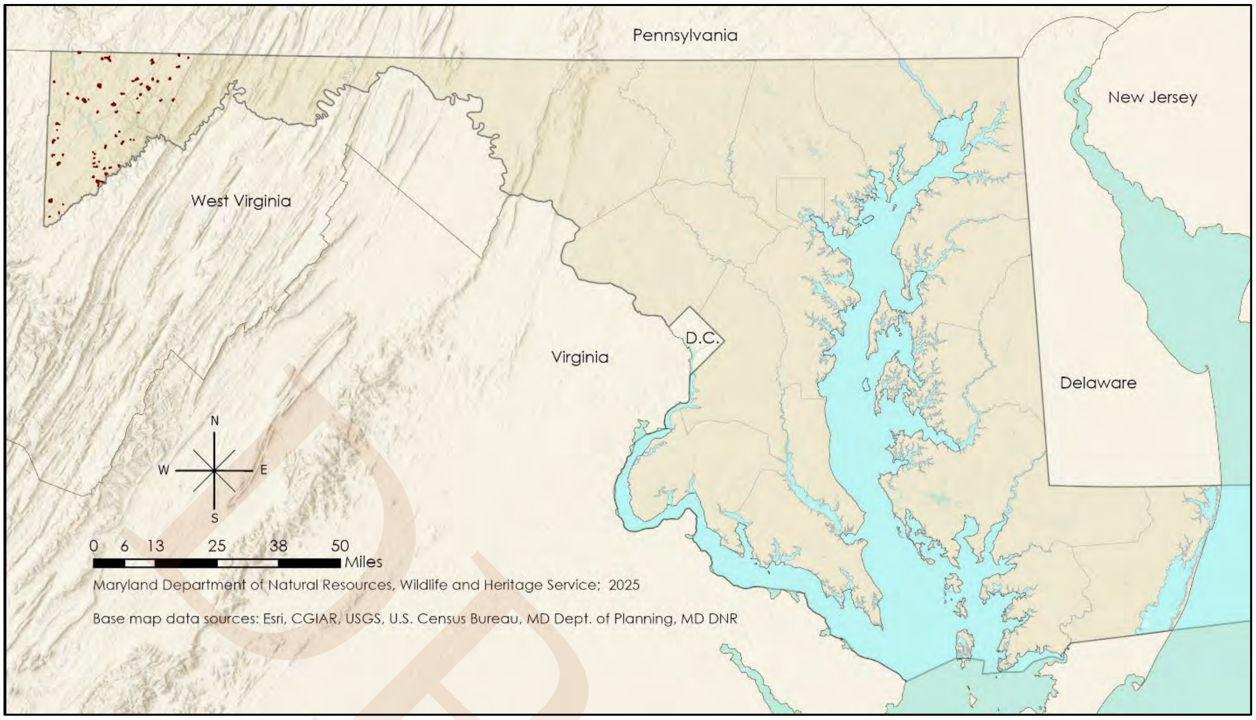


Figure 4.6 Location of Managed Montane Conifer Forests in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Managed Montane Conifer Forests:

Birds

American goshawk
Black-throated green warbler
Blackburnian warbler
Golden-crowned kinglet
Long-eared owl
Magnolia warbler
Pine siskin
Red-breasted nuthatch
Sharp-shinned hawk

Mesic Mixed Hardwood Forest

Region(s): *Central, Eastern, Southern*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands*

Jason Harrison, MD DNR

The revised Mesic Mixed Hardwood Forest Key Wildlife Habitat (KWH) combines the Basic Mesic Forest and Mesic Mixed Hardwood Forest KWHs from the 2015 State Wildlife Action Plan revision. This KWH occurs across the Coastal Plain, Piedmont, and lower elevations of the Blue Ridge and Ridge and Valley regions. These forests occur in landscape positions with greater moisture availability, such as north and east-facing slopes, ravines, lower slopes, undulating uplands, and flatwoods or occasionally upon high floodplain terraces that are well-drained. Soils develop from various substrates, which may vary from calcareous substrates such as limestone, calcareous shales, or greenstone material and mafic substrates that, when weathered, produce basic soils high in calcium and magnesium to those that are more acidic, derived from parent material such as sandstone of low to moderate fertility.

While these forests may differ in the substrate from which they develop, they often have similar dominant species composition characterized by mixed and often diverse canopies. Characteristic canopy dominants include tulip poplar *(Liriodendron tulipifera)*, American beech *(Fagus grandifolia)*, black walnut *(Juglans nigra)*, northern red oak *(Quercus rubra)*, white oak (*Quercus alba*), pignut hickory *(Carya glabra)*, and eastern hop-hornbeam *(Ostrya virginiana)*. Stands with more enriched soils and substrates often have chinkapin oak *(Quercus muhlenbergii)*, bitternut hickory *(Carya cordiformis)*, white ash *(Fraxinus americana)*, eastern redbud *(Cercis canadensis* var. *canadensis)*, and sugar maple *(Acer saccharum)* as canopy and subcanopy associates. On more nutrient-rich sites, the characteristic shrub species often include pawpaw (*Asimina triloba*), and spicebush (*Lindera benzoin*), with flowering dogwood (*Cornus florida*) as a common associate on more acidic substrates. The understories of these forests are dominated by moisture-demanding species but vary from low total cover and diversity on nutrient-poor sites to lush and dense with high species diversity on more enriched substrates. On less enriched sites, ferns such as Christmas fern *(Polystichum acrostichoides)* and New York fern *(Amauropelta noveboracensis)* may be locally abundant in patches with other herbaceous associates, including pink lady's slipper *(Cypripedium acaule)*, false Solomon's-seal (*Maianthemum racemosum*), perfoliate bellwort *(Uvularia perfoliata)*, Indian cucumber-root *(Medeola virginiana)*, cranefly orchid (*Tipularia discolor*), and spotted wintergreen *(Chimaphila maculata)*. On more enriched sites, herbaceous layers are typically more lush and dense with numerous species of forbs such as wild ginger (*Asarum canadense*), Virginia waterleaf (*Hydrophyllum virginianum*), touch-me-not (*Impatiens* sp.), sweet cicely (*Osmorhiza* sp.), mayapple (*Podophyllum peltatum*), black cohosh (*Caulophyllum thalictroides*), and twinleaf (*Jeffersonia diphylla*).

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Carroll, Cecil, Charles, Dorchester, Frederick, Harford, Howard, Kent, Montgomery, Prince George's, Somerset, Queen Anne's, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Mattawoman NEA, Wye Island Natural Resources Management Area-Schoolhouse Woods, Patuxent Research Refuge

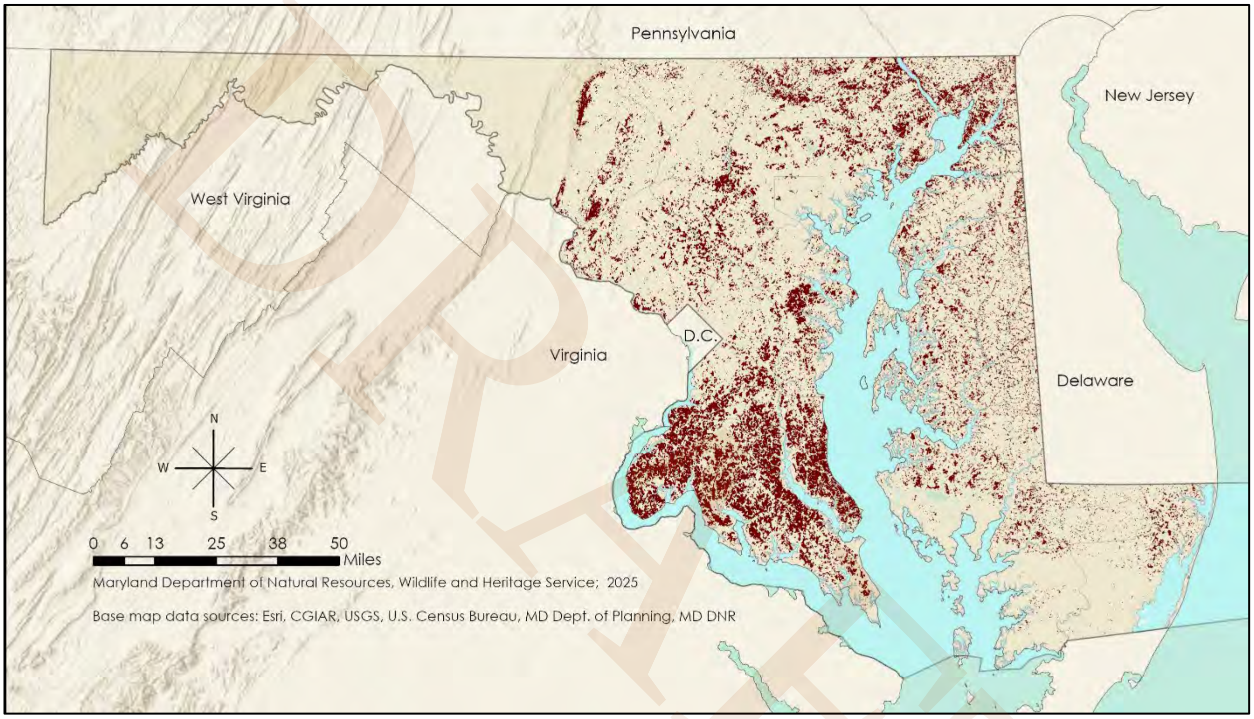


Figure 4.7 Location of Mesic Mixed Hardwood Forests in Maryland. *Source: MD DNR.*

Species of Greatest Conservation Need Associated with Mesic Mixed Hardwood Forests:

Birds	Mammals	Plants
Acadian flycatcher	Allegheny woodrat	Woodland agrimony *(Agrimonia striata)*
American redstart	American mink	Hitchcock's sedge *(Carex hitchcockiana)*
American woodcock	Bobcat	Spring coralroot *(Corallorhiza wisteriana)*
Bald eagle	Delmarva fox squirrel	Small white lady's-slipper *(Cypripedium candidum)*
Baltimore oriole	Eastern red bat	Eastern leatherwood *(Dirca palustris)*
Bicknell's thrush	Eastern small-footed bat	Goldie's fern *(Dryopteris goldieana)*
Black-and-white warbler	Gray fox	Angular-fruit milkvine *(Gonolobus suberosus* var. *suberosus)*
Black-billed cuckoo	Hoary bat	
Blue-winged warbler	Indiana bat	
Broad-winged hawk	Little brown bat	
Brown creeper	Northern long-eared bat	
Cerulean warbler	Silver-haired bat	
Chuck-will's-widow	Smoky shrew	

Eastern whip-poor-will
Great blue heron
Great egret
Hooded warbler
Kentucky warbler
Northern bobwhite
Northern parula
Ovenbird
Prairie warbler
Scarlet tanager
Sharp-shinned hawk
Veery
Wood thrush
Worm-eating warbler
Yellow-breasted chat
Yellow-throated vireo

Reptiles

Bog turtle
Copperhead
Eastern box turtle
Eastern kingsnake
Eastern milksnake
Eastern mud turtle
Eastern ribbonsnake
Northern mole kingsnake
Scarletsnake
Spotted turtle
Striped mud turtle
Timber rattlesnake
Wood turtle

Invertebrates (Snails)

Cherrystone drop

Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Amphibians

Barking treefrog
Carpenter frog
Eastern narrow-mouthed toad
Eastern tiger salamander
Jefferson salamander
Upland chorus frog

Insects (Diptera)

Painted wood fly *(Blera pictipes)*

Insects (Hymenoptera)

A cuckoo bee *(Nomada seneciophila)*
A leafcutter bee *(Paranthidium jugatorium)*
Cranesbill miner bee *(Andrena distans)*
Golden Alexanders miner bee *(Andrena ziziae)*
Half-black bumble bee *(Bombus vagans)*
Rusty-patch bumble bee *(Bombus affinis)*
Texas mason bee *(Osmia texana)*
Yellowbanded bumble bee *(Bombus terricola)*

Insects (Lepidoptera)

Northern oak hairstreak

Virginia heartleaf *(Hexastylis virginica)*
Glade fern *(Homalosorus pycnocarpos)*
Golden-seal *(Hydrastis canadensis)*
Large-leaf waterleaf *(Hydrophyllum macrophyllum)*
Upland dwarf iris (*Iris verna* var. *smalliana*)
Butternut *(Juglans cinerea)*
American ginseng *(Panax quinquefolius)*
Swamp lousewort *(Pedicularis lanceolata)*
Shumard oak *(Quercus shumardii)*
Willow aster *(Symphyotrichum praealtum)*
Purple meadow-parsnip *(Thaspium trifoliatum)*
Nodding trillium *(Trillium flexipes)*
Virginia least trillium *(Trillium pusillum* var. *virginianum)*
Yellowleaf tinker's-weed *(Triosteum angustifolium)*
Nodding pogonia *(Triphora trianthophoros)*

Coastal Plain Oak-Pine Forest

Region(s): *Central, Eastern, Southern*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands*

Jason Harrison, MD DNR

The revised Coastal Plain Oak-Pine Forest Key Wildlife Habitat (KWH) combines the Coastal Plain Pitch Pine Forest and Coastal Plain Oak-Pine Forest KWHs from the 2015 State Wildlife Action Plan revision. The Coastal Plain Oak-Pine Forest KWH is characterized by dry, often fire-prone forests and woodlands of Maryland's inner and outer Coastal Plain. This forest type's range extends from north in Cecil County, inland to scattered locations in Prince George's County and south throughout the Delmarva Peninsula and east to the intercoastal zone. Several different natural communities are represented in this KWH and are largely differentiated by landscape setting, substrate, and soil moisture, which can range from extremely dry to dry-mesic and acidic to alkaline. This KWH is associated with deep, sandy loams and sandy clay-loams with soils that are typically very acidic and have exceedingly low base cation and base saturation levels, indicative of a low capacity to retain essential plant nutrients. Landscape settings include flat-to-gently rolling uplands, steep ravine slopes, north-facing bluffs, terraces, ancient inland dunes, and ridges, as well as calcareous river-fronting bluffs.

In Maryland, some of these forests are considered to be a southern extension of the New Jersey Pine Barrens and many components of the flora found in this region of Maryland also suggest a phytogeographical relationship to natural communities of those barrens. These forests are fire-dependent ecosystems, and pitch pine (*Pinus rigida*), the dominant tree species, and many associated species within this ecosystem exhibit fire adaptations that allow them to establish, persist and/or regenerate in burned areas. Though mean fire return intervals in portions of the New Jersey Pine Barrens occurred at much higher frequencies because of drier fuels and higher evaporation rates, fire intervals in Maryland's pitch pine forest likely occurred every 40–60 years. It is believed by many that this fire return interval would allow pitch pine to persist while also allowing for continued oak regeneration.

Tree canopies are variable with mixed oak-pine composition and often related to the environmental setting as well as fire history and interval. Characteristic species include scarlet oak (*Quercus coccinea)*, southern red oak *(Quercus falcata)*, white oak *(Quercus alba)*, black oak *(Quercus velutina)*, blackjack oak *(Quercus marilandica)*, chestnut oak *(Quercus montana)*, black gum *(Nyssa sylvatica)*, and sassafras *(Sassafras albidum)*. Virginia pine (*Pinus virginiana*), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*) are considered successional in this KWH and often indicate disturbance such as logging or agricultural conversion. American beech (*Fagus grandifolia*) may also be prominent on submesic sites such as steep ravine slopes or north-facing bluffs. Inflammable shrubs of dangleberry *(Gaylussacia frondosa)*, black huckleberry *(Gaylussacia baccata*), early lowbush blueberry *(Vaccinium pallidum),* black highbush blueberry *(Vaccinium fuscatum),* and deerberry *(Vaccinium stamineum)* can be abundant, sometimes forming a continuous layer. Herbs are noticeably sparse throughout the deeply leaf-littered forest floor and may include pink lady's slipper *(Cypripedium acaule),* Indian-pipe *(Monotropa uniflora),* spotted wintergreen *(Chimaphila maculata),* and partridge-berry *(Mitchella repens).*

Two rare natural communities occur as smaller inclusions within this KWH: (1) Inland Sand Dune and Ridge Woodlands and (2) Coastal Plain Dry Calcareous Forests and Woodlands, which are structurally more open and have a more unique and variable floristic composition.

Inland Sand Dune and Ridge Woodlands developed during the late Pleistocene age when strong northwest prevailing winds transported sand across the Coastal Plain, eventually developing into prominent dunes and ridges flanking the east sides of rivers such as the Choptank, Nanticoke, Wicomico, and Pocomoke. The Inland Sand Dune and Ridge Woodland community includes more prominence of dune and dry site-associated species such as blackjack oak *(Quercus marilandica),* post oak *(Quercus stellata),* water oak (*Quercus nigra*), shortleaf pine *(Pinus echinata),* and sand hickory *(Carya pallida).* Ericaceous shrubs typically form an uneven understory with mixtures of late lowbush blueberry (*Vaccinium pallidum*), black huckleberry (*Gaylussacia baccata*), dangleberry (*Gaylussacia frondosa*), and deerberry (*Vaccinium stamineum*). The herbaceous layer is characterized by dry-site graminoids such as Pennsylvania sedge (*Carex pensylvanica*), shaved sedge (*Carex tonsa* var. *tonsa*), black edge sedge (*Carex nigromarginata*), whitetinge sedge (*Carex albicans*), or little bluestem (*Schizachyrium scoparium*), and forbs and ferns such as yellow wild indigo (*Baptisia tinctoria*), pink lady's slipper (*Cypripedium acaul*e), spotted wintergreen (*Chimaphila maculata*), pipsissewa (*Chimaphila umbellata*), butterfly pea (*Clitoria mariana*), variable panicgrass (*Dichanthelium commutatum*), ipecac spurge (*Euphorbia ipecacuanhae*), teaberry (*Gaultheria procumbens*), and bracken fern (*Pteridium aquilinum*). Inland dunes and ridges are considered rare natural communities in Maryland because they exhibit a unique flora adapted to these harsh and dry environments and serve as habitat for specialist beetles, bees, ants, and butterflies, and moths. Many historical stands have been replaced or degraded by development, agriculture, and commercial forestlands.

Coastal Plain Dry Calcareous Forest and Woodlands occur as small, wooded patches of river-fronting bluffs and slopes that have developed over either Tertiary-aged shell deposits or Native American oyster shell middens. Through the process of weathering, these substrates create a substrate composed of dry sandy, alkaline soil with abundant calcium and corresponding unique flora. Canopy dominants include chinkapin oak *(Quercus muhlenbergii),* white ash *(Fraxinus americana),* hackberry *(Celtis occidentalis),* eastern hop-hornbeam *(Ostrya virginiana),* and eastern redbud *(Cercis canadensis*). Unlike most communities in this KWH, the understory and herbaceous layers are diverse and may include species such as blackhaw *(Viburnum rufidulum),* Robin's plantain *(Erigeron pulchellus var. pulchellus),* Bosc's panic grass *(Dichanthelium boscii),* tickweed, white snakeroot *(Ageratina altissima),* columbine *(Aquilegia canadensis),* and slender wild rye *(Elymus villosus).* Examples of this community have been documented along the Chesapeake Bay and river-fronting slopes and bluffs of the Chester, Sassafras, Wye, Great Bohemia, Transquaking, and Piscataway River tributaries.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Idylwild Wildlife Management Area, Pocomoke State Forest, Elk Neck State Forest, Patuxent Research Refuge

State Rare Natural Communities: Coastal Plain Pine-Oak Woodland, Inland Sand Dune and Ridge Woodland, Coastal Plain Dry Calcareous Forest and Woodland

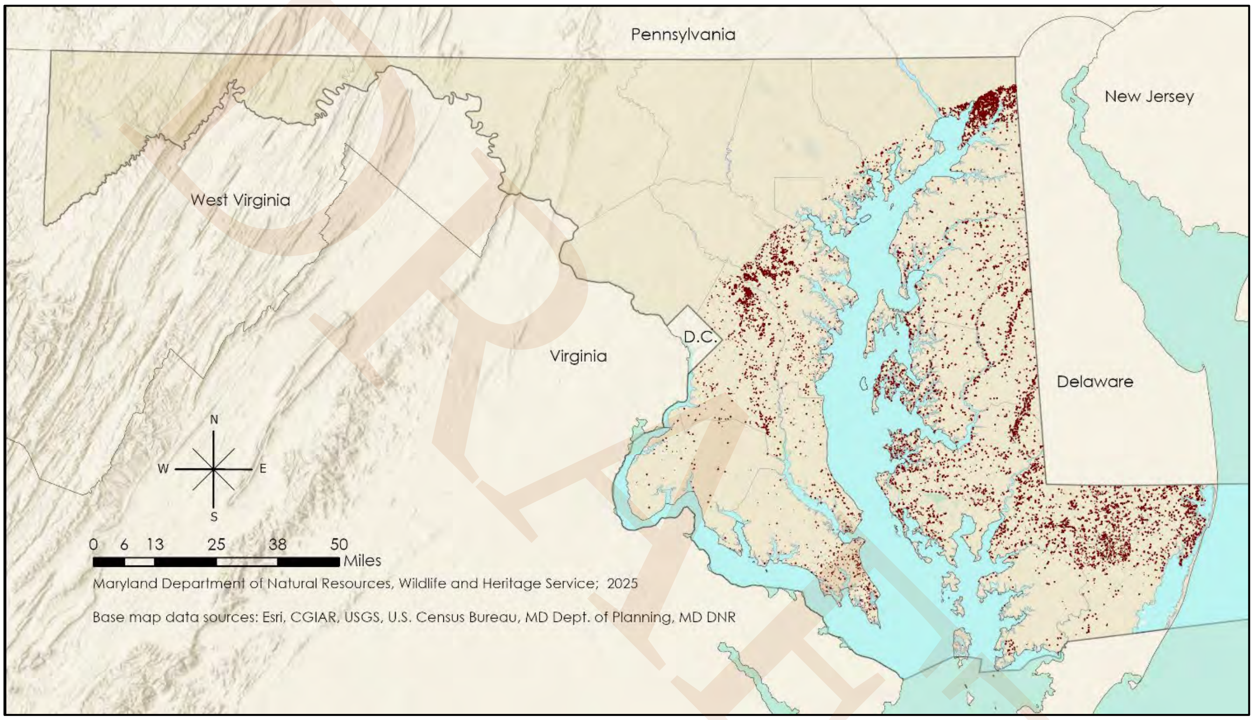


Figure 4.8 Location of Coastal Plain Oak-Pine Forests in Maryland. Sources: MD DNR, Nature Serve's Terrestrial Ecological Systems of the U.S., USFWS.

Species of Greatest Conservation Need Associated with Coastal Plain Oak-Pine Forests:

Birds

Acadian flycatcher
American woodcock
Baltimore oriole
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Broad-winged hawk
Chuck-will's-widow
Common nighthawk
Eastern whip-poor-will
Northern bobwhite

Insects (Hymenoptera)

A cuckoo bee *(Nomada rubicunda)*
A dieunomia bee *(Dieunomia nevadensis)*
A leafcutter bee *(Coelioxys immaculatus)*
A long-horned bee *(Epimelissodes comptus)*
A mason bee *(Osmia chalybea)*
A miner bee *(Perdita boltoniae)*
A miner bee *(Perdita bradleyi)*

Insects (Hemiptera)

Riley's 13-year cicada *(Magicicada tredecim)*

Plants

Threadleaf gerardia *(Agalinis setacea)*
Single-head pussytoes *(Antennaria solitaria)*
Woolly three-awn *(Aristida lanosa)*
Leopard's-bane *(Arnica acaulis)*
Coastal butterfly pea *(Centrosema virginianum)*

Ovenbird
Prairie warbler
Scarlet tanager
Sharp-shinned hawk
Wood thrush
Worm-eating warbler
Yellow-breasted chat

Mammals

American mink
Bobcat
Delmarva fox squirrel
Eastern red bat
Hoary bat
Least shrew
Little brown bat
Silver-haired bat
Tricolored bat

Amphibians

Carpenter frog
Eastern narrow-mouthed toad
Eastern tiger salamander

Reptiles

Copperhead
Eastern box turtle
Eastern kingsnake
Eastern milksnake
Eastern mud turtle
Northern mole kingsnake
Red cornsnake
Scarletsnake
Six-lined racerunner
Spotted turtle
Striped mud turtle

Insects (Coleoptera)

A tenebrionid beetle *(Helops cisteloides)*
A tenebrionid beetle *(Schoenicus puberulus)*
Eastern pinebarrens tiger beetle

Insects (Diptera)

Painted wood fly *(Blera pictipes)*
A mining bee *(Andrena fulvipennis)*
A mining bee *(Protandrena abdominalis)*
A sweat bee *(Lasioglossum arantium)*
A sweat bee *(Lasioglossum nymphale)*
A sweat bee *(Lasioglossum raleighense)*
A sweat bee *(Lasioglossum floridanum)*
A sweat bee *(Lasioglossum sopinci)*
A sweat bee *(Sphecodes brachycephalus)*
Howard's cuckoo nomad bee *(Epeolus howardi)*
Nude plasterer bee *(Colletes nudus)*
Pearly-banded bee *(Nomia maneei)*
Puny cuckoo nomad bee *(Epeolus pusillus)*
Summer miner bee *(Protandrena aestivalis)*
Sunflower sweat bee *(Dieunomia heteropoda)*
Two-spotted miner bee *(Andrena accepta)*

Insects (Lepidoptera)

Bold-based zale moth *(Zale lunifera)*
Cobweb skipper
Eastern cactus-boring moth
Fringed dart moth
Frosted elfin
Great purple hairstreak
King's hairstreak
Ornate bella moth *(Utetheisa ornatrix)*
Pine barrens fungus moth (Chytonix sensilis)
Pine barrens zanclognatha
The record keeper moth (Feltia manifesta)
Many-flowered umbrella-sedge *(Cyperus lancastriensis)*
Plukenet's flatsedge *(Cyperus plukenetii)*
Rough flatsedge *(Cyperus retrofractus)*
Fernald's tick-trefoil *(Desmodium fernaldii)*
Stiff tick-trefoil *(Desmodium obtusum)*
Pineland tick-trefoil *(Desmodium strictum)*
Hairy needle-leaved witchgrass *(Dichanthelium filiramum)*
Few-flowered witchgrass *(Dichanthelium oligosanthes* var. *oligosanthes)*
Tobaccoweed *(Elephantopus tomentosus)*
Box huckleberry *(Gaylussacia brachycera)*
Golden heather *(Hudsonia ericoides)*
Potato dwarf-dandelion *(Krigia dandelion)*
Scaly gayfeather *(Liatris squarrosa)*
Sandplain flax *(Linum intercursum)*
Sundial lupine *(Lupinus perennis)*
Carolina anglepod *(Matelea carolinensis)*
Hairy snoutbean *(Rhynchosia tomentosa)*
Globe beakrush *(Rhynchospora globularis)*
Carolina sandwort *(Sabulina caroliniana)*
Sandyland blue-eyed grass *(Sisyrinchium arenicola)*
Showy goldenrod *(Solidago speciosa)*
Late goldenrod *(Solidago tarda)*
Long-bristle Indian grass *(Sorghastrum elliottii)*
Rough dropseed *(Sporobolus clandestinus)*
Eastern silvery aster *(Symphyotrichum concolor)*
Spiked hoary-pea *(Tephrosia spicata)*
Chapman's redtop *(Tridens chapmanii)*

Case Study: Safeguarding Plukenet's Flatsedge (Cyperus plukenetii) via Inland Dune Woodland Restoration

Plukenet's flatsedge *(Cyperus plukenetii)* is a delicate native of the sun-drenched longleaf pine sandhills and thin, sandy soils of the Eastern United States. Once thought to be a ghost of Maryland's botanical past, this rare plant went unseen in our state for 80 years. Before its recent return, the only evidence of its existence in Maryland was a handful of pressed specimens collected between 1887 and 1939.

The tide turned in 2019 and 2021 when tiny, fragile populations were rediscovered in Wicomico and Worcester Counties. These "lost" colonies were struggling to survive in small, isolated fragments of habitat—one under a suburban powerline and another in an old sand mine. With only a dozen or so plants remaining at these sites, biologists knew they had to act fast to save the species from permanent extinction in Maryland.

To give the flatsedge a second chance, seeds were carefully collected and transported to the Mount Cuba Center, a leader in native plant conservation. There, horticultural experts successfully germinated and grew a "rescue" population. These healthy young plants provided the foundation for a restoration effort within a large, protected inland dune woodland—a habitat perfectly suited for their needs.

Today, the flatsedge is thriving in its new home. This habitat is managed with prescribed fire, a process that clears away competing brush and creates the open, sandy conditions the species loves. By protecting these unique inland dunes and utilizing modern conservation science, we are ensuring that this rare piece of Maryland's natural heritage isn't just a memory, but a living part of our landscape.

Jason Harrison, MD DNR, with plukenet's flatsedge (Cyperus plukenetii) in its new home (Chris Frye, MD DNR)

Signs of Success

Growing Numbers: From a tiny group of founders, the population has expanded to over 64 plants as of 2024.

Natural Growth: For the first time in decades, we are seeing "recruitment"—new seedlings sprouting naturally on their own!

Official Protection: In recognition of its rarity and the ongoing need for conservation, plukenet's flatsedge was officially listed as an Endangered Species in Maryland in 2025.

Maritime Forest and Shrubland

Region(s): *Eastern*
Habitat Group*: Forests*
NEAFWA: *Forests & Woodlands; Shrublands*

Peter Stango, MD DNR

Jason Harrison, MD DNR

The Maritime Forest and Shrubland Key Wildlife Habitat includes forests, woodlands, and shrublands with structure and composition influenced by proximity to marine environments. In Maryland, they are best developed in sheltered dune systems, flats of barrier islands, upper edges of salt marshes, and, less commonly, on rocky headlands of the Atlantic Coast and islands of the lower Chesapeake Bay. The distribution, structure and species composition of these habitats are largely controlled by marine influences such as salt spray and deep sand deposits, transitioning from open to dense shrub-scrub vegetation near the coastline to open forests and woodlands further inland. Soil moisture and drainage also play a critical role in shaping these habitats.

Open forests and woodlands of stunted loblolly pine (*Pinus taeda*) may develop on older, more stable, back dunes, away from the primary dune, where the effects of salt spray are minimized. Forests and woodlands that develop in this zone are primarily dominated by loblolly pine with mixtures of black cherry *(Prunus serotina)*, water oak (*Quercus nigra*), sassafras *(Sassafras albidum)*, southern red oak *(Quercus falcata)*, willow oak *(Quercus phellos)*, red maple *(Acer rubrum)*, and American holly *(Ilex opaca* var. *opaca)*, with bayberry *(Morella* spp.) and muscadine grape (*Vitis rotundifolia)* common in the understory.

Shrublands or "scrub" vegetation, defined as dense, intermixed growth of shrubs and stunted trees, develop on inland edges of back dunes and leeward dune slopes where they are moderately protected from ocean salt spray. Vegetation typically includes stunted trees and low-growing, dwarfed shrub species such as sand heather *(Hudsonia tomentosa)*, bayberry, and high-tide bush *(Baccharis halimifolia)*. Vines are often abundant and include poison ivy *(Toxicodendron radicans)*, muscadine grape, Virginia creeper *(Parthenocissus quinquefolia)*, and common greenbrier *(Smilax rotundifolia)*. Herbaceous species are sparse; however, frequent canopy gaps support many species from adjacent maritime grassland communities, such as beach panic grass *(Panicum amarum* ssp. *amarulum)* and slender spikegrass *(Chasmanthium laxum)*.

These habitats are threatened by coastal development and by natural and anthropogenic disturbances that destroy the protective primary dune system. Because these habitats have a restricted geographic range (Delaware to North Carolina) and narrow habitat requirements, all natural communities within Maritime Forests and Shrublands are considered globally uncommon to rare.

County Distribution: Dorchester, Somerset, Wicomico, Worcester

Places to Visit: Assateague Island National Seashore

State Rare Natural Communities: Maritime Forest, Maritime Dune Scrub, Maritime Dune Woodland

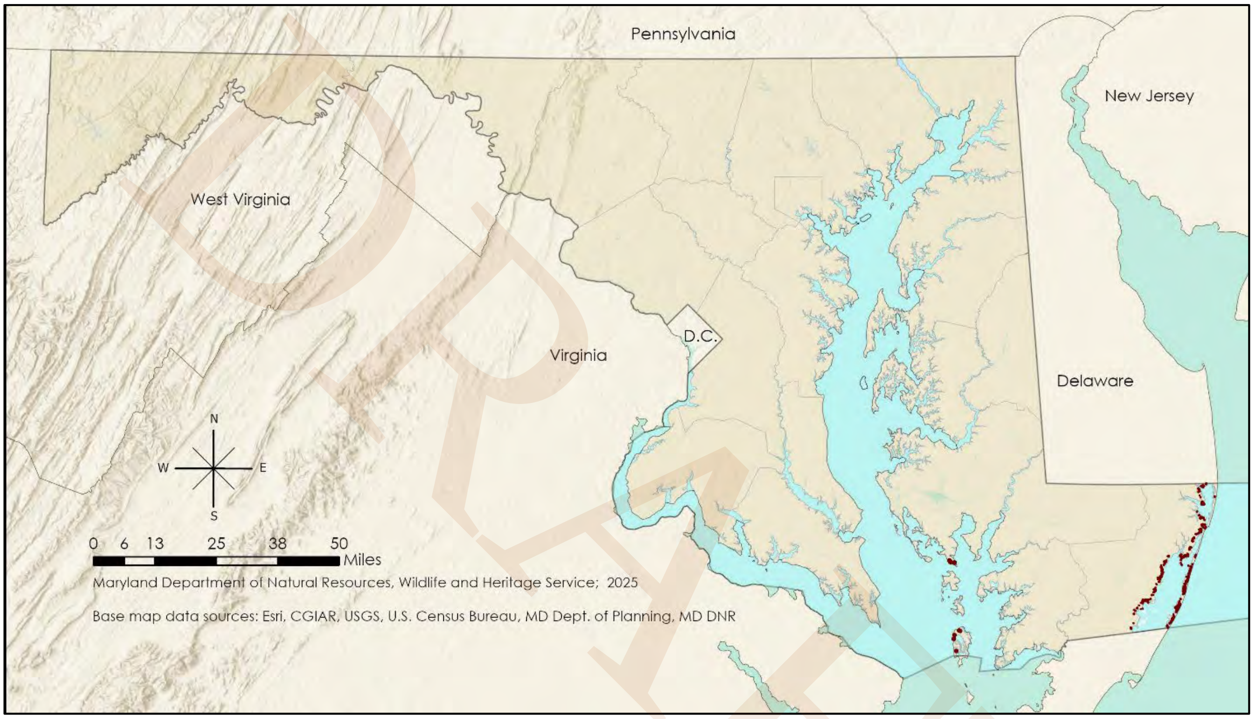


Figure 4.9 Location of Maritime Forests and Shrublands in Maryland. Sources: MD DNR, NETWHCS, USFWS.

Species of Greatest Conservation Need Associated with Maritime Forests and Shrublands:

Birds

American woodcock
Bald eagle
Black-crowned night heron
Boat-tailed grackle
Chuck-will's-widow
Common nighthawk
Glossy ibis
Great blue heron
Great egret
Little blue heron
Long-eared owl

Birds (continued)

Northern bobwhite
Northern saw-whet owl
Ovenbird
Prairie warbler
Red-cockaded woodpecker
Snowy egret
Tricolored heron
Worm-eating warbler
Yellow-breasted chat
Yellow-crowned night heron

Mammals

Delmarva fox squirrel
Eastern red bat
Hoary bat
Least shrew
Silver-haired bat
Tricolored bat

Plants

Coastal water-hyssop *(Bacopa monnieri)*
Carolina fimbry *(Fimbristylis caroliniana)*
Coast bedstraw *(Galium hispidulum)*

Glades, Barrens, and Cliffs

Serpentine Barren

Region(s): *Central*
Habitat Group*: Glades/Barrens/Cliffs*
NEAFWA: *Glades, Barrens & Savannas*

Mark Hall, MD DNR

The Serpentine Barren Key Wildlife Habitat forms on shallow soils over ultramafic bedrock of serpentine, which occurs in a discontinuous band east of the Appalachian Mountains from Canada to Alabama, with the largest known occurrences in the Piedmont of southeastern Pennsylvania and northern Maryland. One of the four remaining serpentine areas in Maryland, the Soldiers Delight Natural Area near Baltimore, is the largest in eastern North America, encompassing nearly 2,000 acres of woodlands and grassland savannas, and is among the most species-rich in the world.

In folklore, the name "serpentine" is attributed to the high magnesium mineral content, which gives the resemblance to a mottled greenish-brown snake native to similar geologic settings in northern Italy. As much as one-third of the bedrock may be composed of magnesium silicate with associated high iron, cobalt, nickel, and chromite content. The soils that develop are normally acidic near the surface, though less so in deeper layers, dry, nutrient-poor, and toxic to plants not specially adapted to the unusual chemistry. High levels of magnesium in the soil typically inhibit plants' ability to take in soil nutrients, especially calcium, and because they are shallow and low in organic material and clay, they do not retain water or nutrients well.

The plant communities associated with them are structurally a mosaic of sparse woodlands, shrublands, and grass savannas, with higher woody species cover associated with deeper soils. Most of these habitats are kept from succeeding to closed forests by periodic fire, drought stress, soil factors, and unstable substrates. As wind and water erode the soil, non-acidic layers are exposed, creating a varied habitat for plants. Plants characteristic of serpentine barrens include little bluestem *(Schizachyrium scoparium)* and Indian grass *(Sorghastrum nutans),* which are typically herbaceous dominants, with associated species including serpentine aster *(Aster depauperatus)*, few-flowered nutrush (*Scleria pauciflora*), field chickweed (*Cerastium arvense* var. *villosum*), field goldenrod (*Solidago nemoralis*), Small's ragwort (*Packera anonyma*), round-seed panic grass (*Dichanthelium sphaerocarpon*), lyre-leaved rock cress (*Arabis lyrata*), and roundleaf fameflower *(Phemeranthus teretifolius)*. Woodlands bordering grassland savannas consist of blackjack oak *(Quercus marilandica)* and post oak *(Quercus stellata)* but are commonly invaded by species such as common greenbrier *(Smilax rotundifolia)*, eastern red cedar *(Juniperus virginiana)*, and Virginia pine *(Pinus virginiana)* when fire suppressed.

County Distribution: Baltimore, Cecil, Harford, Montgomery

Places to Visit: Soldiers Delight Natural Area, Lake Roland Park

State Rare Natural Community: Serpentine Barren

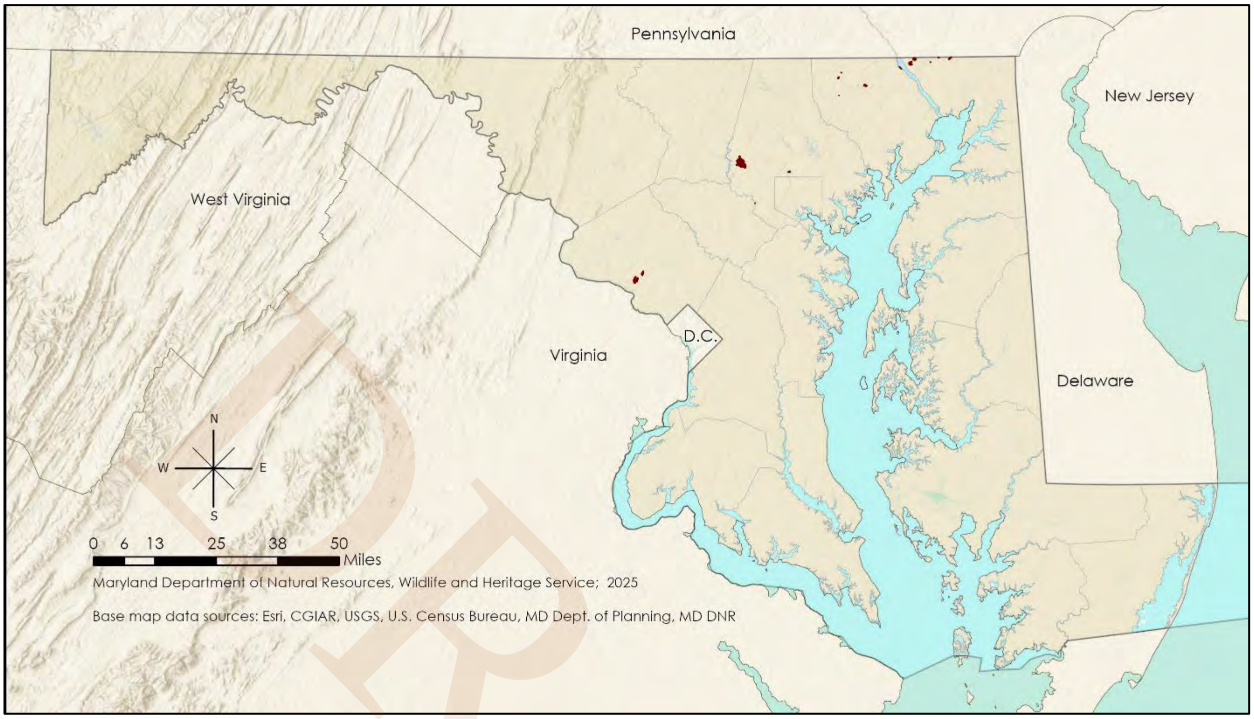


Figure 4.10 Location of Serpentine Barrens in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Serpentine Barrens:

Birds
Eastern whip-poor-will
Ovenbird
Prairie warbler

Mammals
Bobcat
Eastern red bat
Gray fox
Hoary bat
Least shrew
Little brown bat
Silver-haired bat
Tricolored bat

Insects (Coleoptera)
Cow path tiger beetle
Splendid tiger beetle

Insects (Hemiptera)
Eastern sedge barrens leafhopper

Insects (Lepidoptera)
Bold-based zale moth *(Zale lunifera)*
Cobweb skipper
Edwards' hairstreak
Franck's sphinx
Indian skipper
Joyful holomelina moth
Leonard's skipper
Northern oak hairstreak
Pepper and salt skipper
Unexpected cycnia moth

Plants
Sandplain gerardia *(Agalinis decemloba)*
Porcupine sedge *(Carex hystericina)*
Inland sedge *(Carex interior)*
Mead's sedge *(Carex meadii)*
Richardson's sedge *(Carex richardsonii)*
Octoraro creek chickweed *(Cerastium velutinum* var. *villosissimum)*

Plants (continued)
Plains frostweed *(Crocanthemum bicknellii)*
Tufted hairgrass *(Deschampsia cespitosa)*
Scribner's witchgrass *(Dichanthelium oligosanthes* var. *scribnerianum)*
Vanilla grass *(Hierochloe odorata)*
Prairie blazing star *(Liatris spicata)*
Grooved yellow flax *(Linum sulcatum)*
Roundleaf fameflower *(Phemeranthus teretifolius)*
Dwarf prairie willow *(Salix occidentalis)*
Muehlenberg's nutrush *(Scleria muehlenbergii)*
Northern dropseed *(Sporobolus heterolepis)*
Serpentine aster *(Symphyotrichum depauperatum)*

Shale Barren

Region(s): *Western*
Habitat Group*: Glades/Barrens/Cliffs*
NEAFWA: *Glades, Barrens & Savannas*

Jason Harrison, MD DNR

The Shale Barren Key Wildlife Habitat consists of sparse woodlands with scattered herbaceous openings on rock outcrops of acidic and calcareous shales in the Ridge and Valley physiographic province of Maryland. They are best developed on steep, dry slopes with south to west-facing exposures, where surface temperatures are seasonally extremely high. In addition, shales are highly friable and many steep slopes contain loose and unstable channery derived from the continual undercutting of bedrock by streams. This mechanical erosion from constant downslope movement of loose fissile shale—combined with very little soil development, very low soil moisture, rapid water drainage, lack of shading vegetation, and longer daily/annual exposure to the sun (due to south and west aspects)—results in harsh growing conditions and drought stress where only species well adapted to these drought stresses can thrive in such habitats.

The vegetation structure is predominantly a mix of open shrubland with dwarfed trees and less frequently open woodlands composed of stunted chestnut oak *(Quercus montana)*, Virginia pine *(Pinus virginiana)*, eastern red cedar *(Juniperus virginiana)*, and pignut hickory *(Carya glabra)*. Other characteristic trees include white ash *(Fraxinus americana)*, post oak *(Quercus stellata)*, black oak *(Quercus velutina)*, northern red oak (*Quercus rubra*), Table Mountain pine (*Pinus pungens*), white pine *(Pinus strobus)*, and shagbark hickory *(Carya ovata)*. Shrubs common to shale barrens include shadbush *(Amelanchier* spp.*)*, black huckleberry *(Gaylussacia baccata*), deerberry *(Vaccinium stamineum)*, and bear oak *(Quercus ilicifolia)*. Herbaceous openings are sparsely vegetated and often scattered within a woodland matrix. Such openings contain many endemic or near-endemic Shale Barren species such as shale-barren pussytoes *(Antennaria virginica)*, shale-barren ragwort *(Packera antennariifolia)*, shale-barren evening primrose *(Oenothera argillicola)*, low bindweed *(Calystegia spithamaea)*, and Kate's mountain-clover *(Trifolium virginicum)*. Other characteristic species include Pennsylvania sedge *(Carex pensylvanica)*, tufted hairgrass *(Deschampsia flexuosa)*, common dittany *(Cunila origanoides)*, rattlesnake-weed *(Hieracium venosum)*, poverty oatgrass *(Danthonia spicata)*, little bluestem *(Schizachyrium scoparium)*, moss-pink *(Phlox subulata)*, bird's-foot violet *(Viola pedata)*, and reindeer lichens *(Cladonia* spp.*)*.

County Distribution: Allegany, Washington

Places to Visit: Green Ridge State Forest

State Rare Natural Community: Shale Barren

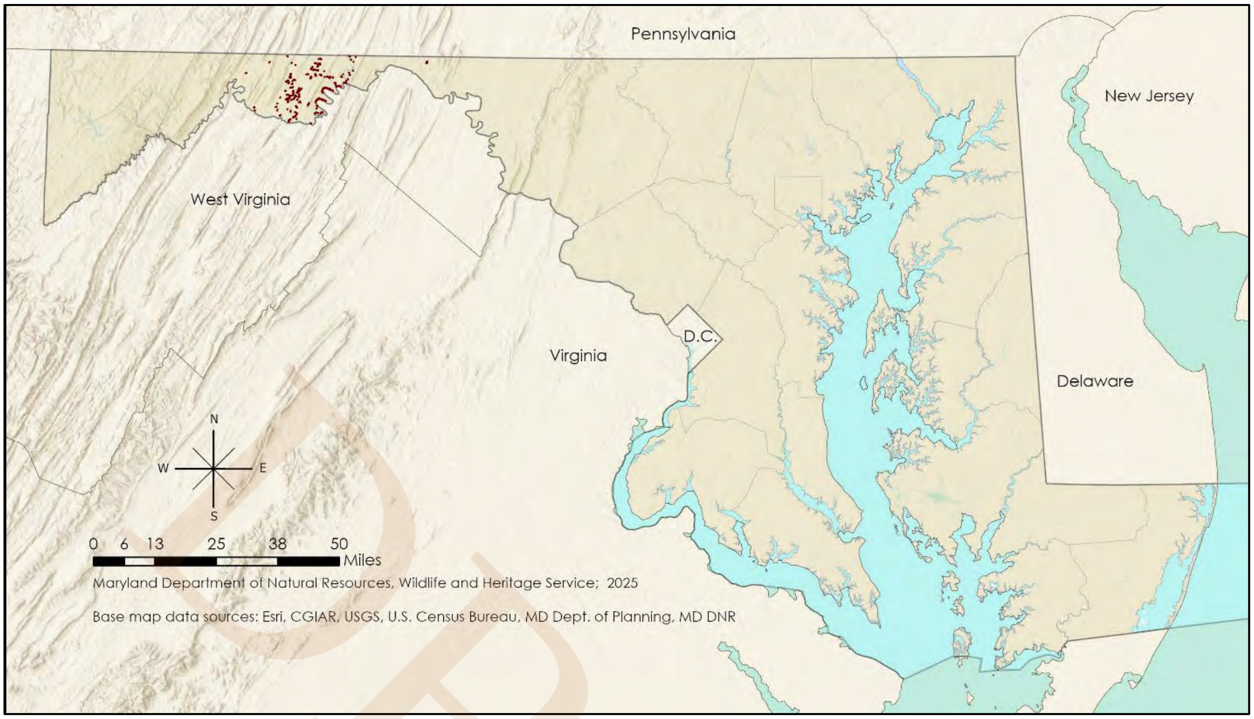


Figure 4.11 Location of Shale Barrens in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Shale Barrens:

Birds
Eastern whip-poor-will
Ovenbird
Prairie warbler
Ruffed grouse

Amphibians
Valley and Ridge salamander

Reptiles
Copperhead
Northern coal skink
Red cornsnake
Six-lined racerunner
Timber rattlesnake

Insects (Coleoptera)
Cow path tiger beetle
Splendid tiger beetle

Insects (Hymenoptera)
Felt's mason bee *(Osmia felti)*

Mammals
Allegheny woodrat
Appalachian cottontail
Bobcat
Eastern red bat
Eastern small-footed bat
Gray fox
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Insects (Lepidoptera)
Cobweb skipper
Franck's sphinx
Indian skipper
Leonard's skipper
Northern metalmark
Northern oak hairstreak
Olympia marble
Pepper and salt skipper
Silvery blue

Plants
Toothed tick-trefoil *(Desmodium cuspidatum)*
Stiff-hair sunflower *(Helianthus hirsutus)*
Smooth sunflower *(Helianthus laevigatus)*
Allegheny plum *(Prunus alleghaniensis)*
Vasey's goldenrod *(Solidago vaseyi)*
Common snowberry *(Symphoricarpos albus)*
Mountain parsley *(Taenidia montana)*
Kate's Mountain clover *(Trifolium virginicum)*
Rusty woodsia *(Woodsia ilvensis)*

Acidic Glade and Barren

***Region(s):** Central, Western*
***Habitat Group**: Glades/Barrens/Cliffs*
***NEAFWA:** Glades, Barrens & Savannas*

Chris Frye, MD DNR

The Acidic Glade and Barren Key Wildlife Habitat is defined as natural clearings within a forested or wooded area consisting of exposed bedrock outcrops and sloping pavements over acidic substrates. They occur only in the Piedmont and mountainous regions of Maryland. Piedmont examples are typically associated with small rock outcrops and bouldery slopes of schist, granite, or quartzite. Those occurring in the mountain region of the Appalachian Plateau are known as Sandstone Glades, which are considered rare in Maryland, are associated with Pottsville sandstone, and are most prominent at 2,700–2,800 feet. In contrast, examples of those in the Ridge and Valley region occur at lower elevations of 800–1,000 feet over Oriskany sandstone. The vegetation of these habitats is variable depending on the region, but most can be generally characterized as a mosaic of stunted woodlands with scrubby thickets, scattered herbaceous plants, and considerable exposed bedrock. Plant growth is typically confined to crevices or depressions where organic material has accumulated over time. Acidic Glades and Barrens exhibit very harsh, drought-prone growing conditions resulting from negligible soil development, low moisture retention, rapid runoff, and sun exposure.

The dominant vegetation is characterized by woody scrub usually consisting of scattered, stunted trees of chestnut oak *(Quercus montana)*, bear oak *(Quercus ilicifolia)*, black gum *(Nyssa sylvatica)*, pitch pine *(Pinus rigida)*, Table Mountain pine (*Pinus pungens*), and sweet birch *(Betula lenta),* and shrub thickets of black huckleberry *(Gaylussacia* baccata), early lowbush blueberry *(Vaccinium pallidum)*, late low blueberry *(Vaccinium angustifolium)*, mountain laurel *(Kalmia latifolia)*, and catbrier *(Smilax glauca)*. Openings in the woody scrub are interspersed with patches of herbaceous species within crevices and moisture pockets, often supporting a mixture of graminoids and forbs such as wintergreen *(Gaultheria procumbens)*, little bluestem *(Schizachyrium scoparium)*, broomsedge *(Andropogon virginicus)*, Pennsylvania sedge *(Carex pensylvanica)*, and oatgrasses *(Danthonia* spp.*)*. Reindeer lichens *(Cladonia* spp.*)* may be especially abundant.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Cunningham Falls State Park, Dans Mountain Wildlife Management Area, Savage River State Forest, South Mountain State Park, Green Ridge State Forest

State Rare Natural Communities: Sandstone Glade

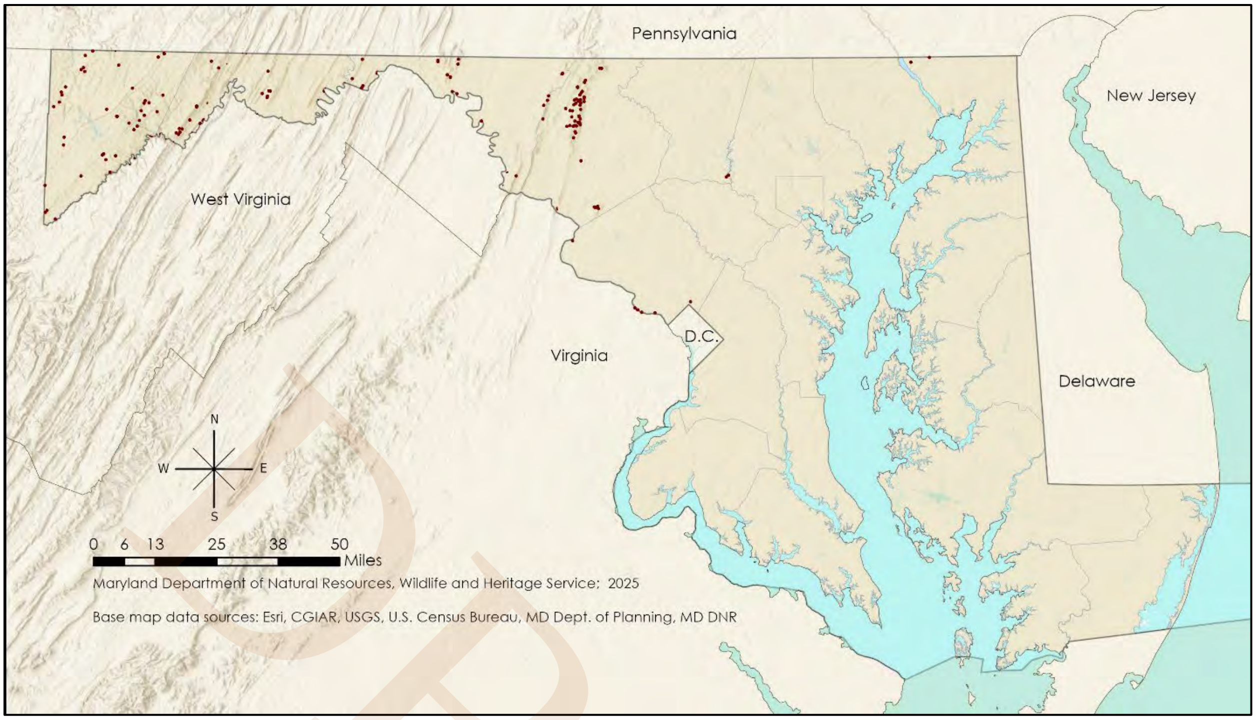


Figure 4.12 Location of Acidic Glades and Barrens in Maryland. Source: MD DNR, Terrestrial Ecological Systems of the United States.

Species of Greatest Conservation Need Associated with Acidic Glades and Barrens:

Birds
Eastern whip-poor-will
Ovenbird
Prairie warbler
Ruffed grouse

Reptiles
Copperhead
Smooth greensnake
Timber rattlesnake

Insects (Coleoptera)
Common claybank tiger beetle
Cow path tiger beetle
Northern barrens tiger beetle
Splendid tiger beetle

Insects (Hymenoptera)
Felt's mason bee *(Osmia felti)*

Mammals
Allegheny woodrat
Appalachian cottontail
Bobcat
Eastern red bat
Eastern small-footed bat
Eastern spotted skunk
Gray fox
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Insects (Lepidoptera)
Bold-based zale moth *(Zale lunifera)*
Edwards' hairstreak
Frosted elfin
Indian skipper
Melsheimer's sack-bearer

Plants
Roundleaf serviceberry *(Amelanchier sanquinea)*
Running serviceberry *(Amelanchier spicata)*
Bristly sarsaparilla *(Aralia hispida)*
Canadian milkvetch *(Astragalus canadensis)*
Ozark milkvetch *(Astragalus distortus)*
Houghton's umbrella-sedge *(Cyperus hougtonii)*
Wild bleedinghearts *(Dicentra eximia)*
Striped gentian *(Gentiana villosa)*
Slender-leaved bluets *(Houstonia tenuifolia)*
Racemed milkwort *(Senega polygama)*
Narrowleaf bluecurls *(Trichostema setaceum)*

Basic Glade and Barren

Region(s): *Central, Western*
Habitat Group*: Glades/Barrens/Cliffs*
NEAFWA: *Glades, Barrens & Savannas*


Jason Harrison, MD DNR

The Basic Glade and Barren Key Wildlife Habitat consists of natural clearings within forested or wooded ecological communities that form on exposed bedrock outcrops and sloping pavements of limestone and mafic (i.e., greenstone, amphibolite, diabase, gabbro) geologic formations in the western Piedmont and mountains of Maryland. These habitats usually occupy small outcrops and steep talus slopes with very thin patches of shallow, dry soils that accumulate in cracks and depressions ranging from moderately acidic to alkaline, but are extremely base-rich and fertile. Vegetation composition and structure are strongly influenced by drought stress due to the lack of moisture retention and exposure within these substrates, resulting in a patchy mosaic of woodlands interspersed with open grassy glades.

Ecological communities that occur on substrates derived from limestone are more alkaline and characterized by stunted, open woodlands of variable composition, which may include chinkapin oak *(Quercus muhlenbergii)*, white ash *(Fraxinus americana)*, eastern red cedar *(Juniperus virginiana)*, common hackberry *(Celtis occidentalis)*, eastern hop-hornbeam *(Ostrya virginiana)*, with pasture rose *(Rosa carolina* var. *carolina)*, northern prickly-ash *(Zanthoxylum americanum)*, and fragrant sumac *(Rhus aromatica)* as characteristic shrub species. The herbaceous layer, patchy and typically restricted to pockets of thin soil that develop in cracks and depressions, consists of a mix of forbs and graminoids, including side-oats grama *(Bouteloua curtipendula* var. *curtipendula)*, bottlebrush grass *(Elymus hystrix* var. *hystrix)*, mountain oatgrass *(Danthonia compressa)*, woodland sunflower *(Helianthus divaricatus)*, hoary puccoon *(Lithospermum canescens)*, and flowering spurge *(Euphorbia corollata)*. While similar in vegetation structure and dynamics, glades and barrens that formed on mafic substrates are also base-rich, but tend to be more acidic, resulting in similar species composition, but with prominence of species such as chestnut oak *(Quercus montana)* and Virginia pine *(Pinus virginiana)* within the canopy.

Not only are these small-patch habitats globally rare, but the mineral-rich, open substrates of these habitats create conditions that make them prone to invasion by non-native plant species.

County Distribution: Allegany, Baltimore, Carroll, Frederick, Garrett, Montgomery, Washington

Places to Visit: C&O Canal National Historical Park, Roundtop Hill Natural Area, Catoctin Mountain Park

State Rare Natural Communities: Limestone Glade, Basic Outcrop Barren

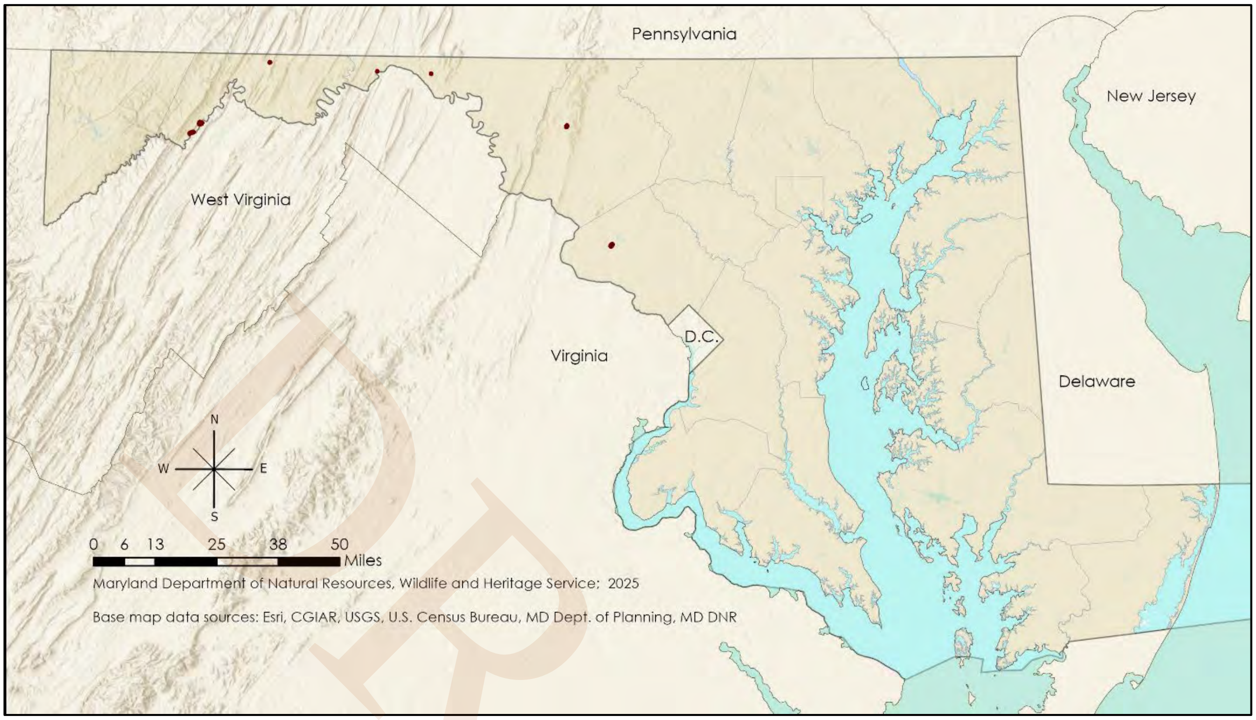


Figure 4.13 Location of Basic Glades and Barrens in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Basic Glades and Barrens:

Birds
Eastern whip-poor-will
Ovenbird
Prairie warbler

Mammals
Allegheny woodrat
Bobcat
Eastern red bat
Eastern small-footed bat
Gray fox
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Reptiles
Copperhead
Smooth greensnake
Timber rattlesnake

Plants
Hairy rockcress *(Arabis adpressipilis)*
Spreading rockcress *(Arabis patens)*
Side-oats grama *(Bouteloua curtipendula)*
Long-stalked sedge *(Carex pedunculata)*
Flat-spiked sedge *(Carex planispicata)*
Standley's goosefoot *(Chenopodium standleyanum)*
Low bindweed *(Convolvulus spithamaea)*
Tall larkspur *(Delphinium exaltatum)*
Cream tick-trefoil *(Desmodium ochroleucum)*
Ringed witchgrass *(Dichanthelium annulum)*
Warty spurge *(Euphorbia spathulata)*
Crested coralroot *(Hexalectris spicata)*
Hairy false gromwell *(Lithospermum parviflorum)*
Climbing milkweed *(Matelea obliqua)*
Three-flower melicgrass *(Melica nitens)*
Roughleaf ricegrass *(Oryzopsis asperifolia)*
Wiry witchgrass *(Panicum flexile)*
American feverfew *(Parthenium integrifolium)*
Pale beardtongue *(Penstemon pallidus)*
Smooth phlox *(Phlox glaberrima)*
Downy phlox *(Phlox pilosa)*
Torrey's mountainmint *(Pycnanthemum torreyi)*

Invertebrates (Snails)
Cherrystone drop

Early buttercup *(Ranunculus fascicularis)*
Pursh's wild petunia *(Ruellia purshiana)*
Shale barren skullcap *(Scutellaria leonardii)*
Seneca snakeroot *(Senega officinalis)*
Prairie goldenrod *(Solidago rigida)*
Yellow nodding ladies' tresses *(Spiranthes ochroleuca)*
Northern white-cedar *(Thuja occidentalis)*
Snow trillium *(Trillium nivale)*
Goosefoot cornsalad *(Valerianella chenopodiifolia)*
Broadleaf bunchflower *(Veratrum hybridum)*
Northern prickly-ash *(Zanthoxylum americanum)*

Artificial Barren (Sand and Gravel Mines)

Region(s): *Southern*
Habitat Group*: Glades/Barrens/Cliffs*
NEAFWA: *Developed Areas*
Additional Notes: *An artificial or human-made habitat*

Sam Droege, USGS, at an abandoned sand mine
(Will Parson, Chesapeake Bay Program)

The Artificial Barren is a Key Wildlife Habitat characterized by human-created, sparsely vegetated areas dominated by exposed mineral soils (i.e., sand and gravel) resulting from surface mining. Maryland contains nearly 300 operating surface mines and many more inactive or reclaimed sites, most located in southern Maryland. These artificial barrens serve as surrogates for early successional and open barren habitats that were historically widespread but have become increasingly rare. Inactive sand mines support a variety of Species of Greatest Conservation Need, particularly invertebrates that depend on bare or sparsely vegetated soils. Ground-nesting bees and wasps, tiger beetles, and other insects rely on these conditions for nesting, foraging, thermoregulation, and larval development. Studies indicate that inactive sand and gravel mines in Maryland support high levels of rare bee diversity (Droege et al. 2009; Seitz et al. 2019).

Maryland currently requires that inactive sand mines be capped with topsoil and vegetated, although seed mixes are not regulated. While well-intentioned, this approach can reduce habitat value for sand-specialist species and other invertebrates that rely on open ground. Instead, reclamation should aim to create a mosaic of ground cover, leaving some areas exposed and uncapped. Native flowering plants should be established to provide pollen and nectar. Active sand mines should also reserve stripped areas for barren-dependent taxa and include pollinator buffer strips to support adjacent populations.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George’s, Queen Anne’s, Somerset, St. Mary’s, Talbot, Wicomico, Worcester

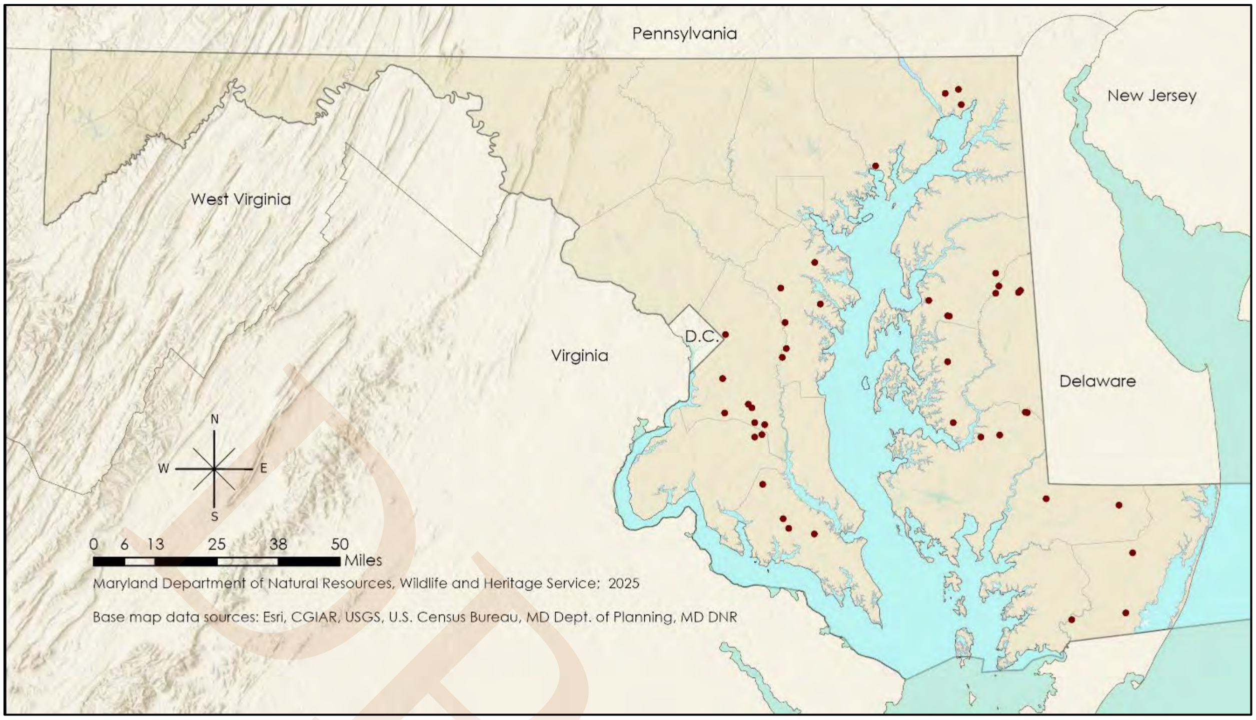


Figure 4.14 Location of Artificial Barrens (Sand and Gravel Mines) in Maryland. Source: *MD DNR.*

Species of Greatest Conservation Need Associated with Artificial Barrens (Sand and Gravel Mines):

Insects (Hymenoptera)

A dieunomia bee *(Dieunomia nevadensis)*
A leafcutter bee *(Coelioxys immaculatus)*
A long-horned bee *(Epimelissodes comptus)*
A mason bee *(Osmia chalybea)*
A miner bee *(Perdita bradleyi)*
A mining bee *(Andrena fulvipennis)*
A sweat bee *(Lasioglossum sopinci)*
American plasterer bee *(Colletes americanus)*
Puny cuckoo nomad bee *(Epeolus pusillus)*
Summer miner bee *(Protandrena aestivalis)*
Sunflower sweat bee *(Dieunomia heteropoda)*
Two-spotted miner bee *(Andrena accepta)*

Cliff and Rock Outcrop

Region(s): *Central, Western*
Habitat Group*: Glades/Barrens/Cliffs*
NEAFWA: *Cliffs & Talus*

Jason Harrison, MD DNR

The Cliff and Rock Outcrop Key Wildlife Habitat includes tall (from 3 to >50 m high), steep to vertical expanses of bare to sparsely vegetated bedrock, soil, or both. The differences between the two are subtle: cliffs are generally considered tall, sheer vertical walls of rock or soil, while outcrops consist of steep to vertical, exposed rock formations with well-developed fissures and crevices. Both are most numerous and prominent in the Appalachian Plateau and Ridge and Valley physiographic regions, although significant examples also occur in the Piedmont. On the Appalachian Plateau, this habitat is typified by extensive (in places, > 0.5 km long) Pottsville sandstone outcrops along the upper slopes and ridges (600-1,000 m) of the state's highest mountains. This includes Dans, Big Savage, Meadow, and Backbone Mountains. In the Ridge and Valley, large sandstone ridgetop outcrops also occur in the Tuscarora Formation on Haystack, Wills, and Evitts Mountains, and in the Bear Pond Mountains; the Purslane Formation on Sideling Hill and Town Hill; and in the Oriskany Formation on numerous ridges such as Fort Hill, Roundtop Hill and Warrior Mountain. Further east between Hagerstown and Frederick, the Weverton Quartzite Formation forms major outcrops along the crests of South and Catoctin Mountains

Many of these outcrops include massive cliff and boulder faces with numerous deep fissures. The outcrop base is often surrounded by extensive, open talus that grades into the Boulderfield Forests and Woodlands natural community. Cool, windswept conditions along with frequent ice storms and heavy snows greatly limit soil development and thus, the type and extent of plant communities present. Vegetation in and around outcrops also varies depending on the physiographic region, elevation, slope, aspect, geological formation, and other factors. On the steepest, most exposed sections, vegetation is absent except for mosses, and patches of lichens growing on rock surfaces. On less exposed areas, scattered, sometimes dense patches of shrubs such as mountain laurel *(Kalmia latifolia)*, great rhododendron *(Rhododendron maximum)*, huckleberries *(Gaylussacia* spp.), and blueberries *(Vaccinium* spp.*)*, as well as occasional stunted trees of chestnut oak *(Quercus montana)*, pitch pine *(Pinus rigida)*, American mountain ash *(Sorbus americana)*, Table Mountain pine *(Pinus pungens)*, or eastern hemlock *(Tsuga canadensis)* can be found growing there. The surrounding vegetation, which influences the types of outcrop fauna present, can range from High Elevation Ridge Forests and Hemlock-Northern Hardwood Forests to Montane-Piedmont Oak-Pine Forests. Prior to the introduction of chestnut blight in the early-mid 1900s, American chestnut *(Castanea dentata)* was a frequent to dominant tree species in many of the forests surrounding ridgetop outcrops.

At lower elevations in the western mountain region of Maryland, large outcrops and cliffs also occur along many of the larger streams and rivers. One example exists in Garrett County, where Pottsville sandstone outcrops overlook sections of the Youghiogheny River and North Branch of the Potomac River. There are also a variety of formations of outcrops in the Piedmont region along the main branch of the Potomac River, including one of the more notable examples on the Weverton Quartzite Formation, which exhibits tall, sheer cliffs near Harpers Ferry and Point of Rocks. This Key Wildlife Habitat also includes the less common shale and limestone outcrops and ledges that occur along the Potomac in Allegany, Washington, and Frederick counties. Cliffs and Rock Outcrops are much less common in the Piedmont region, and most are small; the largest occur along the Susquehanna River, on Sugarloaf Mountain, and in the Great Falls region of the Potomac River.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Catoctin Mountain Park, C&O Canal National Historical Park, Rocks State Park, South Mountain State Park

State Rare Natural Communities: Basic Cliff, Boulderfield Forest and Woodland

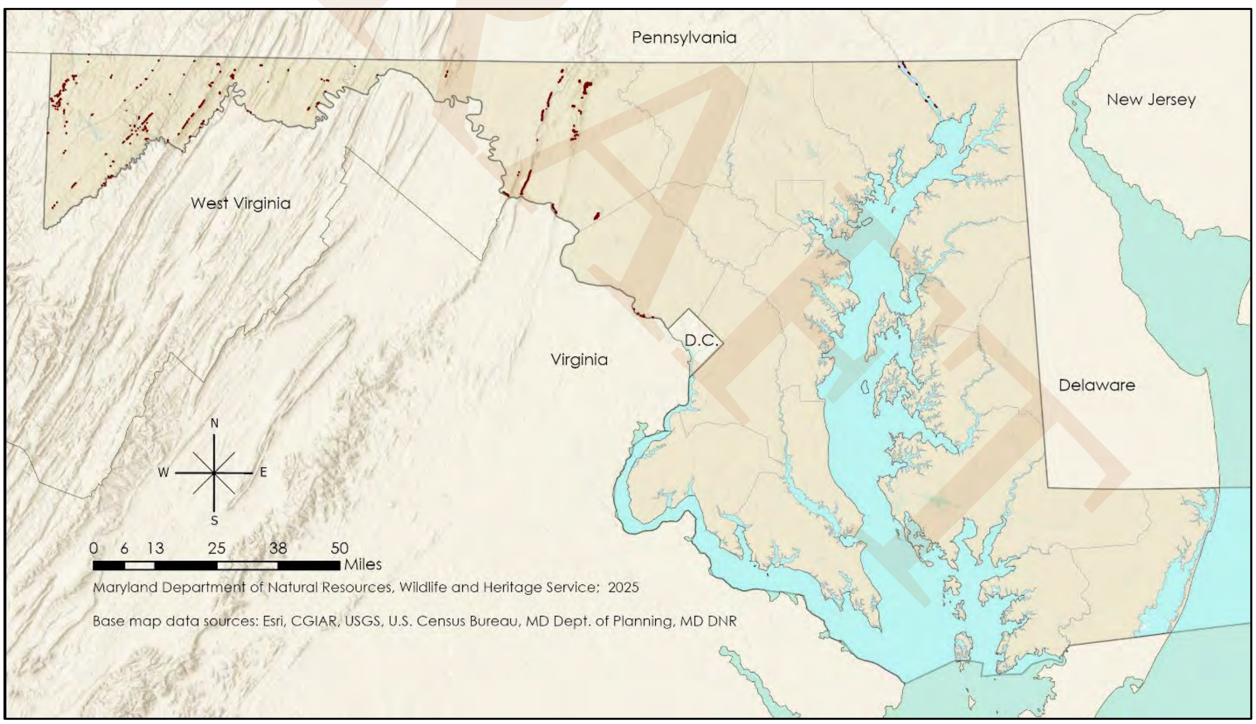


Figure 4.15 Location of Cliffs and Rock Outcrops in Maryland. Sources: MD DNR, NETWHCS.

Species of Greatest Conservation Need Associated with Cliffs and Rock Outcrops:

<u>Birds</u>	<u>Mammals</u>	<u>Plants (continued)</u>
American peregrine falcon	Allegheny woodrat	Lobed spleenwort *(Asplenium pinnatifidum)*
Dark-eyed junco	Appalachian cottontail	
Golden eagle	Bobcat	

Winter wren

Amphibians

Green salamander
Wehrle's salamander

Reptiles

Copperhead
Red cornsnake
Six-lined racerunner
Smooth greensnake
Timber rattlesnake

Insects (Coleoptera)

Common claybank tiger beetle
Cow path tiger beetle
Northern barrens tiger beetle
Splendid tiger beetle

Insects (Hymenoptera)

A cellophane bee *(Colletes aestivalis)*

Eastern small-footed bat
Eastern spotted skunk
Gray fox
Indiana bat
Least weasel
Little brown bat
Long-tailed shrew
Northern long-eared bat
Silver-haired bat
Smoky shrew
Tricolored bat

Plants

Running shadbush *(Amelanchier humilis)*
Nantucket shadbush *(Amelanchier nantucketensis)*
Western hairy rockcress *(Arabis pycnocarpa)*
Bearberry *(Arctostaphylos uva-ursi)*
Bradley's spleenwort *(Asplenium bradleyi)*
Black-stem spleenwort *(Asplenium resiliens)*
Missouri rockcress *(Borodinia missouriensis)*
American harebell *(Campanula rotundifolia)*
Ebony sedge *(Carex eburnea)*
Northern bedstraw *(Galium boreale)*
Appalachian sandwort *(Geocarpon glabrum)*
Highland rush *(Oreojuncus trifidus)*
Canby's mountain-lover *(Paxistima canbyi)*
Smooth cliffbrake *(Pellaea glabella)*
Northern beechfern *(Phegopteris connectilis)*
Michaux's stitchwort *(Sabulina michauxii)*
Cliff stonecrop *(Sedum glaucophyllum)*
Racemose goldenrod *(Solidago racemosa)*

Coastal Bluff

Region(s): *Eastern, Southern*
Habitat Group*: Glades/Barrens/Cliffs*
NEAFWA: *Cliffs & Talus; Shorelines*

Jared Parks, Eastern Shore Land COnservancy

The Coastal Bluff Key Wildlife Habitat is defined as a steep shoreline slope formed in loose sediments of clay, sand, and gravel, often just above the high tide line. By comparison, cliffs or slopes in bedrock (ledge) surfaces are not classified as bluffs and are not subject to significant erosion over a century or more. In addition, beaches and dunes do not form bluffs, except along the seaward dune edge as a result of erosion. On the Coastal Plain, this habitat type is limited to tall (5-40 m), steep to vertical bluffs of Miocene origin along the shorelines of the mid- and upper Chesapeake Bay and large tidal rivers, examples of which include Calvert Cliffs on the Chesapeake Bay and Grove Point at the mouth of the Sassafras River.

Vegetation is usually absent to sparse due to naturally high erosion rates resulting from a combination of shoreline wave action, groundwater percolation, and the weathering effects of wind and precipitation, especially during major storm events (e.g., hurricanes, nor'easters). A sparse early successional community may become temporarily established on less steep or exposed bluff faces. Vegetation composition varies, but small trees such as black locust *(Robinia pseudoacacia)* and sassafras *(Sassafras albidum)* are among the more frequent tree species present, and mixtures of native and non-native woody and herbaceous species may be found in variable composition and abundance, including staghorn sumac (*Rhus typhina)*, multiflora rose (*Rosa multiflora*), common pokeweed (*Phytolacca americana*), Japanese honeysuckle (*Lonicera japonica*), yellow foxtail (*Setaria pumila*), and wild potato-vine (*Ipomoea pandurata*). Smaller (3-8 m tall) bluffs also occur along large inland rivers, such as the Potomac and the Monocacy. In some cases, sand and gravel mining operations create bluff-like conditions around the edges or in the open pits that provide primary habitat for certain Species of Greatest Conservation Need, including bank swallows (*Riparia riparia*).

County Distribution: Anne Arundel, Baltimore, Calvert, Cecil, Charles, Frederick*, Harford, Kent, Montgomery*, Prince George's, Queen Anne's, St. Mary's, Talbot
*(*This Key Wildlife Habitat accommodates "disjunct" and isolated areas that occur in portions of the Piedmont.)*

Places to Visit: Calvert Cliffs State Park, Sassafras Natural Resources Management Area

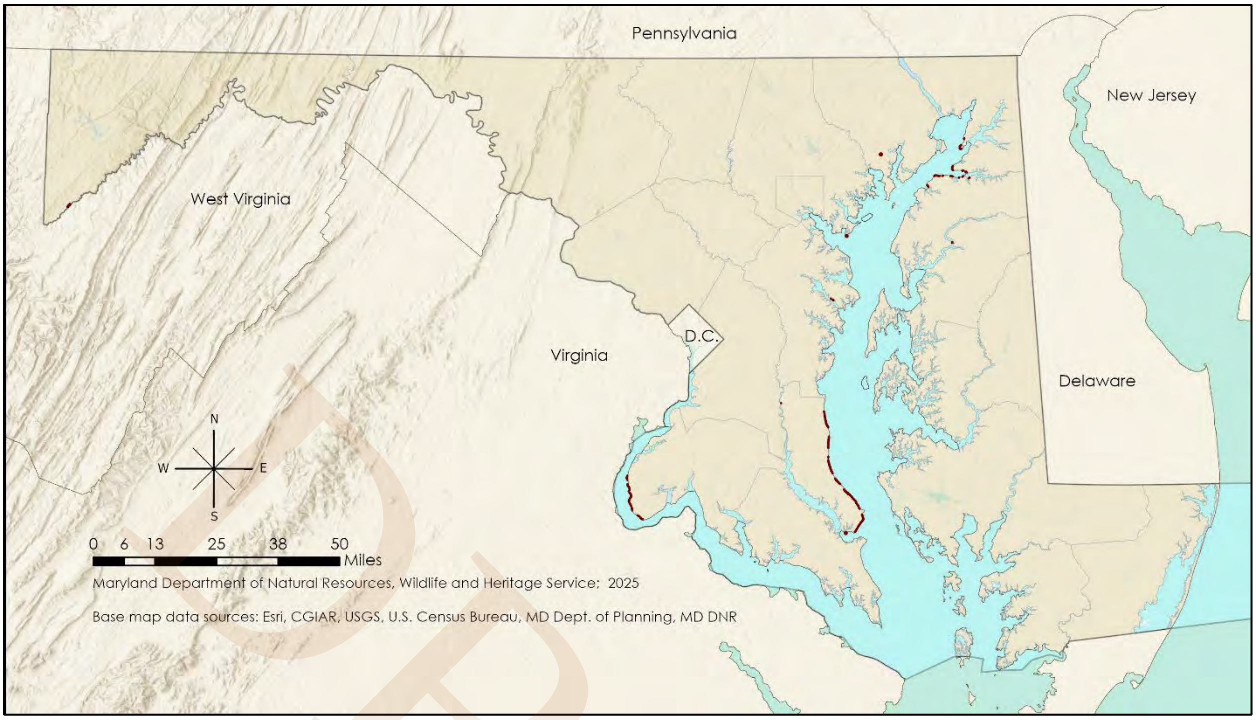


Figure 4.16 Location of Coastal Bluffs in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Coastal Bluffs:

Birds
Bank swallow

Insects (Coleoptera)
Eastern beach tiger beetle
Puritan tiger beetle

Coastal Beaches and Dunes

Coastal Beach

Region(s): *Eastern, Southern*
Habitat Group: *Coastal Beaches/Dunes*
NEAFWA: *Beaches & Dunes*

MD DNR

The Coastal Beach Key Wildlife Habitat is represented by ocean shores and flats behind breached foredunes of the Atlantic coast, as well as along some of the shoreline habitat of the Coastal Bays, Chesapeake Bay, and lower reaches of major rivers. Situated between the mean high tide limit and foredunes, Coastal Beaches along the Atlantic Ocean are subjected to extreme conditions associated with marine environments, such as salt spray, high winds, flooding, and shifting sands. These habitats are generally kept moist due to constant salt spray and rainwater. Substrates are composed of unconsolidated sands and shells, which are constantly being shifted by winds and floods of storm surges and spring high tides.

This dynamic disturbance regime severely limits vegetation establishment to salt-tolerant species, with composition that can change dramatically from year to year, which often includes succulent annuals such as American sea rocket (*Cakile edentula*), seaside sandmat (*Chamaesyce polygonifolia*), sea chickweed (*Honckenya peploides*), and glassworts (*Salicornia* spp.). In addition, broad overwash flats may develop behind primary dunes when breaching occurs during storm surges. Dune construction along the Atlantic coast has greatly reduced the extent of these habitats by increasing oceanside beach erosion and eliminating the natural disturbance regime that creates and maintains overwash flats. Beaches of shorelines away from the ocean are subject to many of the same conditions, except for a minimized or insignificant amount of salt spray, depending on their location. These beaches are also frequently reduced to small, isolated areas. Certain erosion control structures, such as bulkheads and placement of riprap revetments along shorelines, have greatly reduced the extent of this habitat by disrupting natural erosion and longshore or littoral drift of sand.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George’s, Queen Anne’s, Talbot, Somerset, St. Mary’s, Wicomico, Worcester

Places to Visit: Assateague Island National Seashore, Calvert Cliffs State Park, Flag Ponds Nature Park

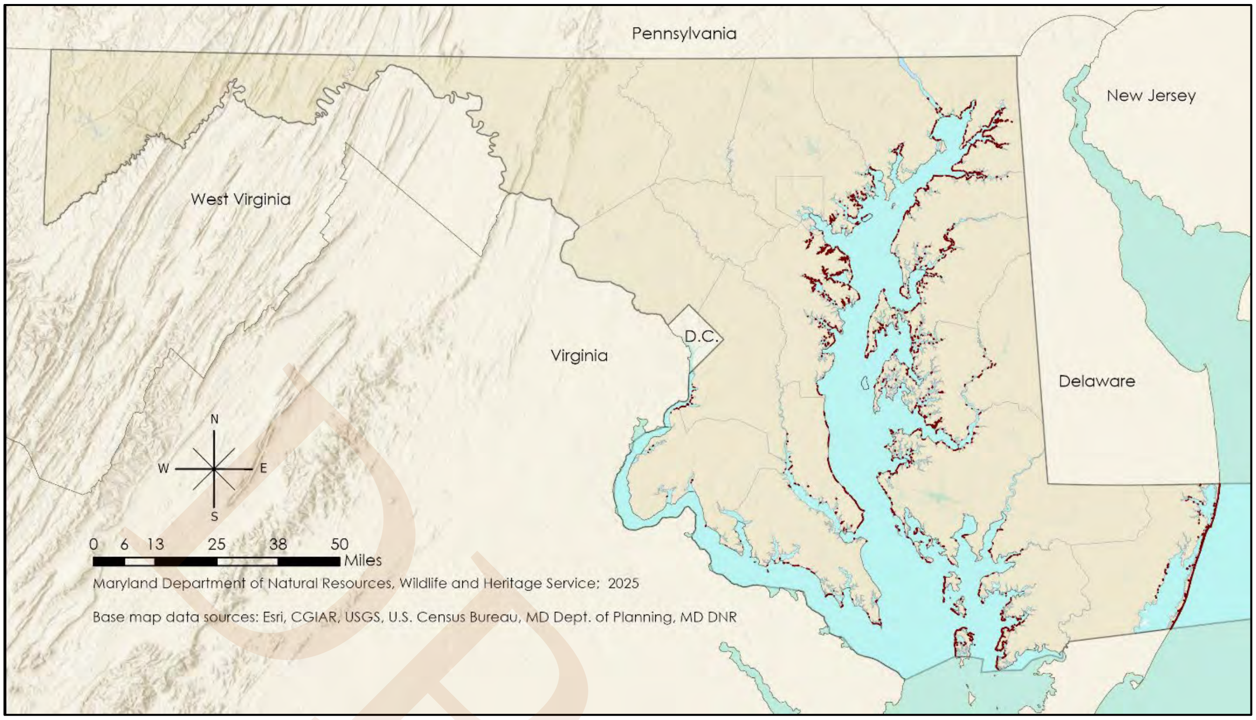


Figure 4.17 Location of Coastal Beaches in Maryland. Sources: MD DNR, NPS, USGS.

Species of Greatest Conservation Need Associated with Coastal Beaches:

Birds
American oystercatcher
Black skimmer
Black-bellied plover
Brant
Brown pelican
Common tern
Dunlin
Forster's tern
Greater yellowlegs
Gull-billed tern
Ipswich sparrow
Laughing gull
Least tern
Lesser yellowlegs
Piping plover
Roseate tern
Royal tern
Ruddy turnstone
Rufa red knot
Sanderling
Sandwich tern
Semipalmated sandpiper
Spotted sandpiper
Whimbrel

Birds (continued)
Willet
Wilson's plover

Reptiles
Loggerhead sea turtle
Diamond-backed terrapin
Six-lined racerunner

Insects (Coleoptera)
Eastern beach tiger beetle
Ghost tiger beetle
White tiger beetle

Insects (Hymenoptera)
A cellophane bee *(Colletes speculiferus)*
A mason bee *(Osmia chalybea)*
A mining bee *(Andrena braccata)*
A sweat bee *(Lasioglossum nymphale)*
American plasterer bee *(Colletes americanus)*
George Eickwort's sweat bee *(Lasioglossum georgeickworti)*
Puny cuckoo nomad bee *(Epeolus pusillus)*

Insects (Lepidoptera)
Brown flower moth
Coastal graphic moth *(Drasteria graphica)*
Eastern cactus-boring moth
Fringed dart moth
Merry melipotis moth
Sand wainscot moth
Seaside goldenrod stem borer

Plants
Seabeach amaranth *(Amaranthus pumilus)*
Seabeach orach *(Atriplex mucronata)*
Seabeach sedge *(Carex silicea)*
Common clammyweed *(Polanisia dodecandra)*
Seabeach knotweed *(Polygonum glaucum)*
Beach plum *(Prunus maritima)*
Narrowleaf willow *(Salix interior)*
Puerto Rico sea-purslane *(Sesuvium maritimum)*

Maritime Dune and Grassland

Region(s): *Eastern*
Habitat Group: *Coastal Beaches/Dunes*
NEAFWA: *Beaches & Dunes; Grasslands*

Jason Harrison, MD DNR

The Maritime Dune and Grassland Key Wildlife Habitat is characterized by dune systems along the Atlantic Ocean. These habitats are dominated by grasses and dwarf shrubs well adapted to extreme gradients of soil moisture and salt spray. Sand movement is also an important factor in shaping dune communities. Active dunes, where sand movement is greatest, tend to support grasses such as American beachgrass *(Ammophila breviligulata)*, beach panic grass *(Panicum amarum* ssp. *amarulum)*, and bitter seabeach grass *(Panicum amarum* ssp. *amarum)*, whereas stabilized dunes support low-growing shrubs such as beach heather *(Hudsonia tomentosa*). Steep, ocean-fronting dunes are usually colonized by linear, nearly monospecific stands of American beachgrass. The crest and back slopes of primary dunes have a slightly more diverse plant assemblage that may include sea oats (*Chasmanthium latifolium*), bitter seabeach grass, seaside goldenrod (*Solidago sempervirens*), seaside spurge (*Euphorbia polygonifolia*), and dune sandbur (*Cenchrus tribuloides*).

A series of smaller secondary dunes spread inland from the primary dune. These dunes are somewhat protected from salt spray and often dominated by beach panic grass. Small, seasonally flooded grasslands in low swales between secondary dunes are commonly referred to as interdunal swales, characterized by perched water tables and shallow seasonal flooding by rainfall. Although they are predominantly freshwater wetlands, periodic saltwater intrusion may occur in some swales during storm surges. Fluctuations in water levels and salinity vary between swales and greatly influence species composition. As water levels draw down late in the growing season, interdunal swales support a variety of grasses, sedges, rushes, and forbs. Maritime dune systems are threatened by development and coastal erosion.

County Distribution: Worcester

Places to Visit: Assateague Island National Seashore

State Rare Natural Communities: Maritime Dune Grassland, Interdunal Swale

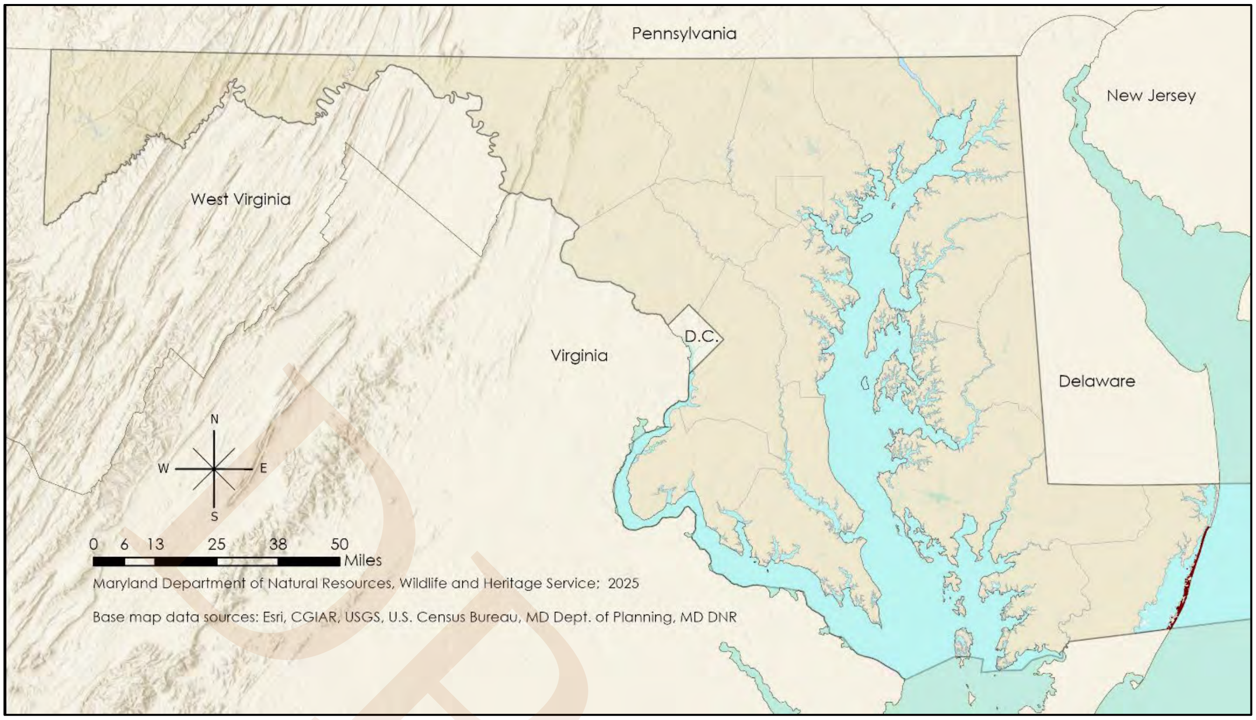


Figure 4.18 Location of Maritime Dunes and Grasslands in Maryland. Sources: MD DNR, NPS.

Species of Greatest Conservation Need Associated with Maritime Dunes and Grasslands:

Birds

American oystercatcher
Black skimmer
Boat-tailed grackle
Common nighthawk
Common tern
Forster's tern
Greater yellowlegs
Gull-billed tern
Ipswich sparrow
Laughing gull
Least tern
Lesser yellowlegs
Northern bobwhite
Northern harrier
Piping plover
Roseate tern
Royal tern
Sandwich tern
Short-eared owl
Whimbrel
Willet
Wilson's plover

Mammals

Eastern red bat
Hoary bat
Silver-haired bat
Tricolored bat

Reptiles

Diamond-backed terrapin

Insects (Hymenoptera)

A cellophane bee *(Colletes speculiferus)*
A mason bee *(Osmia chalybea)*
A mining bee *(Andrena braccata)*
A sweat bee *(Lasioglossum nymphale)*
American plasterer bee *(Colletes americanus)*
George Eickwort's sweat bee *(Lasioglossum georgeickworti)*
Puny cuckoo nomad bee *(Epeolus pusillus)*

Insects (Coleoptera)

Bethany Beach firefly
Ghost tiger beetle
White tiger beetle

Insects (Lepidoptera)

Brown flower moth
Coastal graphic moth *(Drasteria graphica)*
Eastern cactus-boring moth
Fringed dart moth
Merry melipotis moth
Sand wainscot moth
Seaside goldenrod stem borer

Plants

Umbrella flats flatsedge *(Cyperus diandrus)*
Sea chickweed *(Honckenya peploides)*

Wetland Habitats
Floodplain Wetlands

Richard Wiegand, MD DNR

Montane-Piedmont Floodplain
Region(s): *Western, Central*
Habitat Group: *Floodplain Wetlands*
NEAFWA: *Riparian & Floodplains*

The Montane-Piedmont Floodplain Key Wildlife Habitat encompasses a wide variety of floodplain habitats along small streams and large river systems in the Piedmont and mountain regions of Maryland. These habitats are very diverse and dynamic, creating a mosaic of forests, woodlands, shrublands and herbaceous ecological communities where species distribution, composition and structure are influenced by geology, soil properties, and flooding regimes. Beaver herbivory and dam-building can also dynamically alter floodplain connection in small and medium sized systems.

Distinct alluvial landforms are usually present at varying scales along larger rivers along shoreline areas and islands, especially in high-gradient rocky sections and along flood-deposited sand and gravel bars, levees, terraces, old oxbows, and sloughs. These support stunted, flood-scoured woodlands, herbaceous wet meadows, and riverside prairies. Such areas are frequently dominated by dense, nearly pure stands of small (2-8 m tall) sycamore *(Platanus occidentalis)*, box elder *(Acer negundo)*, river birch *(Betula nigra)*, and green ash *(Fraxinus pennsylvanica)* trees with smaller inclusions of graminoid vegetation often dominated by little bluestem (*Andropogon gerardii*) and switchgrass (*Panicum virgatum*). Temporarily and intermittently flooded bottomland forests are prominent along many of the rivers with canopies composed of species including sycamore, silver maple *(Acer saccharinum)*, black walnut *(Juglans nigra)*, river birch, box elder, pawpaw *(Asimina triloba)*, and American elm *(Ulmus americana)*.

Frequently embedded within floodplain forests are floodwater pools and seasonally flooded backswamps and sloughs dominated by red maple *(Acer rubrum)*, silver maple, sweetgum *(Liquidambar styraciflua)*, and hydrophytic oaks such as pin oak *(Quercus palustris)* and swamp white oak *(Quercus bicolor)*. These backwater areas usually exhibit distinctive hummock-and-hollow microtopography with maximum flood depths of 50-70 cm. along smaller, higher gradient streams, where the floodplain is narrower and alluvial landforms develop at much smaller scales, mesophytic species may occur. Commonly encountered is a mixture of bottomland and mesophytic species, which include tulip poplar *(Liriodendron tulipifera)*, sugar maple *(Acer saccharum)*, basswood *(Tilia americana)*, American beech *(Fagus grandifolia)*, and white pine *(Pinus strobus)*. At higher elevations, eastern hemlock *(Tsuga canadensis)*, black cherry *(Prunus serotina)*, yellow birch (*Betula alleghaniensis*), and dense thickets of great laurel *(Rhododendron maximum)* can be prominent.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: C&O National Historical Park, Gunpowder Falls State Park, Patapsco Valley State Park, Susquehanna State Park, Sideling Hill Wildlife Management Area

State Rare Natural Communities: River Scour Woodland, Riverside Prairie, Riverside Outcrop Barren

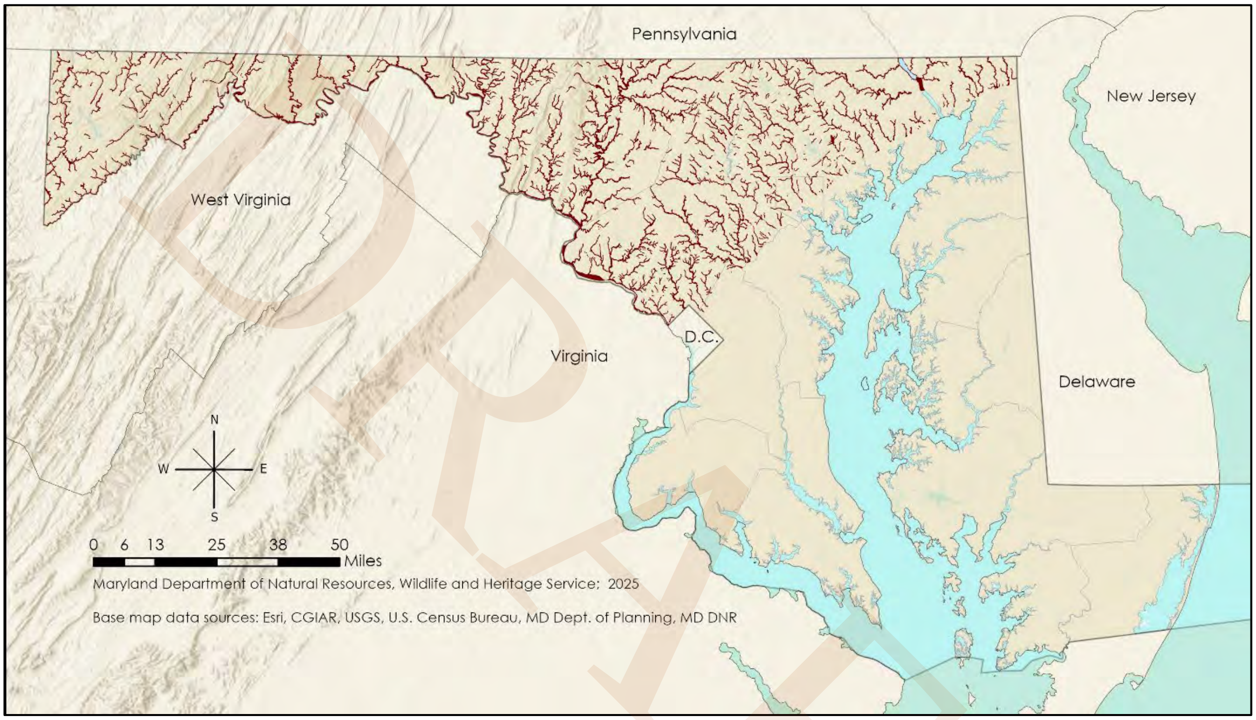


Figure 4.19 Location of Montane-Piedmont Floodplains in Maryland. Sources: MD DNR, FEMA.

Species of Greatest Conservation Need Associated with Montane-Piedmont Floodplains:

Birds	Insects (Coleoptera)	Plants
Acadian flycatcher	An ash seed weevil *(Lignyodes bischoffi)*	Blue monkshood *(Aconitum uncinatum)*
Alder flycatcher	An ash seed weevil *(Lignyodes fraxini)*	Earleaf false foxglove *(Agalinis auriculata)*
American black duck	An ash seed weevil *(Lignyodes helvolus)*	Lake-cress *(Armoracia lacustris)*
American redstart	An ash seed weevil *(Lignyodes horridulus)*	Blue wild indigo *(Baptisia australis)*
American woodcock	Appalachian tiger beetle	Susquehanna doll's-daisy *(Boltonia asteroides* var. *asteroides)*
Bald eagle	Charlie Brown's flea beetle *(Capraita sexmaculata)*	Broad-glumed brome *(Bromus latiglumis)*
Baltimore oriole	Eastern ash bark beetle *(Hylesinus aculeatus)*	Carey's sedge *(Carex careyana)*
Bank swallow		Davis' sedge *(Carex davisii)*
Black-and-white warbler		Cypress-knee sedge *(Carex decomposita)*
Black-billed cuckoo		
Black-crowned night heron		
Black-throated blue warbler		
Black-throated green warbler		
Blackburnian warbler		

Blue-winged warbler
Broad-winged hawk
Brown creeper
Canada warbler
Cerulean warbler
Golden-crowned kinglet
Golden-winged warbler
Great blue heron
Great egret
Greater yellowlegs
Hooded warbler
Kentucky warbler
Lesser yellowlegs
Louisiana waterthrush
Magnolia warbler
Northern parula
Ovenbird
Prothonotary warbler
Ruffed grouse
Rusty blackbird
Scarlet tanager
Spotted sandpiper
Veery
Willow flycatcher
Winter wren
Wood thrush
Worm-eating warbler
Yellow warbler
Yellow-breasted chat
Yellow-crowned night heron
Yellow-throated vireo

Mammals

American mink
Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Least weasel
Little brown bat
Northern long-eared bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Southern water shrew
Tricolored bat

Encircled borer *(Agrilus subcinctus)*
Potomac firefly

Insects (Diptera)

Ash bullet gall midge *(Dasineura pellex)*
Swollen ash gall midge *(Dasineura tumidosae)*

Insects (Hemiptera)

Fringetree lace bug *(Leptoypha mutica)*

Insects (Hymenoptera)

A carpenter ant *(Colobopsis mississippiensis)*
A cuckoo bee *(Nomada seneciophila)*
An andrenid bee *(Andrena lamelliterga)*
An andrenid bee *(Andrena phaceliae)*
Azalea mining bee *(Andrena cornelli)*
Blackheaded ash sawfly *(Tethida barda)*
Fringed loosestrife oil-collecting bee *(Macropis ciliata)*
Golden Alexanders miner bee *(Andrena ziziae)*
Mustard miner bee *(Andrena arabis)*
Trout lily miner bee *(Andrena erythronii)*
Waterleaf mining bee *(Andrena geranii)*

Insects (Lepidoptera)

A grass miner moth *(Ethmia macelhosiella)*
Angel moth
Ash borer moth *(Podosesia syringae)*
Ash leaf cone roller moth *(Caloptilia fraxinella)*
Ash sphinx *(Manduca jasminearum)*

Hairy-fruited sedge *(Carex trichocarpa)*
Big shellbark hickory *(Carya laciniosa)*
Tall tickseed *(Coreopsis tripteris)*
Flatsedge *(Cyperus hystricinus)*
Flat-stem spikerush *(Eleocharis compressa* var. *compressa)*
Matted spikerush *(Eleocharis intermedia)*
Braun's robin's-plantain *(Erigeron pulchellus* var. *brauniae)*
White trout lily *(Erythronium albidum)*
Harperella *(Harperella nodosa)*
Sweet-scented Indian plantain *(Hasteola suaveolens)*
McDowell's sunflower *(Helianthus occidentalis)*
Few-flowered tick-trefoil *(Hylodesmum pauciflorum)*
Eastern bloodleaf *(Iresine rhizomatosa)*
Dwarf crested iris *(Iris cristata)*
Pipevine *(Isotrema macrophyllum)*
American gromwell *(Lithospermum latifolium)*
Virginia false gromwell *(Lithospermum virginianum)*
Winged loosestrife *(Lythrum alatum)*
Starflower Solomon's-plume *(Maianthemum stellatum)*
Ostrich fern *(Matteuccia struthiopteris)*
Purple mecardonia *(Mecardonia acuminata)*
Hair-awn muhly *(Muhlenbergia capillaris)*
Whorled water-milfoil *(Myriophyllum verticillatum)*
Glade mallow *(Napaea dioica)*
Yellow nailwort *(Paronychia virginica)*
Horse-tail paspalum *(Paspalum fluitans)*
Coville's phacelia *(Phacelia covillei)*
Fowl bluegrass *(Poa palustris)*
Large-leaved pondweed *(Potamogeton amplifolius)*

Amphibians
Jefferson salamander
Longtail salamander
Mountain dusky salamander
Seal salamander
Upland chorus frog
Valley and Ridge salamander

Reptiles
Bog turtle
Copperhead
Eastern box turtle
Eastern mud turtle
Eastern ribbonsnake
Eastern spiny softshell
Northern map turtle
Smooth greensnake
Spotted turtle
Timber rattlesnake
Wood turtle

Invertebrates (Mites)
Ash flower gall mite *(Aceria fraxiniflora)*
Ash key gall mite *(Aceria fraxinivora)*
Ash leaf gall mite *(Aceria fraxini)*
Ash tip borer moth *(Papaipema furcata)*
Atlantis fritillary
Baltimore checkerspot
Banded ash clearwing moth *(Podosesia aureocincta)*
Black dash
Braun's ash bark-mining moth *(Marmara fraxinicola)*
Franck's sphinx
Great ash sphinx *(Sphinx chersis)*
Grote's sallow moth
Harris's checkerspot
Inkblot palpita moth *(Palpita illibalis)*
Long dash
Northern oak hairstreak
Pepper and salt skipper
Purple plagodis moth *(Plagodis kuetzingi)*
Silver-bordered fritillary
Splendid palpita moth *(Palpita magniferalis)*
Tuscarora emerald
West Virginia white
Zeller's grass miner moth *(Ethmia zelleriella)*

Insects (Odonata)
Beaverpond baskettail
Black-tipped darner
Canada darner
Green-striped darner
Ski-tailed emerald

Illinois pondweed *(Potamogeton illinoensis)*
Bur oak *(Quercus macrocarpa)*
Wild black currant *(Ribes americanum)*
Virginia mallow *(Ripariosida hermaphrodita)*
Smooth rose *(Rosa blanda)*
Hairy wild petunia *(Ruellia humilis)*
Limestone wild petunia *(Ruellia strepens)*
Tall dock *(Rumex altissimus)*
Blunt-lobe grapefern *(Sceptridium oneidense)*
Little-head nutrush *(Scleria oligantha)*
Hooded skullcap *(Scutellaria galericulata)*
Veined skullcap *(Scutellaria nervosa)*
Rock skullcap *(Scutellaria saxatilis)*
Snowy campion *(Silene nivea)*
Rock goldenrod *(Solidago rupestris)*
Smooth false buttonweed *(Spermacoce glabra)*
Valerian *(Valeriana pauciflora)*
Rock grape *(Vitis rupestris)*

Coastal Plain Floodplain

Region(s): *Central, Eastern, Southern*
Habitat Group: *Floodplain Wetlands*
NEAFWA: *Riparian & Floodplains*

Richard Wiegand, MD DNR

The Coastal Plain Floodplain Key Wildlife Habitat is characterized by a variety of flooded habitats that border Coastal Plain streams and rivers. These floodplain habitats are influenced by temporary or seasonal overbank flooding, groundwater seepage, and beaver activity. The vegetation of Coastal Plain Floodplains is both structurally and compositionally diverse, and often occurs as a mosaic of forests, woodlands, shrublands, and herbaceous communities. Species composition varies widely with stream order, soil type, and flooding regime.

Floodplain forests of small intermittent streams and braided streams may support combinations of sycamore *(Platanus occidentalis)*, green ash *(Fraxinus pennsylvanica)*, red maple *(Acer rubrum)*, sweetgum *(Liquidambar styraciflua)*, black gum *(Nyssa sylvatica)*, river birch *(Betula nigra)*, swamp chestnut oak *(Quercus michauxii)*, and willow oak *(Quercus phellos)*. Diverse understories are often present and characterized by mixtures of subcanopy and shrub species including American hornbeam *(Carpinus caroliniana)*, pawpaw *(Asimina triloba)*, American elm *(Ulmus americana)*, American holly *(Ilex opaca* var. *opaca)*, spicebush *(Lindera benzoin)*, Jack-in-the-pulpit *(Arisaema triphyllum)*, false nettle *(Boehmeria cylindrica)*, poison ivy *(Toxicodendron radicans)*, Virginia creeper *(Parthenocissus quinquefolia)*, stout wood reedgrass *(Cinna arundinacea)*, and various sedges. Similarly, floodplain forests of larger Coastal Plain Rivers with well-drained terraces or natural levees not subject to regular flooding will often support species such as tulip poplar *(Liriodendron tulipifera)*, beech *(Fagus grandifolia)*, and box elder *(Acer negundo)*.

Semi-permanent to permanently flooded areas of this habitat may support swamps dominated by green ash, red maple, and plants tolerant of fluctuating water levels such as lizard's-tail (*Saururus cernuus*). Bald cypress (*Taxodium distichum*) and Atlantic white cedar (*Chamaecyparis thyoides*) swamps are rare natural communities that are also associated with poorly drained settings in regularly flooded floodplains, both of which are associated with slow-moving Blackwater Streams such as those in the Pocomoke and Nanticoke River watersheds.

Floodplain pools, beaver ponds, and other open water habitats are also characteristic of Coastal Plain Floodplains. These habitats are subjected to irregular disturbances that change water levels, such as the breaching of beaver dams and storm events. These habitats are highly variable in size, structure, and species composition. They often support a variety of floating aquatic, emergent, and woody vegetation. Species common to these habitats include white water-lily *(Nymphaea odorata)*, spatterdock *(Nuphar advena)*, pondweeds *(Potamogeton* spp.*)*, duckweeds *(Lemna* spp.*)*, bladderworts *(Utricularia* spp.*)*, rice cutgrass *(Leersia oryzoides)*, common woodrush *(Luzula multiflora)*, knotweeds *(Polygonum* spp.*)*, pickerelweed *(Pontederia cordata)*, arrow-arum *(Peltandra virginica)*, three-way sedge *(Dulichium arundinaceum)*, broad-leaved cattail *(Typha latifolia)*, American bur-reed *(Sparganium americanum)*, swamp loosestrife *(Decodon verticillatus)*, and common buttonbush *(Cephalanthus occidentalis)*.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, Worcester

Places to Visit: Merkle Wildlife Sanctuary, Idylwild Wildlife Management Area, Pocomoke State Forest

State Rare Natural Communities: Bald Cypress - Gum Swamp, Atlantic White Cedar Swamp

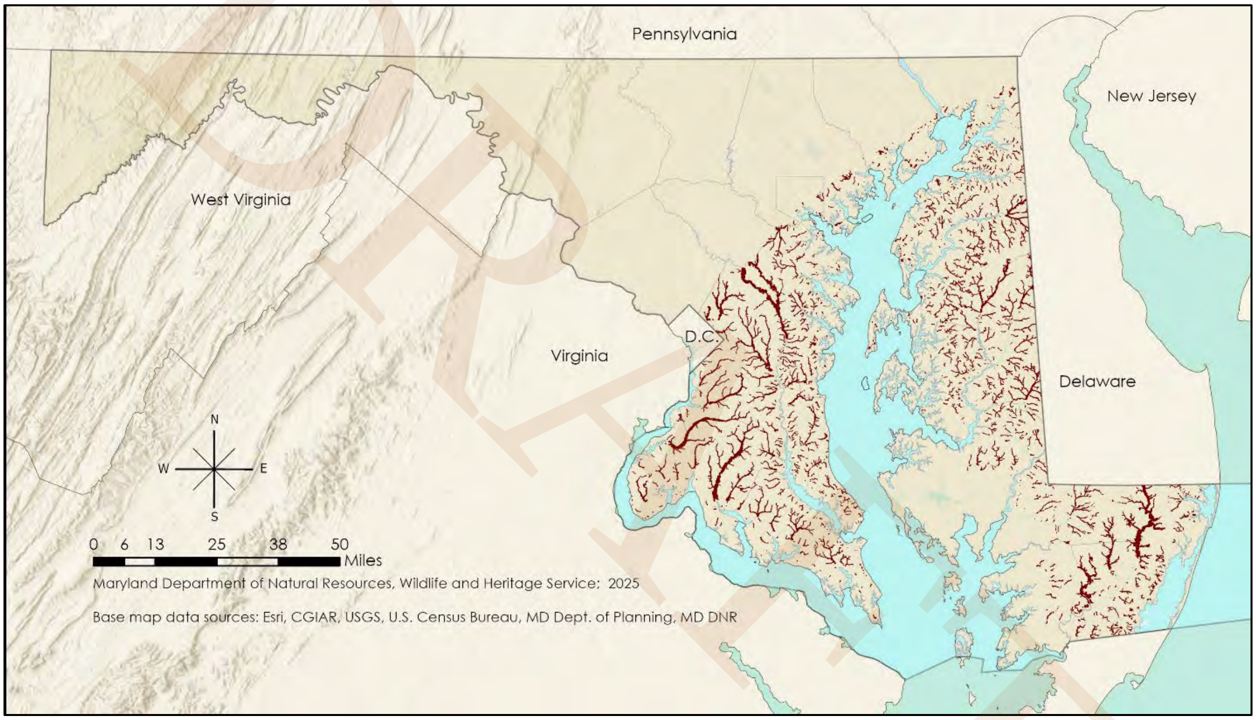


Figure 4.20 Location of Coastal Plain Floodplains in Maryland. Sources: MD DNR, FEMA.

Species of Greatest Conservation Need Associated with Coastal Plain Floodplains:

Birds
Acadian flycatcher
American black duck
American redstart
American woodcock
Bald eagle
Baltimore oriole
Bank swallow
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo

Invertebrates (Mites)
Ash flower gall mite *(Aceria fraxiniflora)*
Ash key gall mite *(Aceria fraxinivora)*
Ash leaf gall mite *(Aceria fraxini)*

Insects (Coleoptera)
An ash seed weevil *(Lignyodes bischoffi)*

Insects (Odonata)
Elfin skimmer
Fine-lined emerald

Insects (Diptera)
Ash bullet gall midge *(Dasineura pellex)*
Painted wood fly *(Blera pictipes)*
Swollen ash gall midge *(Dasineura tumidosae)*

Black-crowned night heron
Blue-winged warbler
Broad-winged hawk
Brown creeper
Chuck-will's-widow
Great blue heron
Great egret
Greater yellowlegs
Hooded warbler
Kentucky warbler
Lesser yellowlegs
Louisiana waterthrush
Nashville warbler
Northern parula
Ovenbird
Prothonotary warbler
Rusty blackbird
Scarlet tanager
Sedge wren
Spotted sandpiper
Swainson's warbler
Veery
Willow flycatcher
Winter wren
Wood thrush
Worm-eating warbler
Yellow warbler
Yellow-breasted chat
Yellow-crowned night heron
Yellow-throated vireo

Mammals

American mink
Bobcat
Delmarva fox squirrel
Eastern red bat
Hoary bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Amphibians

Eastern narrow-mouthed toad
Eastern spadefoot
Mud salamander

Reptiles

An ash seed weevil *(Lignyodes fraxini)*
An ash seed weevil *(Lignyodes helvolus)*
An ash seed weevil *(Lignyodes horridulus)*
Charlie Brown's flea beetle *(Capraita sexmaculata)*
Eastern ash bark beetle *(Hylesinus aculeatus)*
Encircled borer *(Agrilus subcinctus)*
Mysterious lantern firefly

Insects (Hemiptera)

Fringetree lace bug *(Leptoypha mutica)*
Riley's 13-year cicada *(Magicicada tredecim)*

Insects (Lepidoptera)

A twirler moth *(Coleotechnites variiella)*
An owlet moth *(Meropleon titan)*
Angel moth
Ash borer moth *(Podosesia syringae)*
Ash leaf cone roller moth *(Caloptilia fraxinella)*
Ash sphinx *(Manduca jasminearum)*
Ash tip borer moth *(Papaipema furcata)*
Bald cypress coneworm moth
Baltimore checkerspot
Banded ash clearwing moth *(Podosesia aureocincta)*
Bronze copper
Cypress emerald moth
Cypress looper *(Iridopsis pergracilis)*
Cypress pinion *(Lithophane abita)*
Cypress sphinx moth *(Isoparce cupressi)*
Distinguished cypress owlet moth
Franck's sphinx

Insects (Hymenoptera)

A carpenter ant *(Colobopsis mississippiensis)*
A cuckoo bee *(Nomada seneciophila)*
An andrenid bee *(Andrena lamelliterga)*
An andrenid bee *(Andrena phaceliae)*
Azalea mining bee *(Andrena cornelli)*
Blackheaded ash sawfly *(Tethida barda)*
Fringed loosestrife oil-collecting bee *(Macropis ciliata)*
Golden Alexanders miner bee *(Andrena ziziae)*
Mustard miner bee *(Andrena arabis)*
Trout lily miner bee *(Andrena erythronii)*
Waterleaf mining bee *(Andrena geranii)*

Plants

Sharpscale sedge *(Carex oxylepis)*
Smartweed dodder *(Cuscuta polygonorum)*
Dwarf bulrush *(Cyperus subsquarrosus)*
Creeping burhead *(Echinodorus cordifolius)*
Deciduous holly *(Ilex decidua)*
Slender blueflag *(Iris prismatica)*
American frog's-bit *(Limnobium spongia)*
Primrose-willow *(Ludwigia decurrens)*
Small-flower baby-blue-eyes *(Nemophila aphylla)*
Marsh fleabane *(Pluchea camphorata)*
Leafy pondweed *(Potamogeton foliosus)*
Water-plantain *spearwort (Ranunculus ambigens)*
Yellow water-crowfoot *(Ranunculus flabellaris)*
Mississippi buttercup *(Ranunculus laxicaulis)*
Northeastern white water-crowfoot *(Ranunculus trichophyllus)*
Water bulrush *(Schoenoplectus subterminalis)*

Copperhead
Eastern box turtle
Eastern kingsnake
Eastern milksnake
Eastern mud turtle
Eastern ribbonsnake
Northern map turtle
Northern mole kingsnake
Plain-bellied watersnake
Rainbow snake
Spotted turtle
Striped mud turtle

Gray cypress looper *(Cutina albopunctella)*
Great ash sphinx *(Sphinx chersis)*
Great purple hairstreak
Grote's sallow moth
Inkblot palpita moth *(Palpita illibalis)*
King's hairstreak
Mulberry wing
Palamedes swallowtail
Purple plagodis moth *(Plagodis kuetzingi)*
Splendid palpita moth *(Palpita magniferalis)*

Gritty hedge-nettle *(Stachys aspera)*
Hyssopleaf hedge-nettle *(Stachys hyssopifolia)*
Lowland loosestrife *(Steironema hybridum)*
Climbing dogbane *(Thyrsanthella difformis)*
Salad violet *(Viola esculenta)*
Atamasco lily *(Zephyranthes atamasca)*

Groundwater Wetlands

Montane Acidic Fen

Region(s): *Western*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Peter Stango, MD DNR

The Montane Acidic Fen (Montane Bog and Fen in the 2015 State Wildlife Action Plan revision) Key Wildlife Habitat is represented by open acidic seepage wetlands supporting a patchwork of saturated shrub and herbaceous vegetation. These acidic peatlands are more commonly found in boreal and subboreal regions of central and eastern Canada and the northeast and north-central United States. However, in the central Appalachian Mountains, these habitats exist as small, isolated occurrences at high elevations, where climates are cold enough to allow the rate of peat accumulation to exceed its decomposition, which is a diagnostic characteristic of this habitat. While the term “bog” is often used for these habitats, it is a technical misnomer, and in strict usage applies only to peatlands that are rainwater-fed (i.e., ombrotrophic). In Maryland, fens are groundwater-fed (i.e., minerotrophic) peatlands that remain saturated for all or nearly all of the growing season and may have standing water seasonally. They are best developed on seepage slopes, along headwater streams, oxbows of streams, margins of beaver ponds, established millponds, and sandpits. Soils vary from mineral to deep peat, are extremely acidic, nutrient poor, and often support a variety of *Sphagnum* mosses. Beaver herbivory and flooding related to dam building exert additional spatiotemporal effects on vegetative regimes within wetland complexes.

Fens on the Appalachian Plateau are uncommon habitats that often occur in openings on seepage slopes and along streams, creating a mosaic of different vegetation cover types depending on hydrology and position within the fen. The margins of fens, which are perched slightly higher than the central depressional features, are slightly drier with forest and woodland cover composed of red spruce *(Picea rubens)*, eastern hemlock *(Tsuga canadensis)*, white pine *(Pinus strobus)*, American larch *(Larix laricina*), red maple *(Acer rubrum)*, and black gum *(Nyssa sylvatica)*, which grade inwards forming openings of shrub-herbaceous vegetation within the lower, more inundated depressional features. The openings contain a diverse flora often including Virginia cotton-grass *(Eriophorum virginicum)*, rose pogonia *(Pogonia ophioglossoides)*, round-leaf sundew *(Drosera rotundifolia* var. *rotundifolia)*, cranberry *(Vaccinium* spp.), and a variety of ferns, rushes, and sedges. Dense mats of *Sphagnum* and haircap mosses are also characteristic of many Montane Fens. The abundance of shrubs is variable throughout sites and can range from scattered to dense impenetrable thickets. Common species include speckled alder *(Alnus incana* ssp. *rugosa)*, narrow-leafed meadowsweet *(Spiraea alba)*, mountain holly *(Ilex montana)*, and black chokeberry *(Aronia melanocarpa*), although wetlands that have experienced disturbance may be dominated by brookside alder (*Alnus serrulata*) or silky dogwood (*Cornus amomum*).

County Distribution: Allegany, Garrett

Places to Visit: Mt. Nebo Wildlife Management Area, Cranesville Swamp (The Nature Conservancy), Finzel Swamp (The Nature Conservancy)

State Rare Natural Community: Montane Peatland

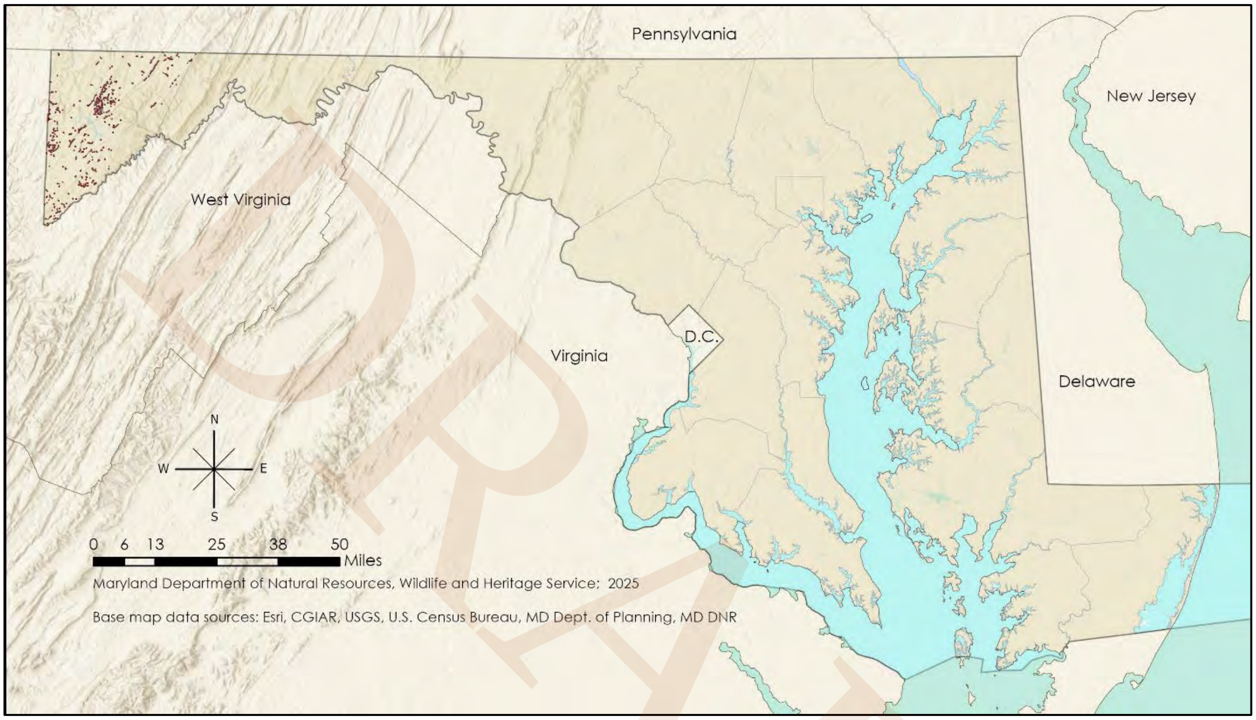


Figure 4.21 Location of Montane Acidic Fens in Maryland. Sources: MD DNR, USFWS.

Species of Greatest Conservation Need Associated with Montane Acidic Fens:

Birds

Acadian flycatcher
Alder flycatcher
American bittern
American black duck
American redstart
American woodcock
Baltimore oriole
Black-and-white warbler
Black-throated blue warbler
Black-throated green warbler
Blackburnian warbler
Blue-winged warbler
Brown creeper
Canada warbler
Dark-eyed junco
Golden-crowned kinglet

Reptiles

Copperhead
Eastern box turtle
Mountain earthsnake
Northern coal skink
Smooth greensnake
Spotted turtle
Timber rattlesnake

Invertebrates (Mites)

Ash flower gall mite *(Aceria fraxiniflora)*
Ash key gall mite *(Aceria fraxinivora)*
Ash leaf gall mite *(Aceria fraxini)*

Invertebrates (Snails)

Spruce knob threetooth

Insects (Hymenoptera)

A carpenter ant *(Colobopsis mississippiensis)*
Blackheaded ash sawfly *(Tethida barda)*

Insects (Coleoptera)

An ash seed weevil *(Lignyodes bischoffi)*
An ash seed weevil *(Lignyodes fraxini)*
An ash seed weevil *(Lignyodes helvolus)*
An ash seed weevil *(Lignyodes horridulus)*
Charlie Brown's flea beetle *(Capraita sexmaculata)*

Golden-winged warbler
Hooded warbler
Kentucky warbler
Lesser yellowlegs
Louisiana waterthrush
Magnolia warbler
Northern harrier
Northern parula
Northern saw-whet owl
Northern waterthrush
Olive-sided flycatcher
Ovenbird
Pine siskin
Red-breasted nuthatch
Ruffed grouse
Rusty blackbird
Scarlet tanager
Sora
Spotted sandpiper
Swainson's thrush
Swamp sparrow
Veery
Willow flycatcher
Winter wren
Wood thrush
Worm-eating warbler
Yellow warbler

Amphibians

Mountain chorus frog
Upland chorus frog

Mammals

American mink
Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Smoky shrew
Southern bog lemming
Southern pygmy shrew
Southern water shrew
Tricolored bat

Striped whitelip

Insects (Diptera)

Ash bullet gall midge *(Dasineura pellex)*
Swollen ash gall midge *(Dasineura tumidosae)*

Insects (Lepidoptera)

Angel moth
Ash borer moth *(Podosesia syringae)*
Ash leaf cone roller moth *(Caloptilia fraxinella)*
Ash sphinx *(Manduca jasminearum)*
Ash tip borer moth *(Papaipema furcata)*
Atlantis fritillary
Baltimore checkerspot
Banded ash clearwing moth *(Podosesia aureocincta)*
Black dash
Bog copper
Franck's sphinx
Great ash sphinx *(Sphinx chersis)*
Grote's sallow moth
Harris's checkerspot
Hoary elfin
Inkblot palpita moth *(Palpita illibalis)*
Long dash
Purple plagodis moth *(Plagodis kuetzingi)*
Silver-bordered fritillary
Splendid palpita moth *(Palpita magniferalis)*
Tuscarora emerald
Two-spotted skipper
West Virginia white

Insects (Odonata)

American emerald
Beaverpond baskettail
Black-tipped darner
Canada darner
Crimson-ringed whiteface
Frosted whiteface
Green-striped darner
Hudsonian whiteface
Northern bluet
Rainbow bluet
Ski-tailed emerald
Spatterdock darner

Eastern ash bark beetle *(Hylesinus aculeatus)*
Encircled borer *(Agrilus subcinctus)*

Plants

Balsam fir *(Abies balsamea)*
Wild calla *(Calla palustris)*
Buxbaum's sedge *(Carex buxbaumii)*
Lesser panicled sedge *(Carex diandra)*
Lake-bank sedge *(Carex lacustris)*
Slender sedge *(Carex lasiocarpa)*
Necklace sedge *(Carex projecta)*
Tuckerman's sedge *(Carex tuckermanii)*
Inflated sedge *(Carex vesicaria)*
Slender cottongrass *(Eriophorum gracile)*
Creeping snowberry *(Gaultheria hispidula)*
Yellow avens *(Geum aleppicum)*
American mannagrass *(Glyceria grandis)*
Jointed rush *(Juncus articulatus)*
Narrow-panicle rush *(Juncus tweedyi)*
American larch *(Larix laricina)*
Bog buckbean *(Menyanthes trifoliata)*
Grove sandwort *(Moehringia lateriflora)*
Bog Jacob's ladder *(Polemonium vanbruntiae)*
Alderleaf buckthorn *(Rhamnus alnifolia)*
Torrey's bulrush *(Schoenoplectus torreyi)*
Fernald's mannagrass *(Torreyochloa pallida* var. *fernaldii)*
Horned bladderwort *(Utricularia cornuta)*
Small cranberry *(Vaccinium oxycoccos)*
Nannyberry *(Viburnum lentago)*

Montane-Piedmont Seepage Swamp

Region(s): *Central, Western*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Richard Orr

Jason Harrison, MD DNR

The revised Montane-Piedmont Seepage Swamp Key Wildlife Habitat (KWH) combines the Montane-Piedmont Acidic Seepage Swamp and Montane-Piedmont Basic Seepage Swamp KWHs from the 2015 State Wildlife Action Plan revision. This KWH occurs in the Piedmont and mountain regions on gently sloping small stream headwaters, large spring seeps, ravine bottoms, toeslopes, and lateral areas in ravines and stream bottoms where groundwater emerges at the base of slopes. Seepage swamps develop where groundwater is forced to the surface along an impermeable clay or rock layer due to hydrostatic pressure resulting from gravity or artesian flow, which frequently results in a diffuse drainage pattern of braided channels and rivulets that typically remain saturated throughout the year due to perennial groundwater seepage. The substrates are often composed of bouldery, cobbly, and gravelly alluvium, and soils vary based on the geologic formations from which they are derived. Throughout their range, substrates most frequently develop from the weathering of nutrient-poor, acidic sandstone and quartzite and less frequently on base-rich granite, calcareous shale, and limestone in the Catoctin Mountains within the Blue Ridge ecoregion and Allegheny Plateau.

Montane-Piedmont Seepage Swamps are structurally defined as closed canopy forests to woodlands with small openings of dense shrubs and herbs typical in areas of windfall or beaver activity. Floristic composition is variable depending on site conditions and soil chemistry. Canopy trees commonly include red maple *(Acer rubrum)*, tulip poplar *(Liriodendron tulipifera)*, black gum *(Nyssa sylvatica)*, yellow birch *(Betula alleghaniensis)*, red spruce *(Picea rubens)*, and eastern hemlock *(Tsuga canadensis)* at higher elevations, with black and white ash (*Fraxinus nigra*, *F. americana*) occurring on sites with more alkaline substrates. The understory is variable and ranges from patches of open to dense shrub thickets to lush herbaceous cover of graminoids, ferns and forbs. Shrubs vary depending on the region and elevation, but common species may include winterberry *(Ilex verticillata)*, swamp azalea *(Rhododendron viscosum)*, highbush blueberry *(Vaccinium* *corymbosum)*, great-laurel *(Rhododendron maximum)*, mountain laurel *(Kalmia latifolia)*, speckled alder *(Alnus incana* spp. *rugosa)*, common elderberry (*Sambucus nigra* ssp. *canadensis*), spicebush (*Lindera benzoin*), and southern arrow-wood *(Viburnum dentatum)*. Ground conditions and herbaceous vegetation cover and structure are often influenced by hummock and hollow microtopography, where hummocks often support woody species and the depressional hollows support herbaceous vegetation.

Between acidic and alkaline sites, there can also be considerable differences in species richness and composition. Common dominant species include skunk cabbage *(Symplocarpus foetidus)*, American false-hellebore *(Veratrum viride)*, cinnamon fern *(Osmunda cinnamomea)*, royal fern (*Osmunda spectabilis*), and bristly-stalked sedge (*Carex leptalea*), any or all of which may produce dense herbaceous cover on both acidic and alkaline sites. However, species richness can be considerably higher on alkaline sites and may also include more nutrient-demanding species such as marsh-marigold (*Caltha palustris*), brome-sedge (*Carex bromoides*), smooth-sheathed sedge (*Carex laevivaginata*), springs clearweed (*Pilea fontana*), bog bluegrass (*Poa paludigena*), bristly buttercup (*Ranunculus hispidus* var. *caricetorum*), swamp saxifrage (*Saxifraga pensylvanica*), and nodding trillium (*Trillium cernuum*) among others. These communities also lack the more abundant *Sphagnum* mosses that characterize acidic groundwater wetlands.

County Distribution: Allegany, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Washington

Places to Visit: Catoctin Mountain Park, Gunpowder Falls State Park, Patapsco Valley State Park, Cranesville Swamp (The Nature Conservancy), Finzel Swamp (The Nature Conservancy), Mt. Nebo Wildlife Management Area, Savage River State Forest, Sugarloaf Mountain

State Rare Natural Communities: Montane-Piedmont Basic Seepage Swamp, High Elevation Seepage Swamp, Montane-Piedmont Acidic Seepage Swamp

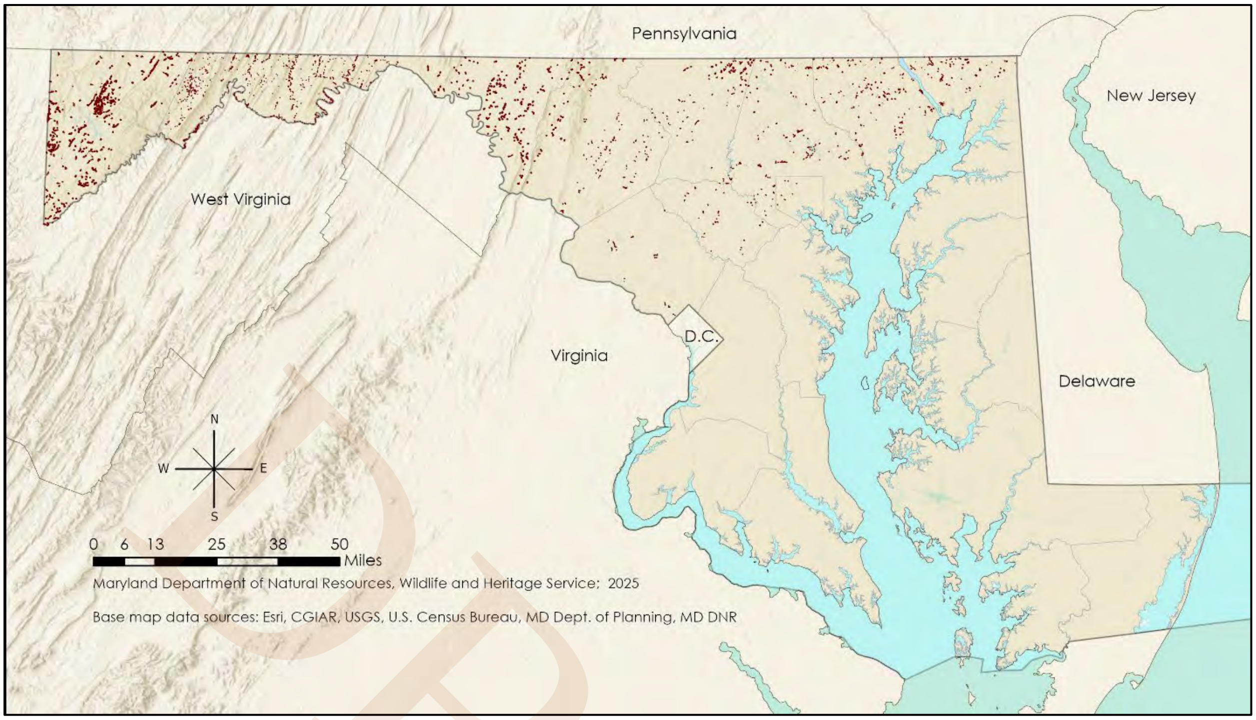


Figure 4.22 Location of Montane-Piedmont Seepage Swamps in Maryland. Sources: MD DNR, NETWHCS, Terrestrial Ecological System for the U.S., USFWS.

Species of Greatest Conservation Need Associated with Montane-Piedmont Seepage Swamps:

Birds

Acadian flycatcher
American redstart
American woodcock
Baltimore oriole
Black-and-white warbler
Black-billed cuckoo
Black-throated blue warbler
Black-throated green warbler
Blackburnian warbler
Blue-winged warbler
Canada warbler
Dark-eyed junco
Golden-winged warbler
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Magnolia warbler
Northern parula
Northern waterthrush
Ovenbird
Prothonotary warbler
Ruffed grouse

Invertebrates (Mites)

Ash flower gall mite *(Aceria fraxiniflora)*
Ash key gall mite *(Aceria fraxinivora)*
Ash leaf gall mite *(Aceria fraxini)*

Insects (Diptera)

Ash bullet gall midge *(Dasineura pellex)*
Swollen ash gall midge *(Dasineura tumidosae)*

Insects (Hymenoptera)

A carpenter ant *(Colobopsis mississippiensis)*
Azalea mining bee *(Andrena cornelli)*
Blackheaded ash sawfly *(Tethida barda)*

Insects (Coleoptera)

An ash seed weevil *(Lignyodes bischoffi)*
An ash seed weevil *(Lignyodes fraxini)*
An ash seed weevil *(Lignyodes helvolus)*
An ash seed weevil *(Lignyodes horridulus)*
Charlie Brown's flea beetle *(Capraita sexmaculata)*
Eastern ash bark beetle *(Hylesinus aculeatus)*
Encircled borer *(Agrilus subcinctus)*

Plants

Cloud sedge *(Carex haydenii)*
Scarlet Indian-paintbrush *(Castilleja coccinea)*
Early coralroot *(Corallorhiza trifida)*
Downy willowherb *(Epilobium densum)*

Scarlet tanager
Veery
Willow flycatcher
Winter wren
Wood thrush
Yellow warbler

Mammals
American mink
Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Southern bog lemming
Southern rock vole
Tricolored bat

Amphibians
Mountain chorus frog
Red salamander
Spring salamander
Upland chorus frog

Reptiles
Eastern box turtle
Eastern ribbonsnake
Queensnake
Smooth greensnake
Spotted turtle

Insects (Lepidoptera)
Angel moth
Ash borer moth *(Podosesia syringae)*
Ash leaf cone roller moth *(Caloptilia fraxinella)*
Ash sphinx *(Manduca jasminearum)*
Ash tip borer moth *(Papaipema furcata)*
Baltimore checkerspot
Banded ash clearwing moth *(Podosesia aureocincta)*
Black dash
Great ash sphinx *(Sphinx chersis)*
Grote's sallow moth
Indian skipper
Inkblot palpita moth *(Palpita illibalis)*
Long dash
Purple plagodis moth *(Plagodis kuetzingi)*
Splendid palpita moth *(Palpita magniferalis)*
Tuscarora emerald

Insects (Odonata)
Seepage dancer

Linear-leaf willowherb *(Epilobium leptophyllum)*
Woodland horsetail *(Equisetum sylvaticum)*
Glade spurge *(Euphorbia purpurea)*
Queen-of-the-prairie *(Filipendula rubra)*
Fringe-top bottle gentian *(Gentiana andrewsii)*
Loesel's twayblade *(Liparis loeselii)*
Yellow fringed orchid *(Platanthera ciliaris)*
Pale green orchid *(Platanthera flava)*
Large purple fringed orchid *(Platanthera grandiflora)*
Purple fringeless orchid *(Platanthera peramoena)*
Small purple fringed orchid *(Platanthera psycodes)*
Shriver's frilly orchid *(Platanthera shriveri)*
Eastern featherbells *(Stenanthium gramineum)*

Piedmont Seepage Wetland

Region(s): *Central*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Bonnie Ott

The Piedmont Seepage Wetland Key Wildlife Habitat encompasses open, graminoid-dominated meadows and shrub swamps scattered throughout low stream valleys of the Piedmont. They are common features at the toeslopes of rolling hills and margins of floodplains where groundwater seepage can be found throughout much of the year. The water table is usually at or near the surface throughout much of the growing season, causing most habitats to remain saturated, but conditions may vary yearly from site to site. The substrates of Piedmont Seepage Wetlands are primarily comprised of mineral soils with mucky, organic layers at the surface.

The vegetation structure varies from graminoid-dominated meadows of tussock sedge *(Carex stricta)*, common rush *(Juncus effusus)*, stoud wood reedgrass *(Cinna arundinacea)*, and rice cutgrass *(Leersia oryzoides)* to a patchwork of shrub swamps dominated by alder *(Alnus* spp.*)*, meadowsweet *(Spiraea* spp.*)*, southern arrow-wood *(Viburnum dentatum)*, buttonbush *(Cephalanthus occidentalis)*, spicebush *(Lindera benzoin)*, swamp rose *(Rosa palustris)*, and black willow *(Salix nigra)*. Other common species include jewelweeds *(Impatiens* spp.*)*, skunk cabbage *(Symplocarpus foetidus)*, sensitive fern *(Onoclea sensibilis)*, wood reedgrass, woolgrass *(Scirpus cyperinus)*, Joe pye-weed *(Eutrochium dubium)*, American golden saxifrage *(Chrysosplenium americanum)*, sallow sedge *(Carex lurida*), knotweeds *(Polygonum* spp.*)*, and marsh fern *(Thelypteris palustris* var. *pubescens)*. In addition, purple loosestrife *(Lythrum salicaria)*, common reed *(Phragmites australis* spp. *australis)*, Japanese stiltgrass *(Microstegium vimineum)*, and reed canarygrass *(Phalaris arundinacea)* are frequently reported non-native invasive plants in these habitats. Though trees are relatively unimportant in these habitats, woody plant succession of red maple *(Acer rubrum)* is a common problem that usually indicates a cessation of grazing or other forms of natural disturbance.

County Distribution: Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery

Places to Visit: Rocks State Park, Eden Mill Nature Center, Gunpowder Falls State Park, Little Bennett Regional Park

State Rare Natural Community: Montane-Piedmont Wet Meadow/Fen

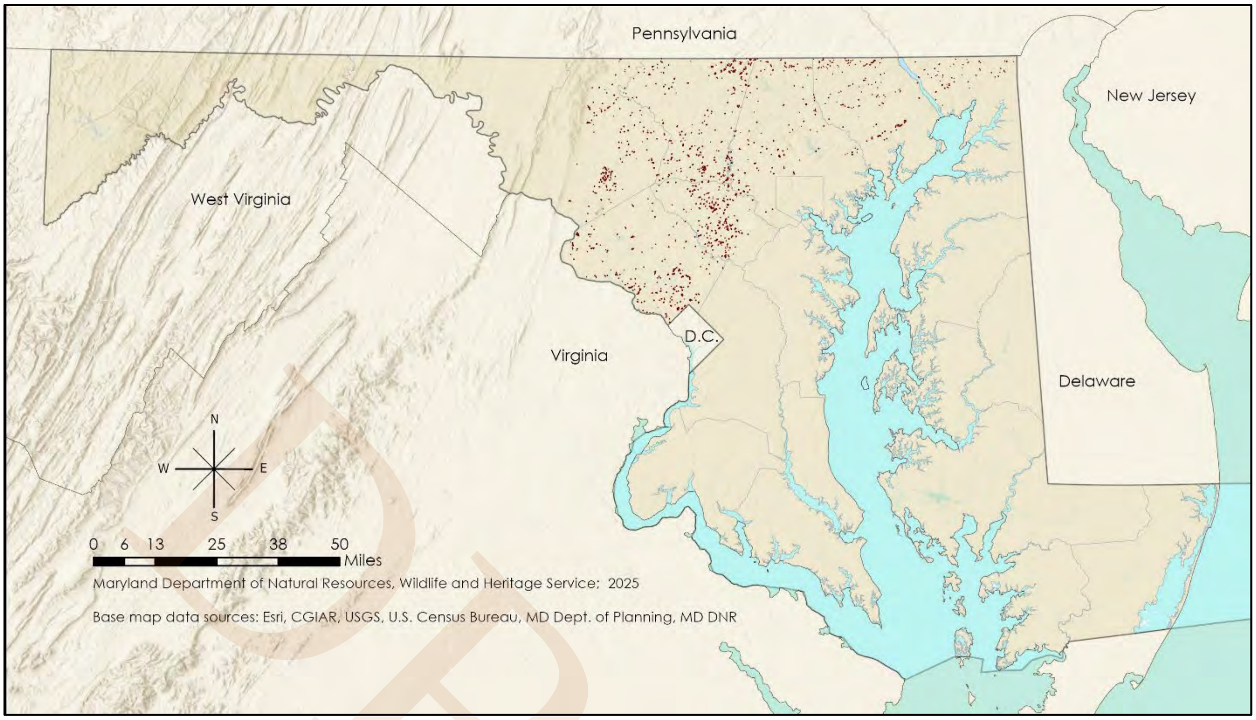


Figure 4.23 Location of Piedmont Seepage Wetlands in Maryland. Sources: MD DNR, NETWHCS.

Species of Greatest Conservation Need Associated with Piedmont Seepage Wetlands:

Birds

Acadian flycatcher
American redstart
American woodcock
Baltimore oriole
Blue-winged warbler
Swamp sparrow
Willow flycatcher
Yellow warbler

Mammals

American mink
Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Insects (Diptera)

Ash bullet gall midge *(Dasineura pellex)*
Swollen ash gall midge *(Dasineura tumidosae)*

Insects (Hymenoptera)

A carpenter ant *(Colobopsis mississippiensis)*
Blackheaded ash sawfly *(Tethida barda)*
Fringed loosestrife oil-collecting bee *(Macropis ciliata)*

Insects (Lepidoptera)

Angel moth
Ash borer moth *(Podosesia syringae)*
Ash leaf cone roller moth *(Caloptilia fraxinella)*
Ash sphinx *(Manduca jasminearum)*
Ash tip borer moth *(Papaipema furcata)*
Baltimore checkerspot

Insects (Coleoptera)

An ash seed weevil *(Lignyodes bischoffi)*
An ash seed weevil *(Lignyodes fraxini)*
An ash seed weevil *(Lignyodes helvolus)*
An ash seed weevil *(Lignyodes horridulus)*
Charlie Brown's flea beetle *(Capraita sexmaculata)*
Eastern ash bark beetle *(Hylesinus aculeatus)*
Encircled borer *(Agrilus subcinctus)*

Plants

Low rough aster *(Eurybia radula)*
Fringed gentian *(Gentianopsis crinita)*
Swamp pink *(Helonias bullata)*
Whorled mountainmint *(Pycnanthemum verticillatum)*
Long-stalked crowfoot *(Ranunculus hederaceus)*
Canada burnet

Amphibians

Longtail salamander
Red salamander
Upland chorus frog

Reptiles

Bog turtle
Eastern box turtle
Eastern ribbonsnake
Queensnake
Spotted turtle

Invertebrates (Mites)

Ash flower gall mite *(Aceria fraxiniflora)*
Ash key gall mite *(Aceria fraxinivora)*
Ash leaf gall mite *(Aceria fraxini)*

Banded ash clearwing moth *(Podosesia aureocincta)*
Black dash
Bronze copper
Great ash sphinx *(Sphinx chersis)*
Grote's sallow moth
Inkblot palpita moth *(Palpita illibalis)*
Long dash
Purple plagodis moth *(Plagodis kuetzingi)*
Splendid palpita moth *(Palpita magniferalis)*

Insects (Odonata)

Seepage dancer

(Sanguisorba canadensis)
Shining ladies'-tresses *(Spiranthes lucida)*
Epling's hedge-nettle *(Stachys eplingii)*
Trailing stitchwort *(Stellaria alsine)*
Pinebarrens death-camas *(Stenanthium leimanthoides)*
Marsh speedwell *(Veronica scutellata)*

Piedmont Upland Depression Swamp

Region(s): *Central*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Jason Harrison, MD DNR

The Piedmont Upland Depression Swamp Key Wildlife Habitat includes seasonally flooded, non-floodplain forested wetlands that form in shallow basins and other depressions, often underlain by shallow bedrock or clay hardpans that impede soil drainage, that result in small patch wetlands formed by perched groundwater. This results in standing water throughout the early part of the growing season, followed by a period of drawdown. The hydroperiods are variable between these swamps and largely depend on rainfall and drought cycles.

The forested canopy structure ranges from open to closed and is primarily oak-dominated, with other hardwoods less frequent. Common tree species include willow oak *(Quercus phellos)*, pin oak *(Quercus palustris)*, swamp chestnut oak *(Quercus michauxii)*, swamp white oak *(Quercus bicolor)*, green ash *(Fraxinus pennsylvanica)*, red maple *(Acer rubrum)*, sweetgum (*Liquidambar styraciflua*), and black gum *(Nyssa sylvatica)*. Shrubs and vines are variable in the understory between sites, but common species often include sweet pepperbush (*Clethra alnifolia*), spicebush (*Lindera benzoin*), common winterberry (*Ilex verticillata*), highbush blueberry (*Vaccinium corymbosum*), and frequently an abundance of common greenbrier (*Smilax rotundifolia*). The herbaceous layer varies from open to sparse and may include species of ferns, sedges, manna-grasses, and rushes. Slightly elevated hummocks of *Sphagnum* mosses frequently form large patches. Piedmont Upland Depression Swamps are isolated wetlands that occur as fine-scale inclusions within upland forests. They are considered rare both globally and within Maryland and are subject to major disturbances including logging, draining, and development.

County Distribution: Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery

Places to Visit: C&O Canal National Historical Park, Hoyles Mill Conservation Park

State Rare Natural Community: Upland Depression Swamp

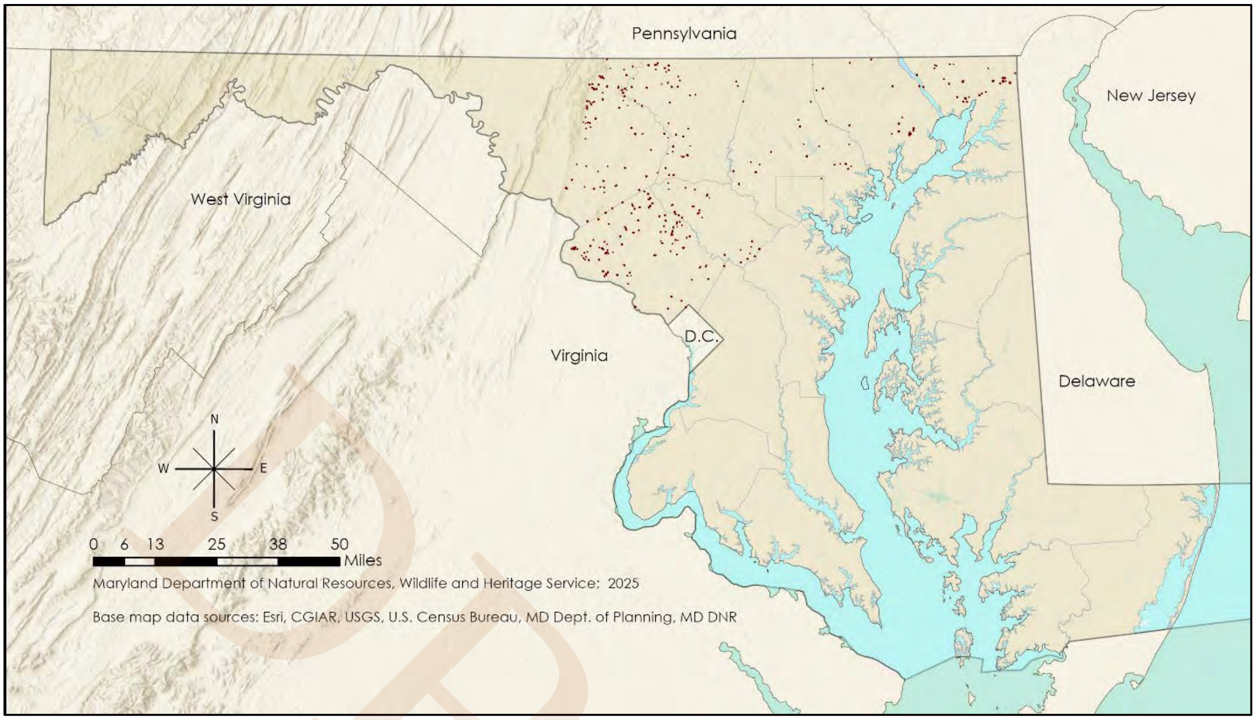


Figure 4.24 Location of Piedmont Upland Depression Swamps in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Piedmont Upland Depression Swamps:

Birds

Acadian flycatcher
American redstart
American woodcock
Baltimore oriole
Black-and-white warbler
Black-billed cuckoo
Blue-winged warbler
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Northern parula
Ovenbird
Prothonotary warbler
Red-cockaded woodpecker
Scarlet tanager

Birds (continued)

Veery
Willow flycatcher
Wood thrush
Worm-eating warbler
Yellow warbler
Yellow-breasted chat
Yellow-throated vireo

Amphibians

Eastern spadefoot
Upland chorus frog

Reptiles

Eastern ribbonsnake
Queensnake
Spotted turtle

Mammals

American mink
Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Coastal Plain Flatwood and Depression Swamp

Region(s): *Central, Eastern, Southern*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Scott Smith, MD DNR

The Coastal Plain Flatwood and Depression Swamp Key Wildlife Habitat (KWH) includes non-alluvial, seasonally flooded flatwoods and depressions of the Coastal Plain. These habitats develop on flat terraces and shallow depressions with seasonally perched water tables. This results in standing water throughout the early part of the growing season, followed by a period of drawdown. Hydroperiods are variable between swamps and largely dependent on rainfall and drought cycles.

The forest canopy structure of flatwoods and depression swamps ranges from open to closed, with compositions ranging from hardwood-dominated to mixtures of hardwoods and conifers. Swamps dominated by oak species such as willow oak *(Quercus phellos)*, pin oak *(Quercus palustris)*, swamp chestnut oak *(Quercus michauxii)*, and cherrybark oak *(Quercus pagoda)* were historically the prevalent and representative ecological communities within these sites pre-European settlement. These are generally considered as higher quality habitat in contrast to much of today's remaining stands dominated by successional hardwoods such as red maple *(Acer rubrum)*, sweetgum *(Liquidambar styraciflua)*, black gum *(Nyssa sylvatica)*, and American holly *(Ilex opaca* var. *opaca)*, with loblolly pine *(Pinus taeda)* as a prominent component of many flatwoods on the lower Coastal Plain. Other species commonly encountered in these habitats include green ash *(Fraxinus pennsylvanica)*, overcup oak *(Quercus lyrata)*, and swamp tupelo *(Nyssa biflora)*. State rare natural communities within this KWH include depressions with mixtures of Atlantic white cedar *(Chamaecyparis thyoides)*, swamp tupelo, pond pine *(Pinus serotina)*, and sweetbay magnolia *(Magnolia virginiana)*. In the understory, shrubs and vines are common but variable, often including an abundance of common greenbrier *(Smilax rotundifolia)*. The herbaceous layer is often sparse and may include species of sedges, manna-grasses, and rushes. Slightly elevated hummocks of *Sphagnum* mosses frequently form large patches. Coastal Plain Flatwoods and Depression Swamps have been greatly reduced in Maryland through ditching, draining, logging, and conversion to agriculture and pine plantations.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Blackwater National Wildlife Refuge, LeCompte Wildlife Management Area, Third Haven Woods (The Nature Conservancy)

State Rare Natural Communities: Coastal Plain Non-Riverine Hardwood Swamps, Atlantic White Cedar Swamp, Upland Depression Swamp

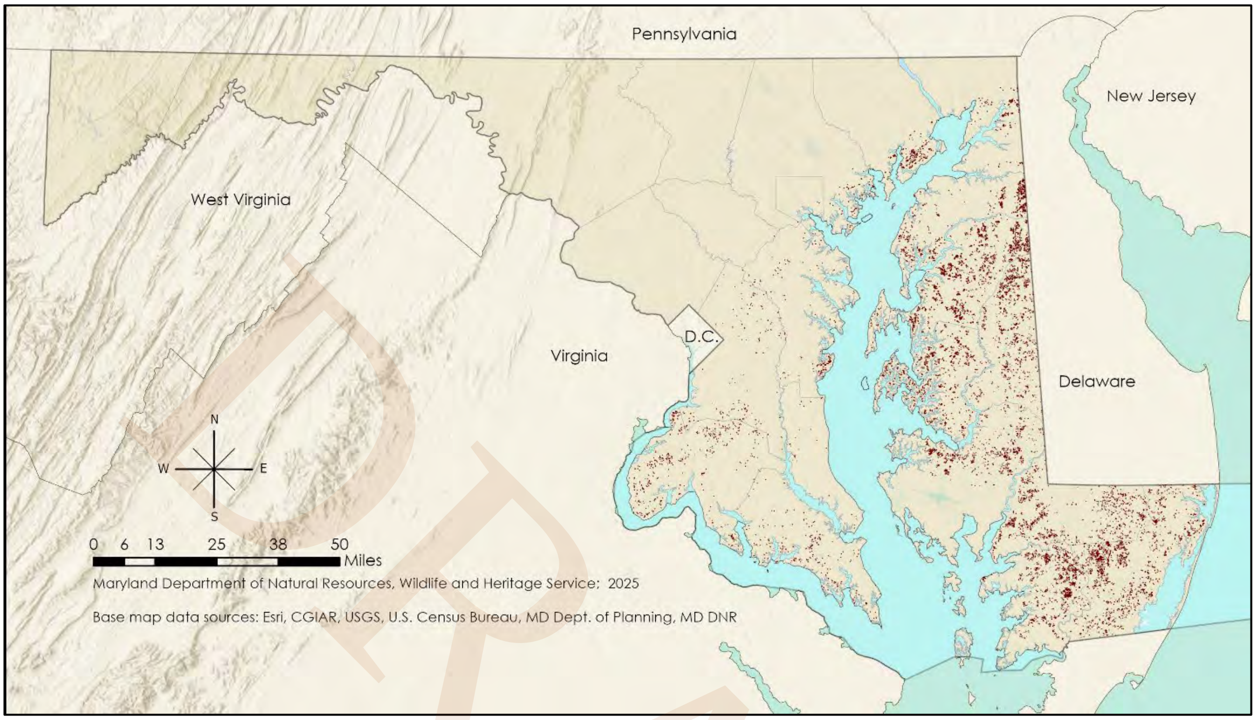


Figure 4.25 Location of Coastal Plain Flatwoods and Depression Swamps in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Coastal Plain Flatwoods and Depression Swamps:

Birds

Acadian flycatcher
American redstart
American woodcock
Baltimore oriole
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Broad-winged hawk
Chuck-will's-widow
Eastern whip-poor-will
Great blue heron
Great egret
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Northern bobwhite
Northern parula
Ovenbird
Prothonotary warbler

Mammals

American mink
Bobcat
Delmarva fox squirrel
Eastern red bat
Hoary bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Amphibians

Barking treefrog
Carpenter frog
Eastern narrow-mouthed toad
Eastern spadefoot
Eastern tiger salamander

Reptiles

Insects (Coleoptera)

Mysterious lantern firefly

Insects (Diptera)

Painted wood fly *(Blera pictipes)*

Insects (Lepidoptera)

An owlet moth *(Meropleon titan)*

Plants

Eastern straw sedge *(Carex straminea)*
Three-angle spikerush *(Eleocharis tricostata)*
Short's hedge-hyssop *(Gratiola viscidula)*
Catchfly cutgrass *(Leersia lenticularis)*
Star duckweed *(Lemna trisulca)*
Climbing fern *(Lygodium palmatum)*

Scarlet tanager
Wood thrush
Worm-eating warbler
Yellow warbler
Yellow-breasted chat
Yellow-throated vireo

Eastern box turtle
Eastern kingsnake
Eastern milksnake
Eastern mud turtle
Eastern ribbonsnake
Northern mole kingsnake
Plain-bellied watersnake
Queensnake
Rainbow snake
Scarletsnake
Striped mud turtle

Little floatingheart *(Nymphoides cordata)*
Small-headed beakrush *(Rhynchospora microcephala)*
Cymose beakrush *(Rhynchospora recognita)*
Torrey's beakrush *(Rhynchospora torreyana)*

Coastal Plain Seepage Swamp

Region(s): *Central, Eastern, Southern*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Richard Wiegand, MD DNR

Coastal Plain Seepage Swamp Key Wildlife Habitat is characterized by gently sloping forests of small stream headwaters, ravine bottoms, and toeslopes where groundwater seepage is discharged at ground surface and carried away as stream flow. Groundwater seepage is typically perennial and characterized by diffuse drainage and braided channels with sand, gravel, or peaty substrates. Typically, soils in most swamps are moderately to strongly acidic and nutrient-poor, with the exception of basic seepage swamps, which may develop in ravines that have downcut into Tertiary-aged shell marl deposits.

Coastal Plain Seepage Swamps are associated with mostly-closed to semi-open canopies of red maple *(Acer rubrum)*, black gum *(Nyssa sylvatica)*, tulip poplar *(Liriodendron tulipifera)*, sweetbay magnolia *(Magnolia virginiana)*, green ash *(Fraxinus pennsylvanica)*, white ash *(Fraxinus americana)*, and pitch pine *(Pinus rigida)*. Shrub and herbaceous layers are characteristically dense and can be quite diverse, composed of a variety of deciduous shrubs, ferns and herbs. The shrub layer may include winterberry *(Ilex verticillata)*, sweet pepperbush *(Clethra alnifolia)*, swamp azalea *(Rhododendron viscosum)*, spicebush *(Lindera benzoin)*, possum-haw viburnum *(Viburnum nudum)*, highbush blueberry *(Vaccinium corymbosum)*, and vines of poison ivy *(Toxicodendron radicans)*, greenbrier *(Smilax* spp.*)*, and Virginia creeper *(Parthenocissus quinquefolia)*. The herbaceous layer is often characterized by dense patches of skunk cabbage *(Symplocarpus foetidus)* and colonies of ferns such as cinnamon fern *(Osmunda cinnamomea)*, marsh fern *(Thelypteris palustris* var. *pubescens)*, royal fern *(Osmunda spectabilis)*, New York fern *(Amauropelta noveboracensis)*, and netted chain fern *(Woodwardia areolata)*. Common herbs include jewelweeds *(Impatiens* spp.*)*, small green wood orchid *(Platanthera clavellata)*, Virginia bugleweed *(Lycopus virginicus)*, Jack-in-the-pulpit *(Arisaema triphyllum)*, false nettle *(Boehmeria cylindrica)*, and numerous sedges. Non-vascular species are often important components of these communities, where hummocks of peat mosses can be quite abundant and diagnostic to Coastal Plain Seepage Swamps of acidic substrates. Coastal Plain Seepage Swamps are naturally small-patched habitats vulnerable to hydrological disturbances, beaver activity, logging, and surface runoff.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George’s, Queen Anne’s, Somerset, St. Mary’s, Talbot, Wicomico, Worcester

Places to Visit: Elk Neck State Forest, Tuckahoe State Park, Pocomoke State Forest

State Rare Natural Community: Coastal Plain-Piedmont Acidic Seepage Swamp

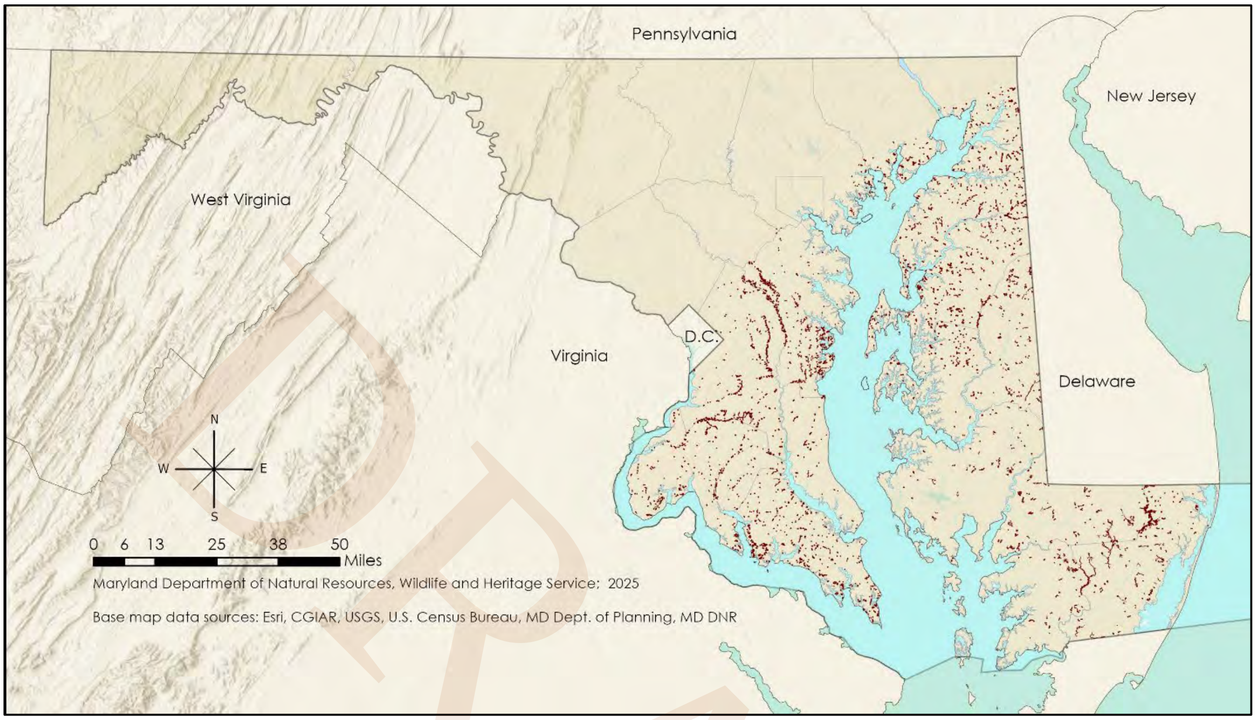


Figure 4.26 Location of Coastal Plain Seepage Swamps in Maryland. Sources: MD DNR, USFWS.

Species of Greatest Conservation Need Associated with Coastal Plain Seepage Swamps:

Birds
Acadian flycatcher
American redstart
American woodcock
Baltimore oriole
Black-and-white warbler
Black-billed cuckoo
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Northern parula
Ovenbird
Prothonotary warbler
Scarlet tanager
Wood thrush
Yellow warbler

Amphibians
Carpenter frog
Mud salamander
Red salamander

Mammals
American mink
Bobcat
Eastern red bat
Hoary bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Insects (Coleoptera)
Mysterious lantern firefly

Insects (Lepidoptera)
An owlet moth *(Meropleon titan)*
Bronze copper
Mulberry wing

Insects (Odonata)
Elfin skimmer
Fine-lined emerald

Insects (Hymenoptera)
Azalea mining bee *(Andrena cornelli)*
Fringed loosestrife oil-collecting bee *(Macropis ciliata)*

Plants
Red turtlehead *(Chelone obliqua)*
Bulb-bearing water-hemlock *(Cicuta bulbifera)*
Bog fern *(Coryphopteris simulata)*
Clinton's woodfern *(Dryopteris clintoniana)*
Dwarf huckleberry *(Gaylussacia dumosa)*
New Jersey rush *(Juncus caesariensis)*
Sessile-leaf bugleweed *(Lycopus amplectens)*
Water loosestrife *(Lysimachia thyrsiflora)*
Evergreen bayberry *(Morella caroliniensis)*

Reptiles

Eastern box turtle
Eastern kingsnake
Eastern mud turtle
Eastern ribbonsnake
Queensnake
Rainbow snake
Spotted turtle
Striped mud turtle

Little blue dragonlet
Seepage dancer
Treetop emerald

Carolina clubmoss *(Pseudolycopodiella caroliniana)*
Long-stalk greenbrier *(Smilax pseudochina)*
Red bay *(Tamala palustris)*

Coastal Plain Seepage Acidic Fen

Region(s): *Central, Eastern, Southern*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Wesley Knapp, MD DNR

The Coastal Plain Seepage Acidic Fen (Coastal Plain Seepage Bog and Fen in the 2015 State Wildlife Action Plan revision) Key Wildlife Habitat occurs as rare, small patches of shrub and herbaceous vegetation typically associated with seepage toeslopes, swales, small stream bottoms and headwaters, and the margins of long-established millponds and sandpits of the upper and lower coastal plain of Maryland. They typically develop at the base of sand and gravel terraces near streams where groundwater seepage is abundant and forced to the surface by an impermeable clay lens or aquiclude. The soils and substrates are usually peaty or sandy, very acidic, infertile, sometimes with large cobbles abundantly exposed at the surface, and often covered by dense mats of mosses (*Sphagnum* spp.) that support a unique flora. The term "bog," widely used in the southeastern United States as a descriptor for open, acidic seepage wetlands, is often applied to these wetlands, but is a technical misnomer, since not all of these habitats are true peatlands and none is an ombrotrophic system (i.e., fed by rainwater).

These fens exist in a variety of open settings, and many are relics of older, larger systems. Many natural examples have been destroyed by hydrologic alterations (e.g., ditching, draining, and impoundment construction), beaver activity, and a long history of fire suppression across the landscape. Remaining sites that support fen vegetation persist in artificially maintained habitats such as millponds, powerline rights-of-way, and sandpits where woody plant succession is usually controlled.

The vegetation is heterogeneous and irregular, forming a mosaic of shrub and graminoid-dominated patches. Most commonly, these small openings are found along the margins of slow-moving streams, millponds, and abandoned sandpits. They often support shrubs such as brookside alder (*Alnus serrulata*), leatherleaf (*Chamaedaphne calyculata*), sweet pepperbush (*Clethra alnifolia*), swamp loosestrife (*Lysimachia terrestris*), sweetbay magnolia (*Magnolia virginiana*), swamp azalea (*Rhododendron viscosum*), swamp dewberry (*Rubus hispidus*), poison sumac (*Toxicodendron vernix*), Virginia marsh St. John's-wort (*Triadenum virginicum*), northern highbush blueberry (*Vaccinium corymbosum*), large cranberry (*Vaccinium macrocarpon*), and possum-haw viburnum (*Viburnum nudum*). Hummocks of *Sphagnum* mosses are characteristic and usually support species such as giant cane (*Arundinaria gigantea*), beggarticks (*Bidens* spp.), northern pitcherplant *(Sarracenia purpurea)*, white beak-sedge *(Rhynchospora alba)*, cinnamon fern (*Osmunda cinnamomea*), rose pogonia *(Pogonia ophioglossoides)*, three-way sedge

(*Dulichium arundinaceum*), broadleaf arrowhead (*Sagittaria latifolia*), St. John's-worts *(Hypericum* spp.*)*, and Virginia meadow-beauty *(Rhexia virginica)*. Orchids, sundews (*Drosera* spp.), bladderworts (*Utricularia* spp.), and yellow-eyed-grasses *(Xyris* spp.*)* are also common. Tree species composition and cover are variable between sites, occasionally important to the community composition, and where present, may form sparse to open canopies of short-statured species that may include black gum (*Nyssa sylvatica*), sweetbay magnolia, and red maple (*Acer rubrum*).

County Distribution: Anne Arundel, Calvert, Caroline, Cecil, Charles, Dorchester, Prince George's, Somerset, Wicomico, Worcester

Places to Visit: Suitland Bog

State Rare Natural Community: Coastal Plain-Piedmont Acidic Seepage Fen

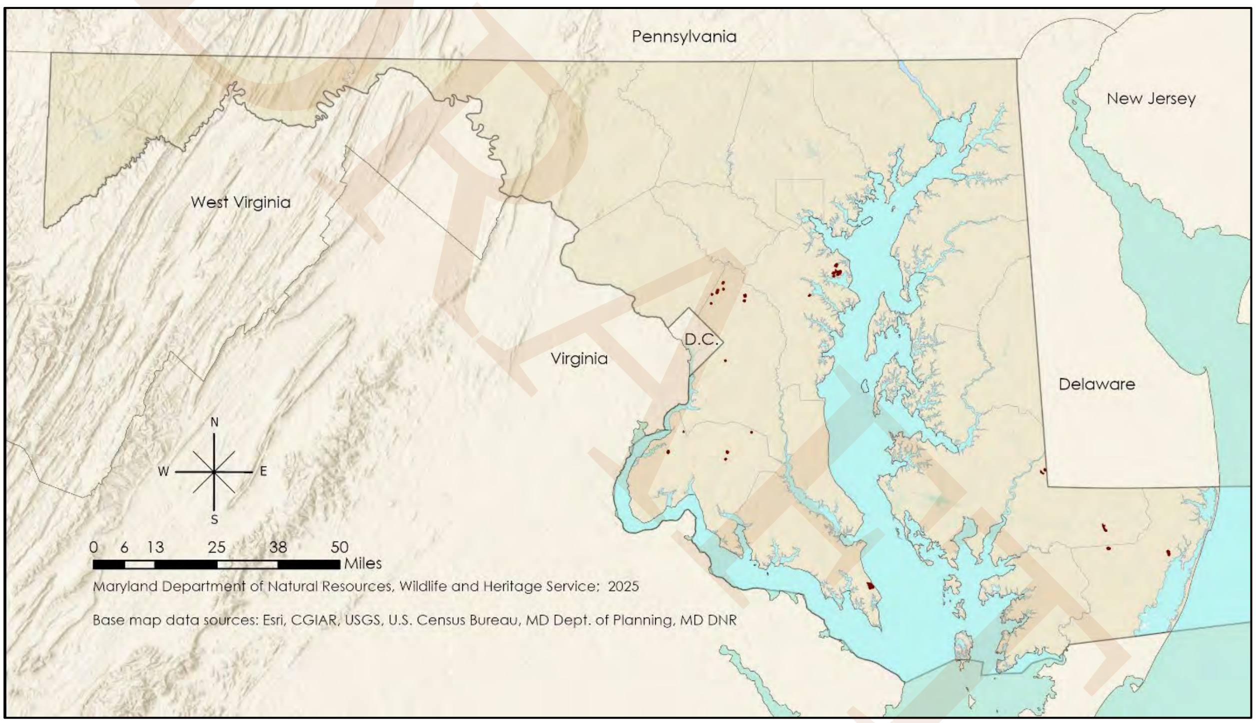


Figure 4.27 Location of Coastal Plain Seepage Acidic Fens in Maryland. Sources: MD DNR, USFWS.

Species of Greatest Conservation Need Associated with Coastal Plain Seepage Acidic Fens:

Birds
- Acadian flycatcher
- American redstart
- American woodcock
- Baltimore oriole
- Kentucky warbler
- Prothonotary warbler
- Swamp sparrow
- Yellow warbler

Insects (Aquatic Orders)
- Variable needlefly

Insects (Diptera)
- Pitcher plant midge *(Metriocnemus knabi)*
- Pitcher plant mosquito *(Wyeomyia smithii)*

Plants (continued)
- Leatherleaf *(Chamaedaphne calyculata)*
- Spreading pogonia *(Cleistesiopsis divaricata)*
- Tall swamp witchgrass *(Dichanthelium scabriusculum)*
- White-edged witchgrass *(Dichanthelium tenue)*

Mammals
American mink
Bobcat
Eastern red bat
Hoary bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Southern pygmy shrew
Tricolored bat

Amphibians
Carpenter frog
Mud salamander
Red salamander

Reptiles
Eastern box turtle
Eastern kingsnake
Eastern ribbonsnake
Queensnake
Rainbow snake
Spotted turtle

Invertebrates (Mites)
Pitcher plant mite *(Sarraceniopus gibsoni)*

Pitcher plant flesh fly *(Fletcherimyia fletcheri)*

Insects (Lepidoptera)
An owlet moth *(Meropleon titan)*
Epauletted pitcher plant moth *(Exyra fax)*

Insects (Odonata)
Atlantic bluet
Black-tipped darner
Burgundy bluet
Elfin skimmer
Fine-lined emerald
Pale bluet
Seepage dancer
Southern sprite
Sphagnum sprite
Treetop emerald
White corporal

Plants
Red milkweed *(Asclepias rubra)*
White doll's-daisy *(Boltonia asteroides* var. *glastifolia)*
Tuberous grass-pink *(Calopogon tuberosus)*
Coastal sedge *(Carex exilis)*
Southern waxy sedge *(Carex glaucescens)*
Dwarf sundew *(Drosera brevifolia)*
Pink sundew *(Drosera capillaris)*
Horsetail spikerush *(Eleocharis equisetoides)*
Seven-angle pipewort *(Eriocaulon aquaticum)*
Flattened pipewort *(Eriocaulon compressum)*
Ten-angle pipewort *(Eriocaulon decangulare)*
White-bracted boneset *(Eupatorium leucolepis)*
Elliott's rush *(Juncus elliottii)*
Long's rush *(Juncus longii)*
Brown-fruit rush *(Juncus pelocarpus)*
Kidneyleaf grass-of-parnassus *(Parnassia asarifolia)*
White fringed orchid *(Platanthera blephariglottis)*
Crossleaf milkwort *(Polygala cruciata)*
Short-beaked baldrush *(Rhynchospora nitens)*
Northern pitcherplant *(Sarracenia purpurea)*
Slender nutrush *(Scleria minor)*
Low nutrush *(Scleria verticillata)*
Flatleaf bladderwort *(Utricularia intermedia)*

Delmarva Bay

Region(s): *Eastern*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Richard Wiegand, MD DNR

The Delmarva Bay Key Wildlife Habitat is characterized by a shallow, seasonally flooded depression wetland on Maryland's lower Coastal Plain. Research suggests this habitat developed from ancient interdunal depressions approximately 16,000 years ago when the climate of the Coastal Plain was very cold and windy and supported an extensive sand dune ecosystem. The majority of Delmarva Bays have been shaped by these wind and erosional processes into circular depressions up to one meter in depth with prominent sand rims. A perched water table and seasonal fluctuations in groundwater recharge and precipitation cause these wetlands to be irregularly flooded or seasonally inundated. During very dry seasons, surface water may be absent or limited to the deepest point within the bay. Likewise, during very wet years when rainfall is abundant, bays may retain water throughout the entire growing season. Depth and duration of seasonal inundation are apparently the most important factors influencing plant communities and the degree to which woody species become established. Dry-season fires in adjacent uplands may spread into bays and may be another factor limiting the invasion of woody species, although fire frequencies throughout the region have been much reduced in recent decades.

The vegetation of Delmarva Bays is closely linked to its hydrologic regime. As water level draws down or recedes during the growing season, plant communities typically develop concentric rings from the outer edge towards the center or deepest point in the bay. Outer rings of a bay may include shrubs of buttonbush *(Cephalanthus occidentalis)*, fetterbush *(Leucothoe racemosa)*, swamp loosestrife *(Lysimachia terrestris)*, and sweet pepperbush *(Clethra alnifolia)*, or nearly pure stands of Walter's sedge *(Carex striata)*, maidencane *(Panicum hemitomon)*, and Virginia chain fern *(Anchistea virginica)*. Interior portions of bays may include species such as Eaton's witchgrass *(Dichanthelium spretum)*, warty panicgrass *(Panicum verrucosum)*, and Virginia meadow-beauty *(Rhexia virginica)*. Many of these species grade into the "draw down pocket" or lowest portion of a bay, which is the last to dry out during the growing season. Common to this zone are slender fimbry *(Fimbristylis autumnalis)* and flood tolerant shrubs like buttonbush. Many plants and animals considered rare in Maryland are known to occur in Delmarva Bays.

County Distribution: Caroline, Dorchester, Kent, Queen Anne's, Somerset, Talbot, Wicomico, Worcester

State Rare Natural Community: Delmarva Bay

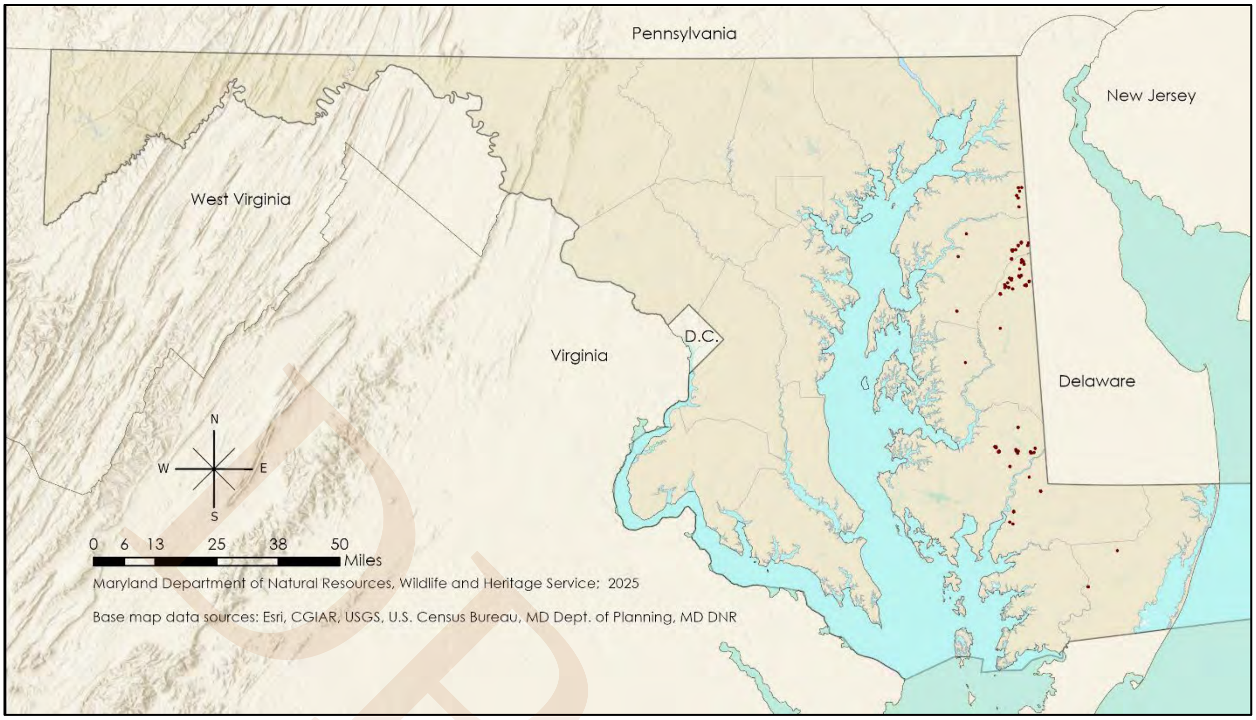


Figure 4.28 Location of Delmarva Bays in Maryland. Sources: MD DNR, USFWS.

Species of Greatest Conservation Need Associated with Delmarva Bays:

Birds

American woodcock
Baltimore oriole
Yellow warbler

Mammals

American mink
Bobcat
Eastern red bat
Hoary bat
Silver-haired bat
Southern bog lemming
Tricolored bat

Amphibians

Barking treefrog
Carpenter frog
Eastern tiger salamander

Reptiles

Eastern box turtle
Eastern kingsnake
Eastern ribbonsnake
Spotted turtle

Plants

Rose coreopsis *(Coreopsis rosea)*
Wright's witchgrass *(Dichanthelium wrightianum)*
Black-fruit spikerush *(Eleocharis melanocarpa)*
Robbins' spikerush *(Eleocharis robbinsii)*
Harper's fimbristylis *(Fimbristylis perpusilla)*
Sharp-scaled mannagrass *(Glyceria acutiflora)*
Featherfoil *(Hottonia inflata)*
Creeping St. John's-wort *(Hypericum adpressum)*
Coppery St. John's-wort *(Hypericum denticulatum)*
Red root *(Lachnanthes caroliniana)*
Club-head cutgrass *(Leersia hexandra)*
Pondspice *(Litsea aestivalis)*
Canby's lobelia *(Lobelia canbyi)*
Wrinkled joingrass *(Mnesithea rugosa)*

Plants (continued)

Capitate beakrush *(Rhynchospora cephalantha)*
Drowned hornrush *(Rhynchospora inundata)*
Mid-Atlantic beakrush *(Rhynchospora mesoatlantica)*
Long-beaked baldrush *(Rhynchospora scirpoides)*
Slender marsh pink *(Sabatia campanulata)*
Two-formed pink *(Sabatia difformis)*
Engelmann's arrowhead *(Sagittaria engelmanniana)*
Sessile-fruit arrowhead *(Sagittaria rigida)*
Reticulated nutrush *(Scleria reticularis)*
One-flower sclerolepis *(Sclerolepis uniflora)*
Canby's dropwort *(Tiedemannia canbyi)*
Swollen bladderwort *(Utricularia inflata)*
Purple bladderwort *(Utricularia purpurea)*

Insects (Coleoptera)
A dytiscid beetle *(Hoperius planatus)*
Seth Forest water scavenger beetle

Insects (Odonata)
Fine-lined emerald

Torrey's dropseed *(Muhlenbergia torreyana)*
Big floatingheart *(Nymphoides aquatica)*
Walter's paspalum *(Paspalum dissectum)*

Northeastern bladderwort *(Utricularia resupinata)*
Fibrous bladderwort *(Utricularia striata)*
Fringed yellow-eyed-grass *(Xyris fimbriata)*
Small's yellow-eyed-grass *(Xyris smalliana)*

Maritime Swamp

Region(s): *Eastern*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

Jason Harrison, MD DNR

The Maritime Swamp Key Wildlife Habitat encompasses saturated and seasonally flooded swamps and shrublands of barrier islands along the Atlantic Coast, and low-lying flats behind tidal marshes just inland from estuarine zones. The structure of these swamps may vary from shrubland to woodland to forest because of differing stand ages as well as the amount of exposure to harsh maritime conditions, such as salt spray and wind pruning. Shrub swamps of back-dune hollows and inlet heads are frequent on barrier islands where perched water tables and seasonal flooding characterize the hydrology. Though primarily freshwater, these shrub swamps may periodically be subjected to higher salinity levels as a result of storm surges from hurricanes and other storm events. Small-scale structural variability is also common within these wetlands, with hummocks (i.e., elevated mounds created by vegetation growth and the decomposition of organic matter) and hollows (i.e., the low-lying, often saturated depressions between them) creating an undulating landscape.

The species composition is variable from stand to stand, but southern bayberry *(Morella cerifera)*, black highbush blueberry *(Vaccinium fuscatum)*, poison ivy *(Toxicodendron radicans)*, royal fern *(Osmunda spectabilis)*, whorled water-pennywort *(Hydrocotyle verticillata)*, and marsh fern *(Thelypteris palustris* var. *pubescens)* are common. Saturated and seasonally flooded forests typically develop in protected swales between dunes and flats behind tidal marshes. Red maple *(Acer rubrum)*, sweetgum *(Liquidambar styraciflua)*, black gum *(Nyssa sylvatica)*, willow *(Salix* spp.*)*, swamp tupelo *(Nyssa biflora)*, and sweetbay magnolia *(Magnolia virginiana)* are common trees. The shrub layers are often dense with southern bayberry, black highbush blueberry, poison ivy, and greenbrier *(Smilax* spp.*)*. Back-dune depressions of barrier islands and low-lying flats bordering tidal marsh of estuaries further inland are characterized by a dominance of loblolly pine *(Pinus taeda)* and a saturated hydrology. These fringing pine forests are nearly level and may contain areas of standing water. Some common associates include southern bayberry, greenbrier, cinnamon fern *(Osmunda cinnamomea)*, royal fern, switchgrass *(Panicum virgatum)*, and whorled marsh-pennywort. In Maryland, Maritime Swamps are of conservation significance because of a limited distribution along the Atlantic Coast and a high vulnerability to coastal development, sea-level rise, and stochastic storm events.

County Distribution: Dorchester, Somerset, Wicomico, Worcester

Places to Visit: Assateague Island National Seashore, Blackwater National Wildlife Refuge

State Rare Natural Communities: Maritime Swamp

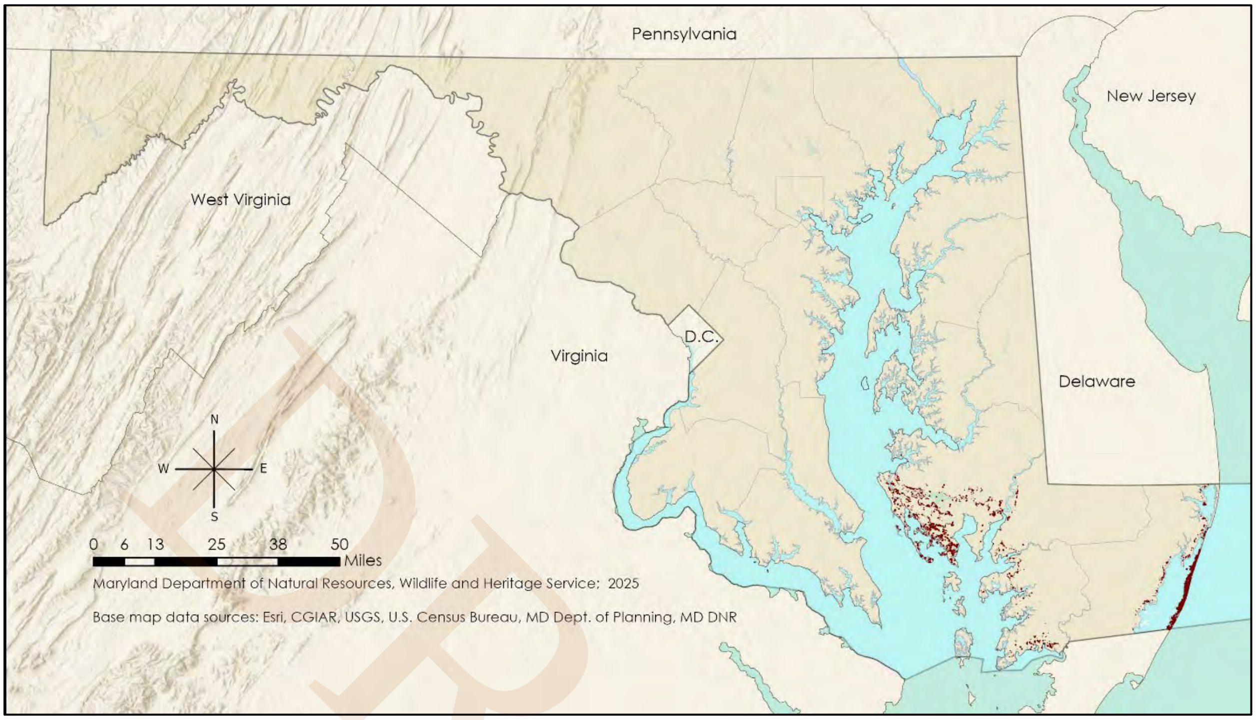


Figure 4.29 Location of Maritime Swamps in Maryland. Sources: MD DNR, NETWHCS, USFWS.

Species of Greatest Conservation Need Associated with Maritime Swamps:

Birds
American black duck
American woodcock
Black-crowned night heron
Glossy ibis
Great blue heron
Great egret
Little blue heron
Northern bobwhite
Snowy egret
Tricolored heron
Yellow warbler
Yellow-crowned night heron

Insects (Lepidoptera)
Palamedes swallowtail

Mammals
American mink
Bobcat
Eastern red bat
Hoary bat
Silver-haired bat
Tricolored bat

Amphibians
Carpenter frog

Reptiles
Eastern box turtle
Eastern ribbonsnake
Plain-bellied watersnake
Spotted turtle

Vernal Pool

Region(s): *All*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

James McCann, MD DNR

The Vernal Pool Key Wildlife Habitat is defined as small (~0.1-2 ha), non-tidal palustrine forested wetlands formed within a well-defined, discrete basin lacking a permanent, above-ground outlet. The basin overlies an impermeable soil or rock layer that impedes drainage, such as a clay hardpan, creating a perched water table. As the water table rises in fall and winter, the basin fills, forming a shallow pool. By spring, the pool typically reaches maximum depth (~0.5-2.5 m) following snowmelt and the onset of spring rains. By mid to late summer, the pool usually dries up completely, although some surface water may persist in relatively deep basins, especially in years with above-average precipitation. Important abiotic features of Vernal Pools are a lack of hydrologic input and periodic seasonal drying, which prevent fish populations from becoming established. However, many species have evolved to use these ephemeral wetlands, some of which are obligate Vernal Pool species, so-called because they require a Vernal Pool to complete all or part of their life cycle. This is especially true for amphibians, as Vernal Pools provide critical fish-free breeding habitat for many amphibious species.

Vernal Pools occur throughout the state, most often as scattered, isolated habitats. They are most numerous on the Lower Coastal Plain, especially on the mid to upper Eastern Shore, and uncommon west of the Fall Line. They are typically situated in low areas or depressions in a forest, but they can also occur in floodplain forests as isolated floodwaters, among backwaters of old beaver impoundments, old sinkholes, or as perched spring- or seep-fed basins along mountain slope benches, or at the base of slopes. Vernal Pools may also persist in open areas such as agricultural fields, pastures, clearcuts, and suburban areas, though usually in a degraded ecological state.

Because Vernal Pools occur throughout the state in a variety of forest types and settings, the vegetation in and around these habitats varies considerably, but exhibits similar physical features and structure. The substrate of basins typically consists of dense mats of submerged leaf litter and scattered, coarse woody debris, and tends to have a semi-open to closed forest canopy around them, the degree of closure generally decreasing with increasing pool size. Herbaceous vegetation is usually absent to sparse in and around the basin, although small mossy patches frequently occur along the basin edge. Shrub cover along the shoreline or in small patches within the basin is variable, with some pools having dense shrub cover along basin margins, especially on the Coastal Plain, but may be lacking entirely or sparse in others.

County Distribution: Statewide

Places to Visit: Seth Demonstration Forest

State Rare Natural Community: Vernal Pool

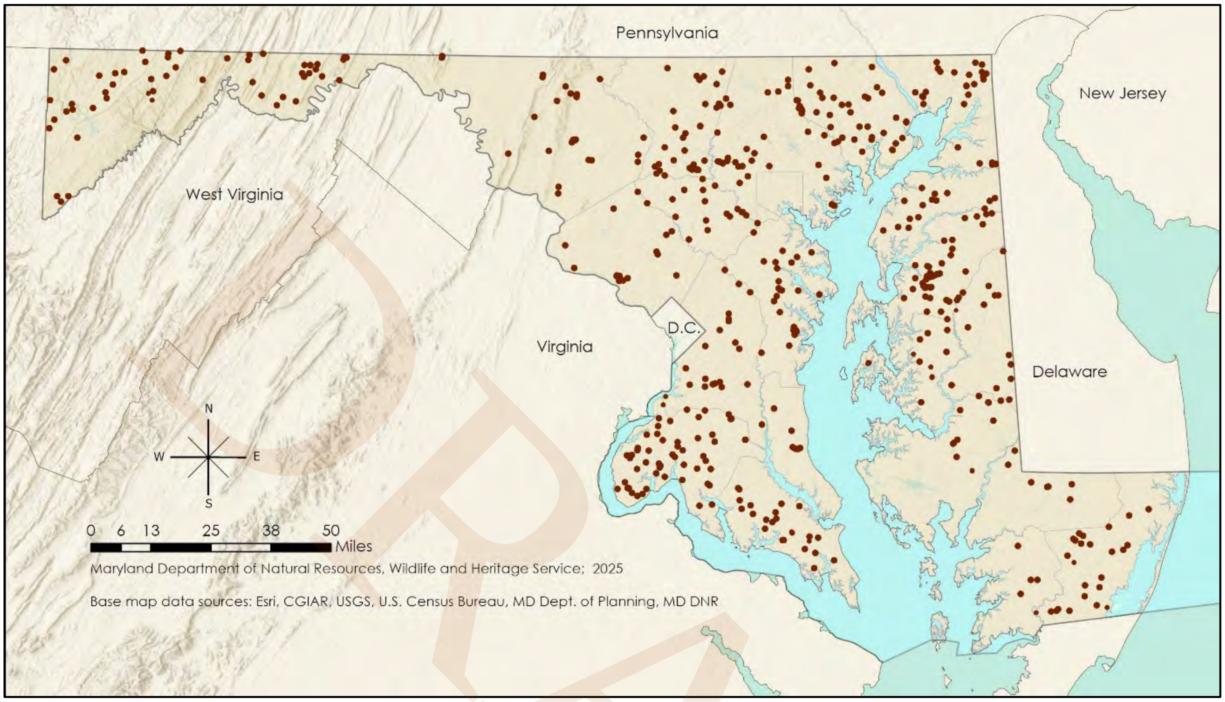


Figure 4.30 Location of Vernal Pools in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Vernal Pools:

Mammals
American mink
Eastern red bat
Eastern small-footed bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Insects (Coleoptera)
A dytiscid beetle *(Hoperius planatus)*
Seth Forest water scavenger beetle

Insects (Odonata)
Little blue dragonlet

Amphibians
Carpenter frog
Eastern narrow-mouthed toad
Eastern spadefoot
Eastern tiger salamander
Jefferson salamander
Mountain chorus frog
Upland chorus frog

Reptiles
Eastern box turtle
Eastern kingsnake
Eastern ribbonsnake
Rainbow snake
Spotted turtle

Plants
Northeastern bulrush *(Scirpus ancistrochaetus)*

Spring

Region(s): *Western, Central, Southern*
Habitat Group: *Groundwater Wetlands*
NEAFWA: *Non-tidal Wetlands*

MD DNR

The Spring Key Wildlife Habitat (KWH) is a concentrated discharge of groundwater at a small (usually < 1 m^2), distinct site or opening in the ground. Springs emit groundwater due to hydrostatic pressure resulting from gravity or artesian flow, although other physical forces may play a role (e.g., buoyant effect of dissolved gases). Springs are uncommon, typically isolated features, primarily occurring west of the Fall Line. They provide critical habitat for highly rare salamanders, aquatic snails, crayfish, subterranean invertebrates, and other invertebrates; a number of these species are endemic to spring habitats and may only occur at a single or few locations within the state. Some Springs discharge directly into streams or wetlands, playing a vital role in maintaining the ecological integrity of these habitats and associated species, including those of conservation concern (e.g., Allegheny pearl dace *[Margariscus margarita]*, brook trout *[Salvelinus fontinalis]*, rare dragonflies and damselflies).

Several types of Spring KWHs exist in Maryland, including contact, scree, and fault Springs. Perhaps the most common type is fracture or crevice springs. Here, groundwater moves downward due to gravity, flowing through fractures and crevices underneath the ground and emerging as a spring where a major fracture in a rock formation occurs at the earth's surface, usually along a ravine or swale. The flow or discharge rates of Maryland's Springs range from less than one gallon per minute to nearly 10,000 gallons per minute. Springs are similar to seeps, but have distinct discharge sites that are associated with unique aquatic and geological features, whereas seeps and seepage wetlands form at the surface as broad, diffuse zones of groundwater discharge or percolation, where groundwater naturally comes to the surface, often with associated wetlands that support distinct plant communities.

County Distribution: Allegany, Anne Arundel, Baltimore, Carroll, Cecil, Charles, Frederick, Garrett, Howard, Montgomery, Prince George's, Washington

Places to Visit: Henryton Spring, Annapolis Rock Spring

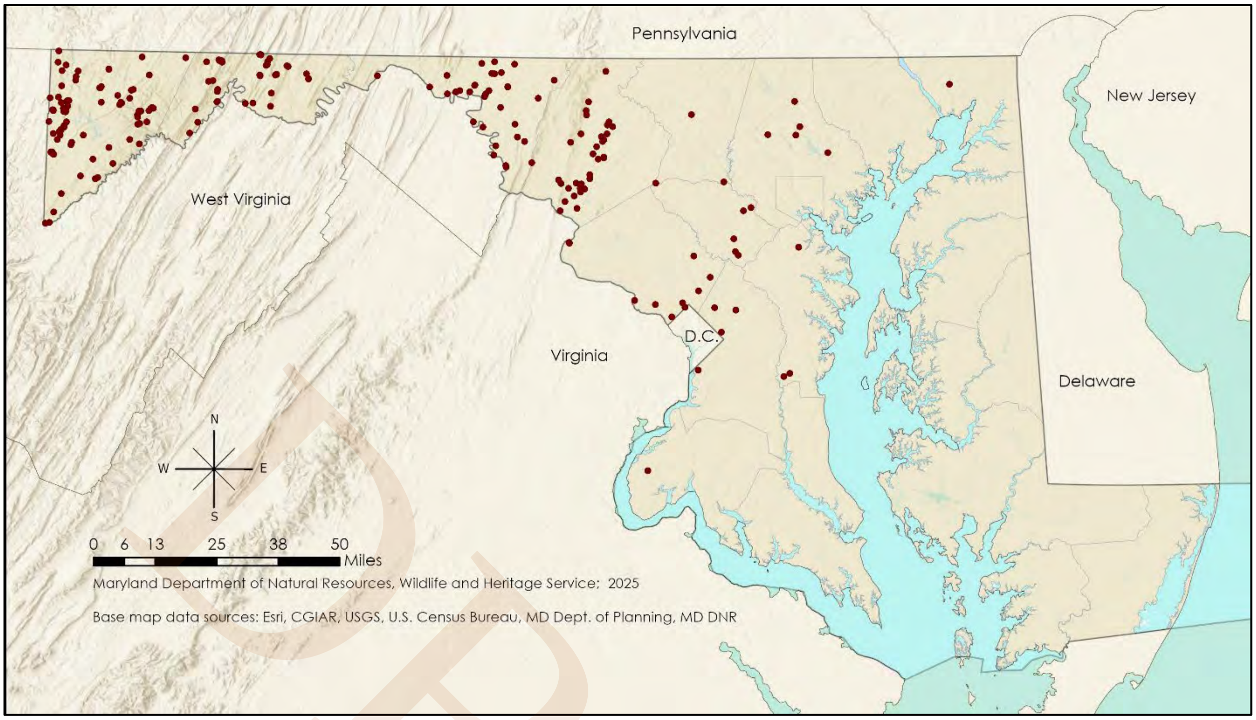


Figure 4.31 Location of Springs in Maryland. Sources: MD DNR, Geographic Names Information System (USGS).

Species of Greatest Conservation Need Associated with Springs:

Amphibians
Longtail salamander
Mountain chorus frog
Mountain dusky salamander
Mud salamander
Red salamander
Seal salamander
Spring salamander
Upland chorus frog

Reptiles
Eastern kingsnake

Insects (Aquatic Orders)
Shenandoah needlefly
Shenandoah sallfly

Invertebrates (Snails)
Appalachian springsnail
Blue Ridge springsnail

Invertebrates (Cave and Groundwater)
A cave obligate planarian *(Sphalloplana buchanani)*
A planarian *(Paraplanaria dactyligera)*
A planarian *(Procotyla typhlops)*
Allegheny spring isopod *(Caecidotea alleghenyensis)*
Biggers' cave amphipod *(Stygobromus biggersi)*
Capital Area groundwater amphipod *(Stygobromus sextarius)*
Cecil groundwater amphipod *(Stygobromus caecilius)*
Feller's groundwater amphipod *(Stygobromus felleri)*
Friendly cave amphipod *(Stygobromus amicus)*
Greenbrier cave amphipod *(Stygobromus emarginatus)*
Pizzini's cave amphipod *(Stygobromus pizzinii)*
Prettyboy groundwater amphipod *(Stygobromus paxillus)*
Price's cave isopod *(Conasellus pricei)*
Rappahannock spring amphipod *(Stygobromus foliatus)*
Refton Cave planarian *(Sphalloplana pricei)*
Rock Creek groundwater amphipod *(Stygobromus kenki)*
Shenandoah Valley cave amphipod *(Stygobromus gracilipes)*
Tidewater amphipod *(Stygobromus indentatus)*

Tidal Wetlands

Tidal Forest

Region(s): *Central, Eastern, Southern*
Habitat Group: *Tidal Wetlands*
NEAFWA: *Tidal Wetlands & Flats*

Jason Harrison, MD DNR

The Tidal Forest Key Wildlife Habitat includes a variety of tidally flooded forests that border the upper reaches of Maryland's rivers and tributaries on the Coastal Plain, developing in narrow ecotones between regularly tidally flooded areas and the upland interface. These habitats are species-rich and structurally complex with open canopies and floristically diverse lower strata. In much of our region, these freshwater habitats are composed of mixtures of hardwoods where species such as green ash (*Fraxinus pensylvanica*), water tupelo (*Nyssa aquatica*), and red maple (*Acer rubrum*) are characteristic and/or dominant. On some sites, globally and state rare communities occur, such as those within the Pocomoke and Nanticoke River watersheds, where bald cypress *(Taxodium distichum)* and Atlantic white cedar *(Chamaecyparis thyoides)* are dominant, co-dominant, or occur as scattered individuals within these stands. Both Atlantic white cedar and bald cypress swamps are designated as rare ecological communities in Maryland as a result of various historical and current impacts, including widespread logging that occurred in the early 1900s, wetland drainage, habitat conversion, and salination from resulting sea-level rise.

The shrub layer in freshwater Tidal Forests is usually dense and diverse, often including species such as northern arrow-wood *(Viburnum recognitum)*, winterberry *(Ilex verticillata)*, silky dogwood *(Cornus amomum)*, swamp azalea *(Rhododendron viscosum)*, swamp rose *(Rosa palustris)*, fetterbush *(Leucothoe racemosa)*, and sweet pepperbush *(Clethra alnifolia)*. Climbing vines are common in multiple layers and may include species such as common wild yam *(Dioscorea villosa)*, poison ivy *(Toxicodendron radicans)*, common greenbrier *(Smilax rotundifolia)*, and Virginia creeper *(Parthenocissus quinquefolia)*. Pronounced hummock-and-hollow microtopography is characteristic of tidal forests. Hollows are regularly inundated by tidal water, whereas hummocks are less frequently flooded, thus supporting the establishment of trees and numerous herbs. The exceptional species diversity and richness in these habitats can be attributed to the topography as well as flooding frequency. Regularly flooded hollows support many flood-tolerant swamp species, such as jewelweed *(Impatiens capensis)*, arrow arum *(Peltandra virginica)*, halberd-leaved tearthumb *(Polygonum arifolium)*, lizard's-tail *(Saururus cernuus)*, and sedges such as tussock sedge *(Carex stricta)*. Elevated above normal high tides, hummocks provide habitat for marsh blue violet *(Viola cucullata)*, water hemlock *(Cicuta maculata* var. *maculata)*, greenfruit clearweed *(Pilea pumila)*, false nettle *(Boehmeria* *cylindrica)*, and ferns such as royal fern *(Osmunda spectabilis)*, cinnamon fern *(Osmunda cinnamomea)*, and marsh fern *(Thelypteris palustris* var. *pubescens)*.

In brackish river systems, small fringing tidal woodlands dominated by loblolly pine *(Pinus taeda)* occur along portions of tidal rivers and creeks, in narrow ecotones between high salt marshes and adjacent uplands, and as islands within extensive salt marshes. Examples of these tidal forests can be found in the lower tidewater areas of Dorchester, Wicomico, Somerset, Worcester and St. Mary's counties. These habitats are believed to be an artifact of sea-level rise and marsh subsidence, which subsequently allows for a higher frequency of tidal encroachment to the surrounding upland, pine-dominated communities. The flood tolerance of loblolly pine is relatively high, but signs of stress have become more apparent as the frequency and length of tidal inundation have increased in duration. Indicators of stress may include stunted growth, thinning crowns, and significant tree mortality. These habitats are generally species-poor, with loblolly pine often forming a monospecific canopy and southern bayberry *(Morella cerifera)* comprising the shrub layer. Indicative of brackish conditions, species diversity in the herbaceous layer is quite low and chiefly composed of vegetation tolerant of such conditions. Most frequent and dominant of these species include salt meadow cordgrass *(Spartina patens)*, switchgrass *(Panicum virgatum)*, and salt grass *(Distichlis spicata)*.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Blackwater National Wildlife Refuge, Piscataway Park, Pocomoke River State Forest

State Rare Natural Communities: Tidal Bald Cypress Swamp, Tidal Hardwood Swamp

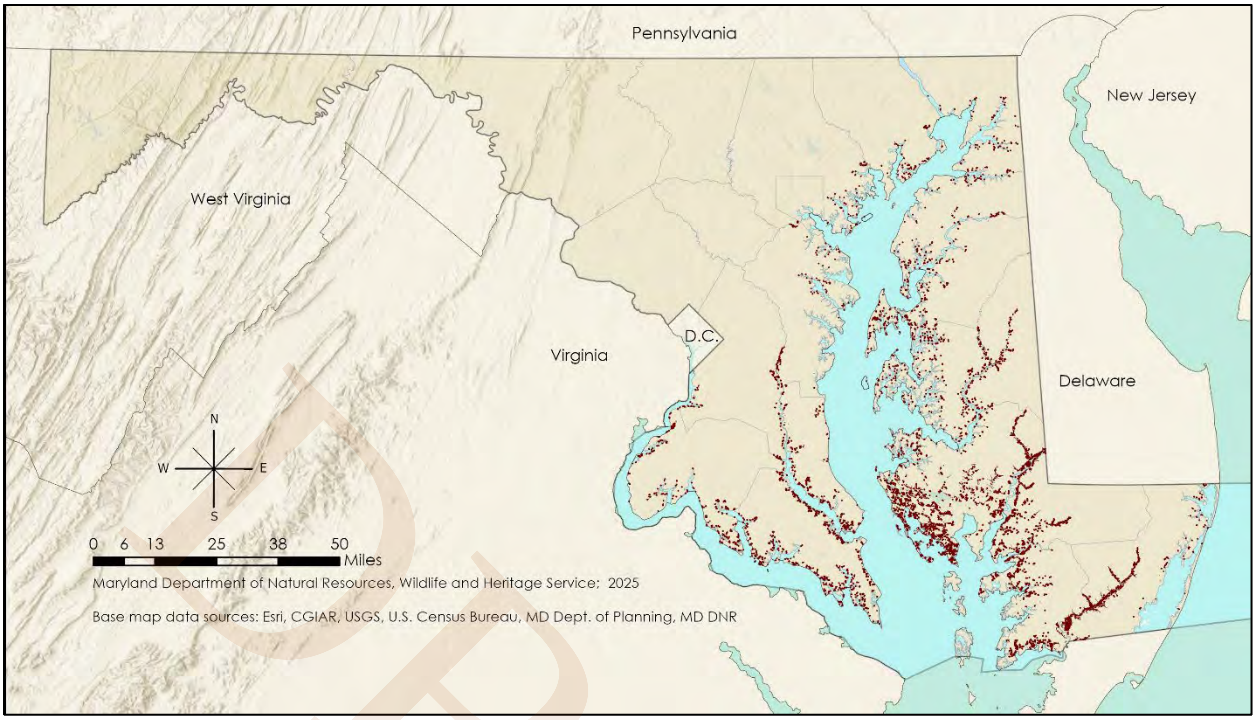


Figure 4.32 Location of Tidal Forests in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Tidal Forests:

Birds
Acadian flycatcher
American redstart
American woodcock
Bald eagle
Black-and-white warbler
Black-billed cuckoo
Chuck-will's-widow
Great blue heron
Great egret
Hooded warbler
Kentucky warbler
Louisiana waterthrush
Northern parula
Ovenbird
Prairie warbler
Prothonotary warbler
Rusty blackbird
Scarlet tanager
Swainson's warbler
Wood thrush
Worm-eating warbler
Yellow-breasted chat
Yellow-throated vireo

Mammals
Bobcat
Delmarva fox squirrel
Eastern red bat
Hoary bat
Silver-haired bat
Tricolored bat

Amphibians
Carpenter frog
Eastern narrow-mouthed toad
Mud salamander

Reptiles
Eastern box turtle
Eastern kingsnake
Eastern milksnake
Eastern ribbonsnake
Northern mole kingsnake
Plain-bellied watersnake
Rainbow snake
Spotted turtle
Wood turtle

Plants
Hazel dodder *(Cuscuta coryli)*
Carolina ash *(Fraxinus caroliniana)*
Three-ribbed arrow-grass *(Triglochin striata)*

Insects (Lepidoptera)
A twirler moth *(Coleotechnites variiella)*
Bronze copper
Bald cypress coneworm moth
Cypress emerald moth
Cypress looper *(Iridopsis pergracilis)*
Cypress pinion *(Lithophane abita)*
Cypress sphinx moth *(Isoparce cupressi)*
Distinguished cypress owlet moth
Gray cypress looper *(Cutina albopunctella)*
Great purple hairstreak
Mulberry wing
Palamedes swallowtail

Tidal Freshwater Marsh and Shrubland

Region(s): *Central, Eastern, Southern*
Habitat Group: *Tidal Wetlands*
NEAFWA: *Tidal Wetlands & Flats*

Jason Harrison, MD DNR

In Maryland, the Tidal Freshwater Marsh and Shrubland Key Wildlife Habitat is widely distributed along upper tidal rivers, creeks and shores of the Chesapeake Bay, which are subject to lunar tides and subsequent flooding that occurs twice daily, in zones where water is consistently fresh (salinity less than 0.5 ppt). Pulses of higher salinity are common during spring high tides and episodes of low river discharge during drought cycles. In addition, where these marshes begin the transition to saline ones, a zone of slightly brackish conditions (i.e., oligohaline) occurs where salt concentrations may range from 0.5–5 ppt.

The vegetation of these wetlands is very diverse and dynamic, exhibiting floristic zonation with spatial vegetation patterns that may change seasonally or yearly with variability based on location within the wetland, age, water depth, and tidal regime, with emergent herbaceous and graminoid dominated vegetation forming in the lower, permanently flooded zones, grading outwards to shrub dominated vegetation at the higher, semi-permanently to seasonally flooded margins that grade into Tidal Forests.

Typically, there are two distinct zones in the marsh: a low-elevation zone dominated by short, broad-leaf emergent herbaceous species bordering mudflats or open water, and a slightly higher-elevation area dominated by tall graminoids. Plants in the low zone may include spatterdock *(Nuphar advena)*, arrow-arum *(Peltandra virginica)*, and pickerelweed *(Pontederia cordata)*, while higher zones often support species such as wild rice *(Zizania aquatica* var. *aquatic)*, jewelweeds *(Impatiens* spp.*)*, sweetflag *(Acorus calamus)*, dotted smartweed *(Polygonum punctatum)*, rice cutgrass *(Leersia oryzoides)*, arrowleaf tearthumb *(Polygonum sagittatum)*, halberdleaf tearthumb *(Polygonum arifolium)*, and beggar-ticks *(Bidens* spp.*)*. This zonation can be attributed to flooding depth, duration, and frequency. Oligohaline marshes frequently support the latter species in addition to species tolerant of brackish conditions, such as water-hemp pigweed *(Amaranthus cannabinus)*, eastern-rose mallow *(Hibiscus moscheutos* ssp. *moscheutos)*, seashore mallow *(Kosteletzkya virginica)*, saltmarsh bulrush *(Schoenoplectus robustus)*, and extensive stands of big cordgrass *(Spartina cynosuroides)* and narrow-leaved cattail *(Typha angustifolia)*. Tidal freshwater shrublands commonly form small, linear patches on floodplains between tidal emergent marshes and Tidal Forests.

Discrete shrub-dominated vegetation occurs within the drier transitional areas of freshwater tidal marshes and adjacent uplands. The vegetation of these shrub wetlands is very diverse and typically contains species characteristic of both tidal marshes and tidal forests. Common shrubs are such as brookside alder *(Alnus serrulata)*, winterberry *(Ilex verticillata)*, swamp rose *(Rosa* *palustris)*, northern arrow-wood *(Viburnum recognitum)*, southern bayberry *(Morella cerifera)*, and silky dogwood *(Cornus amomum)*. Pronounced hummock and hollow microtopography is characteristic and contribute to relatively high species richness, with most species confined to irregularly flooded hummocks, whereas hollows are regularly flooded and typically contain only those species tolerant of frequent inundation.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Pocomoke State Forest

State Rare Natural Communities: Tidal Freshwater Marsh and Shrubland, Tidal Oligohaline Marsh and Shrubland

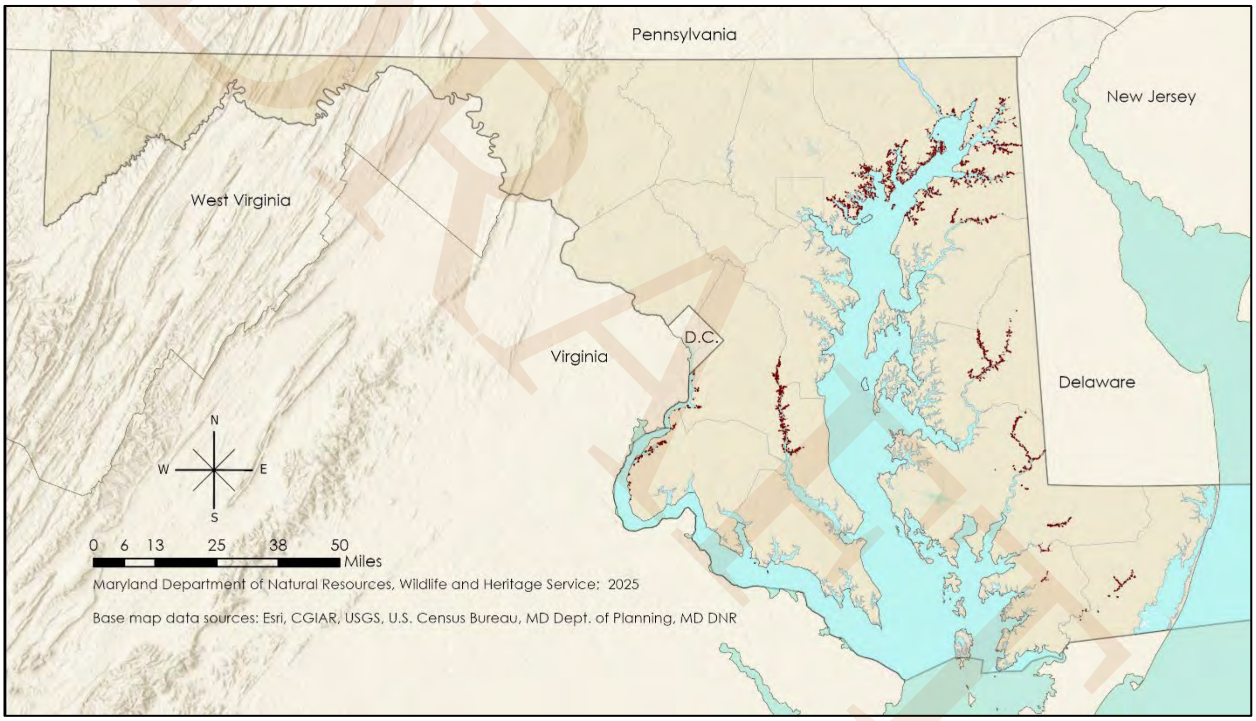


Figure 4.33 Location of Tidal Freshwater Marshes and Shrublands in Maryland. Sources: MD DNR, Nature Serve's Terrestrial Ecological Systems of the U.S.

Species of Greatest Conservation Need Associated with Tidal Freshwater Marshes and Shrublands:

Birds	**Mammals**	**Plants**
American barn owl	American mink	Seaside alder *(Alnus maritima* ssp. *maritima)*
American bittern	Bobcat	Switch cane *(Arundinaria tecta)*
American black duck	Eastern red bat	Smooth orange milkweed *(Asclepias lanceolata)*
Bald eagle	Hoary bat	
Baltimore oriole	Least shrew	
Black-crowned night heron	Silver-haired bat	

Blue-winged teal
Brown pelican
Coastal Plain swamp sparrow
Dunlin
Gadwall
Glossy ibis
Great blue heron
Great egret
Greater yellowlegs
King rail
Least bittern
Least tern
Lesser yellowlegs
Little blue heron
Marsh wren
Northern harrier
Pied-billed grebe
Ruddy turnstone
Rusty blackbird
Sanderling
Sedge wren
Semipalmated sandpiper
Short-eared owl
Snowy egret
Sora
Spotted sandpiper
Swamp sparrow
Tricolored heron
Yellow warbler
Yellow-crowned night heron

Tricolored bat

<u>Reptiles</u>

Eastern kingsnake
Eastern mud turtle
Diamond-backed terrapin
Plain-bellied watersnake
Rainbow snake
Spotted turtle
Striped mud turtle

<u>Insects (Hymenoptera)</u>

Pickerelweed long-horned bee *(Melissodes apicatus)*

<u>Insects (Lepidoptera)</u>

An owlet moth *(Meropleon titan)*
Bronze copper
Rare skipper

<u>Insects (Odonata)</u>

Fine-lined emerald

Saltmarsh bulrush *(Bolboschoenus novae-angliae)*
Long's bittercress *(Cardamine longii)*
Mitchell's sedge *(Carex mitchelliana)*
Partridge pea *(Chamaecrista fasciculata* var. *macrosperma)*
Water horsetail *(Equisetum fluviatile)*
Parker's pipewort *(Eriocaulon parkeri)*
Dwarf umbrella-sedge *(Fuirena pumila)*
Vetchling peavine *(Lathyrus palustris)*
Gibbous panic-grass *(Sacciolepis striata)*
Swamp wedgescale *(Sphenopholis pensylvanica)*
Southern wild rice *(Zizaniopsis miliacea)*

Tidal Brackish Marsh and Shrubland

Region(s): *Central, Eastern, Southern*
Habitat Group: *Tidal Wetlands*
NEAFWA: *Tidal Wetlands & Flats*

Jason Harrison, MD DNR

The Tidal Brackish Marsh and Shrubland Key Wildlife Habitat (KWH) is a transitional, mesohaline wetland between tidal freshwater systems and salt marshes. It is the most abundant wetland type in Maryland, occurring along the many miles of coastal plain rivers and shores where the salinity of water ranges from 5–18 ppt. This wide transition zone is diverse, with species tolerant of both saline and freshwater conditions.

The vegetation of this KWH is influenced by salinity, elevation, and the depth and duration of tidal flooding. Lower, more regularly flooded zones consist of species such as saltmarsh cordgrass *(Spartina alterniflora)*, saltgrass *(Distichlis spicata)*, glassworts *(Salicornia* spp.*)*, narrow-leaved cattail *(Typha angustifolia)*, olney threesquare *(Schoenoplectus americanus)*, saltmarsh bulrush *(Schoenoplectus robustus)*, and extensive stands of black needlerush *(Juncus roemerianus)*, which is believed by many to have had its range expanded due to a decrease in natural fires in brackish marshes of the mid-Atlantic. Higher portions of brackish marshes may support saltmeadow cordgrass *(Spartina patens)*, sea-lavender *(Limonium carolinianum)*, seashore mallow *(Kosteletzkya virginica)*, marsh fleabane *(Pluchea camphorata)*, switchgrass *(Panicum virgatum)*, and seaside goldenrod *(Solidago sempervirens)*. Shrubby ecotones of southern bayberry *(Morella cerifera)*, bigleaf marsh-elder *(Iva frutescens)*, and high-tide bush *(Baccharis halimifolia)* are also frequent throughout the habitat.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Dorchester, Kent, Prince George’s, Queen Anne’s, Somerset, St. Mary’s, Talbot, Wicomico, Worcester

Places to Visit: Blackwater National Wildlife Refuge, Eastern Neck Wildlife Refuge, Fishing Bay Wildlife Management Area

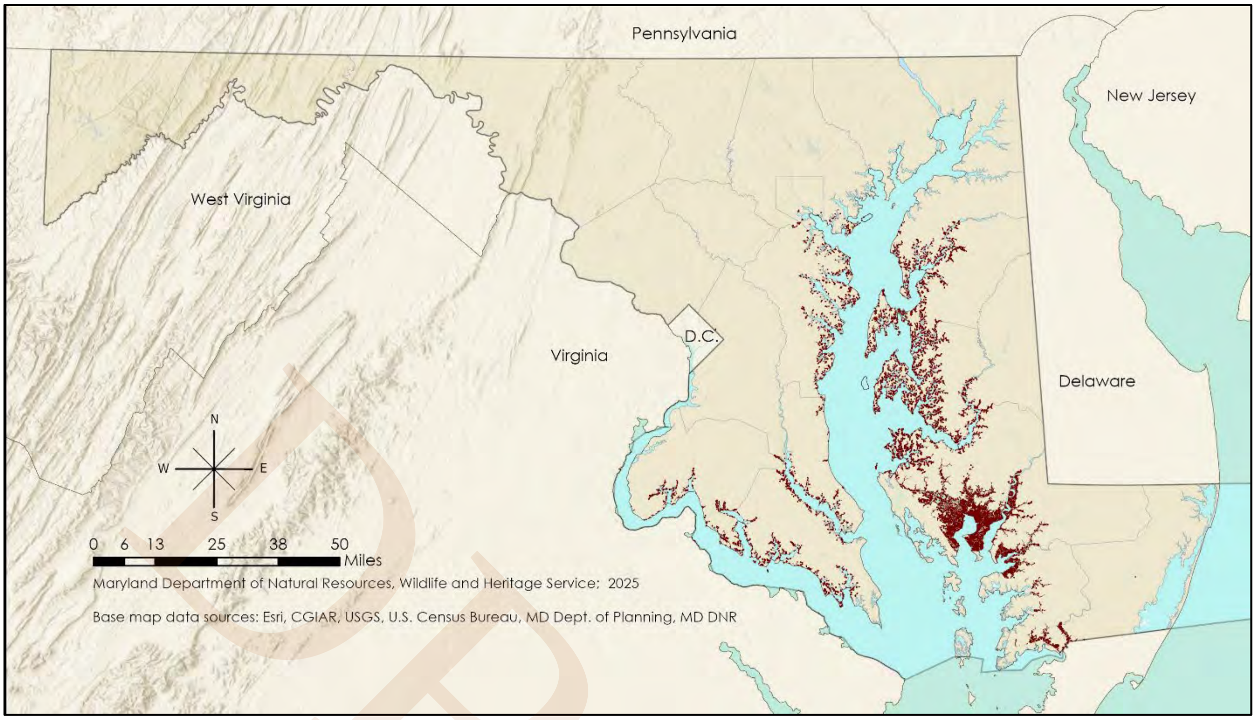


Figure 4.34 Location of Tidal Brackish Marshes and Shrublands in Maryland. Sources: MD DNR, Nature Serve's Terrestrial Ecological Systems of the U.S.

Species of Greatest Conservation Need Associated with Tidal Brackish Marshes and Shrublands:

Mammals
American mink
Bobcat
Eastern red bat
Hoary bat
Least shrew
Silver-haired bat
Tricolored bat

Reptiles
Eastern kingsnake
Diamond-backed terrapin
Plain-bellied watersnake

Insects (Coleoptera)
Keel-necked firefly
Salt marsh firefly

Insects (Lepidoptera)
Bronze copper
Rare skipper

Birds
American barn owl
American bittern
American black duck
American peregrine falcon
Bald eagle
Black rail
Black-crowned night heron
Blue-winged teal
Boat-tailed grackle
Brown pelican
Coastal Plain swamp sparrow
Common gallinule
Common nighthawk
Dunlin
Eastern meadowlark
Gadwall
Glossy ibis
Golden eagle
Great blue heron

Birds (continued)
Great egret
Greater yellowlegs
Horned grebe
King rail
Least bittern
Least tern
Lesser yellowlegs
Little blue heron
Marsh wren
Nelson's sparrow
Northern harrier
Pied-billed grebe
Ruddy turnstone
Saltmarsh sparrow
Sanderling
Seaside sparrow
Sedge wren
Semipalmated sandpiper
Short-billed dowitcher
Short-eared owl
Snowy egret
Sora

Birds (continued)
Spotted sandpiper
Swamp sparrow
Tricolored heron
Whimbrel
Willet
Yellow warbler
Yellow-crowned night heron

Plants
Sensitive joint-vetch *(Aeschynomene virginica)*
Koehne ammannia *(Ammannia latifolia)*
Shoreline sedge *(Carex hyalinolepis)*

Tidal Salt Marsh and Shrubland

Region(s): *Eastern, Southern*
Habitat Group: *Tidal Wetlands*
NEAFWA: *Tidal Wetlands & Flats*

Jason Harrison, MD DNR

The Tidal Salt Marsh and Shrubland Key Wildlife Habitat includes salt meadows along the coast and lower portions of the Chesapeake Bay that form essentially flat plains of low-statured vegetation with moderate species diversity and distinct zonation between low and high salt marshes. Lower, more regularly flooded salt zones with lower salinity are often dominated by saltmarsh cordgrass *(Spartina alterniflora)* and extensive stands of black needlerush *(Juncus roemerianus)*. Shorter-statured salt marshes or salt meadows are dominated by saltgrass *(Distichlis spicata)* and saltmeadow cordgrass *(Spartina patens)* and generally occur on slightly elevated surfaces where tides may be less regular and where soils may concentrate salts. High salt marsh zones often support a diverse assemblage of plants that may include species such as camphorweed *(Pluchea* spp.*)*, saltmarsh false-foxglove *(Agalinis maritima)*, annual saltmarsh aster *(Symphyotrichum subulatum)*, perennial saltmarsh aster *(Symphyotrichum tenuifolium)*, sea oxeye *(Borrichia frutescens)*, sea-lavender *(Limonium carolinianum)*, glassworts *(Salicornia* spp.*)*, sea pink *(Sabatia stellaris)*, and narrow loosestrife *(Lythrum lineare)*.

The salinity of tidal water is usually 18–30 ppt and flooding is less regular because of slightly elevated landscapes. Embedded in salt marshes are shallow, poorly drained depressions called “salt pannes.” Like the adjacent salt marsh, salt pannes are flooded by tidal water, but water does not drain freely into creeks or guts. After a panne has been flooded, the standing water evaporates and the salinity of the soil water greatly increases above the level of seawater, thus supporting the most salt tolerant perennials and annuals.

Salt scrub is generally species poor and composed only of plants tolerant of high salinity such as southern bayberry *(Morella cerifera)*, high-tide bush *(Baccharis halimifolia)*, and bigleaf marsh-elder *(Iva frutescens)*. These communities are found in saline environments throughout the outer Coastal Plain. Although salt scrub does occur in tidal habitats, it more commonly occupies higher, only irregularly flooded landscape positions in a mosaic with lower, regularly flooded salt marsh. Salt scrub stands often occur in maritime environments, where they are influenced especially by high winds and salt spray.

Sea-level fens are also associated with higher landscape positions in tidal salt marsh and shrubland systems. These small seepage wetlands develop at the upland edge of salt marshes where abundant groundwater discharges at the bases of gentle slopes. The hydrology of these sites is best characterized as saturated, although shallow standing water and small, muck-filled pools are locally present at most sites. The soils are organic and extremely nutrient poor.

Because of freshwater groundwater seepage, the vegetation of these features exhibits characteristics of both inland acidic seepage bogs and oligohaline tidal marshes. Stands are generally a mosaic of open woodland, scrub, and herbaceous patches. Sea-level fens are globally rare natural communities threatened by sea-level rise, encroachment of non-native species (e.g., *Phragmites*), and excessive nutrient input via agricultural runoff.

County Distribution: Dorchester, Somerset, St. Mary's, Wicomico, Worcester

Places to Visit: Assateague Island National Seashore

State Rare Natural Community: Sea-level Fen

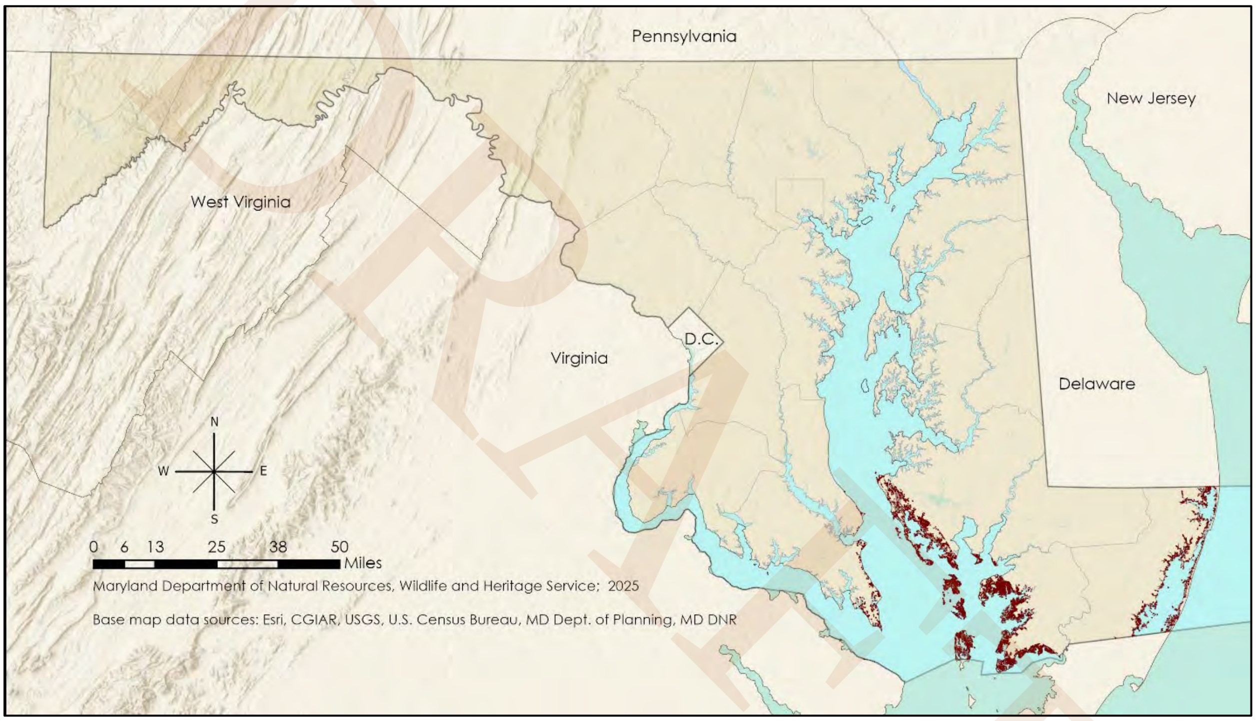


Figure 4.35 Location of Tidal Salt Marshes and Shrublands in Maryland. Sources: MD DNR, Nature Serve's Terrestrial Ecological Systems of the U.S.

Species of Greatest Conservation Need Associated with Tidal Salt Marshes and Shrublands:

Birds	Birds (continued)	Mammals
American barn owl	Least bittern	American mink
American bittern	Least tern	Bobcat
American black duck	Lesser yellowlegs	Eastern red bat
American oystercatcher	Little blue heron	Hoary bat
American peregrine falcon	Marsh wren	Least shrew
Bald eagle	Nelson's sparrow	Little brown bat
Black rail	Northern harrier	Silver-haired bat
Black skimmer	Pied-billed grebe	Tricolored bat
Black-crowned night heron	Royal tern	

Blue-winged teal
Boat-tailed grackle
Brown pelican
Common gallinule
Common nighthawk
Common tern
Dunlin
Eastern meadowlark
Forster's tern
Gadwall
Glossy ibis
Golden eagle
Great blue heron
Great egret
Greater yellowlegs
Gull-billed tern
Horned grebe
Laughing gull
Ruddy turnstone
Rufa red knot
Saltmarsh sparrow
Sanderling
Sandwich tern
Seaside sparrow
Sedge wren
Semipalmated sandpiper
Short-billed dowitcher
Short-eared owl
Snowy egret
Sora
Spotted sandpiper
Tricolored heron
Whimbrel
Willet
Yellow warbler
Yellow-crowned night heron

Insects (Coleoptera)

Keel-necked firefly
Salt marsh firefly

Insects (Lepidoptera)

Rare skipper

Plants

Maryland bur-marigold *(Bidens bidentoides)*
White spikerush *(Eleocharis albida)*
Saltmarsh spikerush *(Eleocharis halophila)*

Intertidal Mudflat and Sand Flat

Region(s): *Central, Eastern, Southern*
Habitat Group: *Tidal Wetlands*
NEAFWA: *Tidal Wetlands & Flats*


Jason Harrison, MD DNR

The Intertidal Mudflat and Sand Flat Key Wildlife Habitat (KWH) is characterized by mudflats and sand flats of embayed and riverine areas of the Coastal Plain. They are best developed in shallow, protected estuarine bays and pools, and along small tidal creeks and guts, with sand flats often occurring as tidally exposed extensions adjacent to areas of Coastal Beach KWH. The depth and frequency of tidal flooding are variable depending on the landscape setting, but most flats are exposed twice daily during low tide cycles. Additional intertidal areas are less frequently exposed during certain lunar cycles that cause extra low tides and especially during extended periods of strong winds. Though somewhat lacking in plant diversity, vascular aquatic species cover can be abundant with characteristic species such as eelgrass *(Vallisneria americana)*, beaked ditch-grass *(Ruppia maritima)*, horned pondweed *(Zannichellia palustris)*, and sago pondweed *(Potamogeton pectinatus)*. On some sites, aquatic algae can also be abundant and may frequently include species of sea-lettuce (*Ulva* spp.).

Mudflats are especially critical for invertebrate communities. Nutrient-rich and highly productive, Mudflats provide habitat for numerous aquatic invertebrates that form complex communities on the surface and in burrows within the soft sediment. Example species include mud snails, fiddler crabs, polychaete worms, mussels, clams, and oysters. These species serve as a significant food source for animals such as blue crabs, fish, and colonial waterbirds. The exposed Mudflats and Sand Flats also provide crucial resting areas for shorebirds, colonial waterbirds, and the diamond-backed terrapin (*Malaclemys terrapin*).

Among the stressors affecting this KWH are nutrification leading to oxygen-depleted dead zones, and land subsidence and sea-level rise leading to eventual submersion. However, drowned Mudflats may be replaced by new ones as tidal marshes become too flooded to maintain their vegetation and eventually become Mudflats..

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George’s, Queen Anne’s, Somerset, St. Mary’s, Talbot, Wicomico, Worcester

Places to Visit: Blackwater National Wildlife Refuge, Assateague Island National Seashore, Piscataway Park

State Rare Natural Community: Intertidal Shore

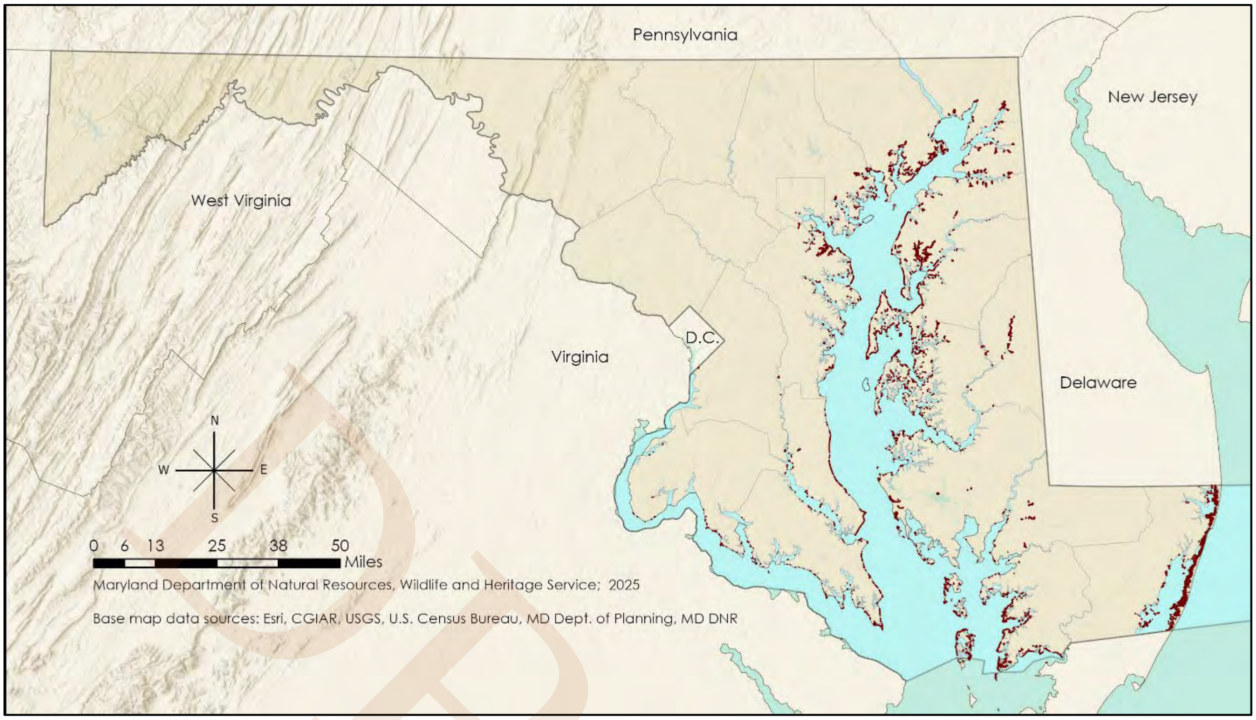


Figure 4.36 Location of Intertidal Mudflats and Sandflats in Maryland. Sources: USFWS, USGS, MD DNR.

Species of Greatest Conservation Need Associated with Intertidal Mudflats and Sandflats:

Birds

American black duck
American oystercatcher
American peregrine falcon
Bald eagle
Black skimmer
Black-bellied plover
Black-crowned night heron
Blue-winged teal
Brant
Brown pelican
Common tern
Dunlin
Forster's tern
Gadwall
Glossy ibis
Great blue heron
Great egret
Greater yellowlegs
Gull-billed tern
Laughing gull

Birds (continued)

Least tern
Lesser yellowlegs
Little blue heron
Piping plover
Roseate tern
Royal tern
Ruddy turnstone
Rufa red knot
Sanderling
Sandwich tern
Semipalmated sandpiper
Short-billed dowitcher
Snowy egret
Sora
Spotted sandpiper
Tricolored heron
Whimbrel
Willet
Wilson's plover
Yellow-crowned night heron

Mammals

Little brown bat

Reptiles

Diamond-backed terrapin

Insects (Coleoptera)

Eastern beach tiger beetle

Plants

Water pygmyweed *(Crassula aquatica)*
Mudwort *(Limosella australis)*
Spongy arrowhead *(Sagittaria spatulata)*

Artificial Wetlands

Artificial Impoundment and Artificial Wetland

***Region(s):** All*
***Habitat Group:** Artificial Wetlands*
***NEAFWA:** Lakes & Ponds*
***Additional Notes:** An artificial or human-made habitat*

Jason Harrison, MD DNR

Lakes usually form naturally when water collects in basins created from geological processes, such as glacial scouring. No such geologically formed natural lakes occur in Maryland because the state lies well south of the southern extent of glaciation. While Maryland does contain some small natural, open freshwater habitats—including beaver impoundments, wetland openings (e.g., Delmarva Bays, Vernal Pools, montane bogs and fens, flooded riverine floodplain openings), and river oxbows—that provide habitat for a variety of Species of Greatest Conservation Need (SGCN), the number and overall extent of the state's natural open water areas and wetlands have been greatly reduced due to various forms of ditching, drainage, degradation, and conversion of wetlands and stream and river habitats. Beaver populations in many parts of the state have also never fully recovered from pre-1900 declines due to fur trapping pressure, and the long-term effects on aquatic ecosystems and associated wildlife have been significant.

Although these natural habitats are few in number, numerous man-made lakes, ponds, pools, and wetlands of varying sizes exist in Maryland. These habitats are usually the result of water diversion. In many cases, impoundments were created at the expense of natural streams and river systems or natural marshes. Unfortunately, many man-made ponds and wetlands, such as stormwater management ponds, are lacking or have somewhat limited suitability as habitat for most SGCN. In other instances, however, artificial impoundments provide critical refugia where natural aquatic habitats have been destroyed or degraded (e.g., black-banded sunfish *[Enneacanthus chaetodon])*.

Large artificial impoundments in the Chesapeake Bay, such as Hart-Miller Island and Poplar Island, have been created by the U.S. Army Corps of Engineers to hold dredge spoil from shipping channels. While dredging is ongoing, these areas provide important stopover feeding and resting habitat for migrant shorebirds. When active dredging ends, these areas dry up unless water is pumped in to maintain some areas as artificial wetlands and mudflats. The dried out open areas can become suitable for colonial nesting waterbirds, especially terns. Since these large artificial islands are designed to be permanent, the habitats they contain can be planned and designed to support SGCN, and will require regular maintenance to sustain them long-term. Smaller dredge spoil impoundments are usually created on land and are often too small and too short-lived to support SGCN for more than a few years. These areas usually become overgrown by the invasive common reed (*Phragmites australis* spp. *australis*).

County Distribution: Statewide

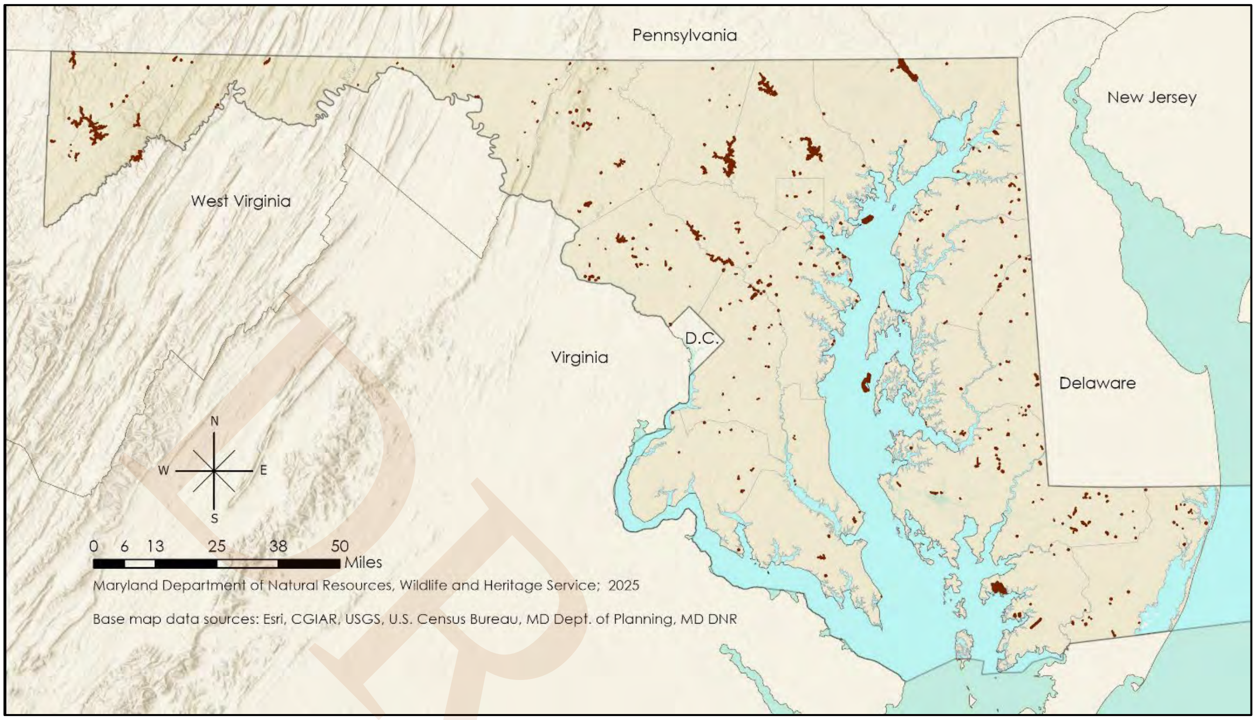


Figure 4.37 Location of Artificial Impoundments and Artificial Wetlands in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Artificial Impoundments and Artificial Wetlands:

Birds
American bittern
American black duck
Bald eagle
Black rail
Black scoter
Black-bellied plover
Black-crowned night heron
Blue-winged teal
Canvasback
Common gallinule
Common goldeneye
Common loon
Dunlin
Gadwall
Glossy ibis
Golden eagle
Great blue heron
Great egret
Greater scaup
Greater yellowlegs

Birds (continued)
Rufa red knot
Sanderling
Semipalmated sandpiper
Short-billed dowitcher
Snowy egret
Sora
Spotted sandpiper
Surf scoter
Swamp sparrow
Tricolored heron
White-winged scoter
Willet
Yellow warbler

Mammals
American mink
Eastern red bat
Hoary bat
Indiana bat
Little brown bat

Fish
Blackbanded sunfish
Striped shiner

Invertebrates (Aquatic)
Eastern lampmussel
Northern lance
Paper pondshell

Insects (Odonata)
American emerald
Atlantic bluet
Black-tipped darner
Burgundy bluet
Canada darner
Elfin skimmer
Green-striped darner
Little blue dragonlet
Pale bluet
Rainbow bluet
Rapids clubtail

Gull-billed tern
Horned grebe
Least bittern
Lesser scaup
Lesser yellowlegs
Little blue heron
Long-tailed duck
Pied-billed grebe
Red phalarope
Red-necked phalarope
Redhead
Ruddy turnstone

Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians

Barking treefrog
Eastern narrow-mouthed toad
Eastern tiger salamander

Reptiles

Eastern box turtle
Eastern musk turtle
Eastern spiny softshell
Diamond-backed terrapin
Queensnake
Spotted turtle

Spatterdock darner

Plants

Broadleaf water-milfoil
(Myriophyllum heterophyllum)
Flatstem pondweed
(Potamogeton zosteriformis)

Aquatic Habitats
Streams and Rivers

Coldwater Stream

Region(s): *Central, Western*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

Richard Wiegand, MD DNR

Coldwater Streams are freshwater streams that are unique in form, function, and biota. They are most common in the Appalachian Plateau and Ridge and Valley physiographic provinces, particularly in the Youghiogheny and North Branch Potomac drainages, but are also found in the Piedmont physiographic province within the Middle Potomac, Susquehanna, Gunpowder, and Patapsco drainages. These streams may support coldwater taxa such as trout and stoneflies. They are characterized by a maximum daily mean water temperature of less than 20° C and dissolved oxygen levels greater than 5 mg/L. Coldwater streams are typically found only in the headwater reaches of a watershed. Most are riffle-dominated, high gradient (>2%) streams with well-shaded riparian canopies allowing for aeration and regulation of water temperature. Fallen trees play an important role in shaping Coldwater Stream channels, creating pools and slow-water areas beneficial to aquatic species. Logs and leaf litter are also a primary source of organic matter that form the base of the food web. In certain areas, beaver activity along Coldwater Streams may represent an important form of natural disturbance and create habitat heterogeneity. Beaver impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife Species of Greatest Conservation Need.

Compared to downstream and warm water streams, aquatic biodiversity and productivity are low, with few fish and benthic macroinvertebrate species. Brook trout *(Salvelinus fontinalis)*, Maryland's only native trout species, are found in these streams along with introduced brown and rainbow trout. Common nongame fish species include mottled *(Cottus bairdii)* and Blue Ridge sculpin, longnose dace, and creek chub. Stoneflies of the genera *Sweltsa* and *Tallaperla* are considered coldwater obligate taxa (i.e., found only in these habitats). Mayflies of the genera *Ephemerella*, *Epeorus*, *Stenonema*, and *Paraleptophlebia* often dominate the benthic macroinvertebrate community. In contrast to the low diversity of fish species, Coldwater Streams support the greatest diversity of aquatic and semi-aquatic salamanders in the state, including spring salamanders *(Gyrinophilus porphyriticus)*, seal salamanders *(Desmognathus monticola)*, and mountain dusky salamanders *(Desmognathus ochrophaeus)*.

The quantity and quality of Coldwater Stream habitats have declined as a result of disturbance associated with agriculture and urban development. Although the historical extent of Coldwater Streams in Maryland is not known, these streams were likely more widespread in the past.

County Distribution: Allegany, Anne Arundel, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Prince George's, Washington

Places to Visit: Savage River State Forest, Big Run State Park, Gunpowder Falls State Park

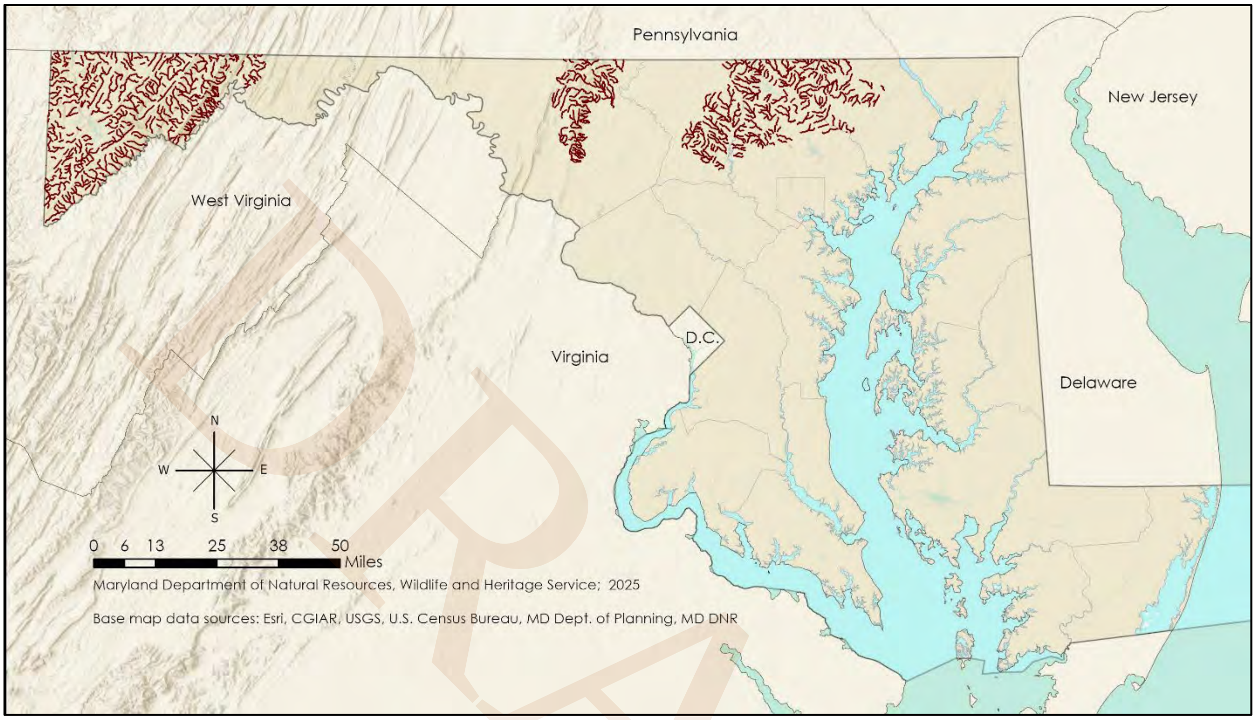


Figure 4.38 Location of Coldwater Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Coldwater Streams:

Birds
Louisiana waterthrush

Amphibians
Eastern hellbender
Longtail salamander
Mountain dusky salamander
Red salamander
Seal salamander
Spring salamander

Reptiles
Eastern ribbonsnake
Queensnake
Wood turtle

Mammals
American mink
Eastern red bat
Eastern small-footed bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Southern water shrew
Tricolored bat

Fish
Brook trout
Mottled sculpin

Insects (Aquatic Orders)
Dusky sallfly
Lash springfly
Lobed stone
Pocahontas sallfly
Shenandoah sallfly

Insects (Odonata)
Harpoon clubtail
Mustached clubtail
Ski-tailed emerald
Southern pygmy clubtail
Spine-crowned clubtail
Superb jewelwing
Zebra clubtail

Invertebrates (Aquatic)
Rock crayfish

Limestone Stream

Region(s): *Western*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

Wikimedia Commons

Limestone Streams are strongly influenced by the underlying geology of the Ridge and Valley physiographic province of Maryland, resulting in systems that are physically and chemically distinct from freestone (non-limestone) streams. Fractures, cracks, and channels are abundant in limestone, making springs and seeps common. This connectivity between groundwater and surface water serves to stabilize water pH and temperature. Submerged logs and tree roots are important features in Limestone Streams that shape channels and create pools and other slow-water areas beneficial to aquatic species. Logs and leaf litter form the base of the food web in these streams. Limestone Streams are also biologically unique. Plants, such as watercress *(Rorippa nasturtium-aquaticum)* and waterweed *(Elodea* spp.*)* are abundant, especially near spring sources and groundwater seeps. Fish and benthic macroinvertebrate communities tend to exhibit low diversity but maintain high abundance in response to the stable water chemistry. In certain areas, beaver activity along Limestone Streams may represent an important form of natural disturbance and create habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife Species of Greatest Conservation Need. Fish species common in Limestone Streams include checkered sculpin (*Cottus* n. sp.) and Allegheny pearl dace (*Margariscus margarita*). In contrast to the region's freestone streams, which are dominated by mayfly and stonefly taxa, the benthic macroinvertebrate communities of Limestone Streams tend to be dominated by crustaceans, like scuds and aquatic sow bugs.

The majority of Maryland's Limestone Streams are located in the Ridge and Valley physiographic province, a predominately agricultural area that is under increasing pressure from suburban development. Agricultural land-use practices have altered many of these streams by chemical and physical degradation.

County Distribution: Frederick, Washington

Places to Visit: Chesapeake and Ohio National Park at Antietam Creek, South Mountain State Park

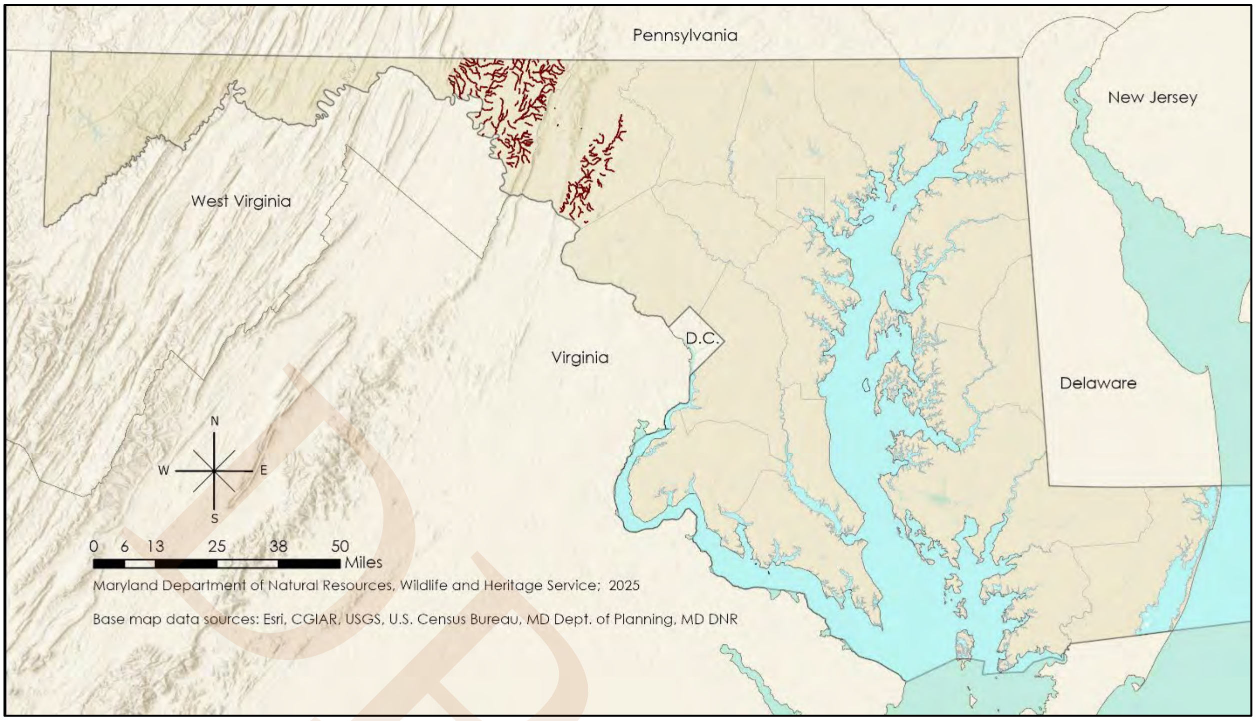


Figure 4.39 Location of Limestone Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Limestone Streams:

Birds
Louisiana waterthrush

Mammals
American mink
Eastern red bat
Eastern small-footed bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians
Longtail salamander
Red salamander
Spring salamander

Reptiles
Eastern ribbonsnake
Queensnake
Wood turtle

Fish
Allegheny pearl dace
Checkered sculpin

Highland Stream

Region(s): *Western*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

Paul Kayzak, MD DNR

Highland Streams flow through several physiographic regions, including the Appalachian Plateau, Ridge and Valley, and Blue Ridge. They are typically high gradient systems (>4 %), ranging in elevation from 140 to 2,800 feet. Their substrate is dominated by gravel, cobble, and boulders interspersed with bedrock outcroppings. Many of these streams fall within the rain shadow of the Appalachians, and thus receive the lowest annual rainfall amounts in the state. Consequently, stream flow in the summer is often markedly reduced for many Highland Streams. In certain areas, beaver activity along Highland Streams may represent an important form of natural disturbance and create habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife Species of Greatest Conservation Need. Native fish species found in Highland Streams include mottled sculpin (*Cottus bairdii*), Potomac sculpin, silverjaw minnow, striped shiner *(Luxilus chrysocephalus)*, and fantail darter. Stoneflies and mayflies often dominate the benthic macroinvertebrate community. Streamside trees and logs play an important role in shaping Highland Stream channels and banks, creating pools and slow-water areas beneficial to aquatic species. Logs and leaf litter are also a primary source of organic matter, forming the base of the food web in these streams.

County Distribution: Allegany, Frederick, Garrett, Washington

Places to Visit: Green Ridge State Forest

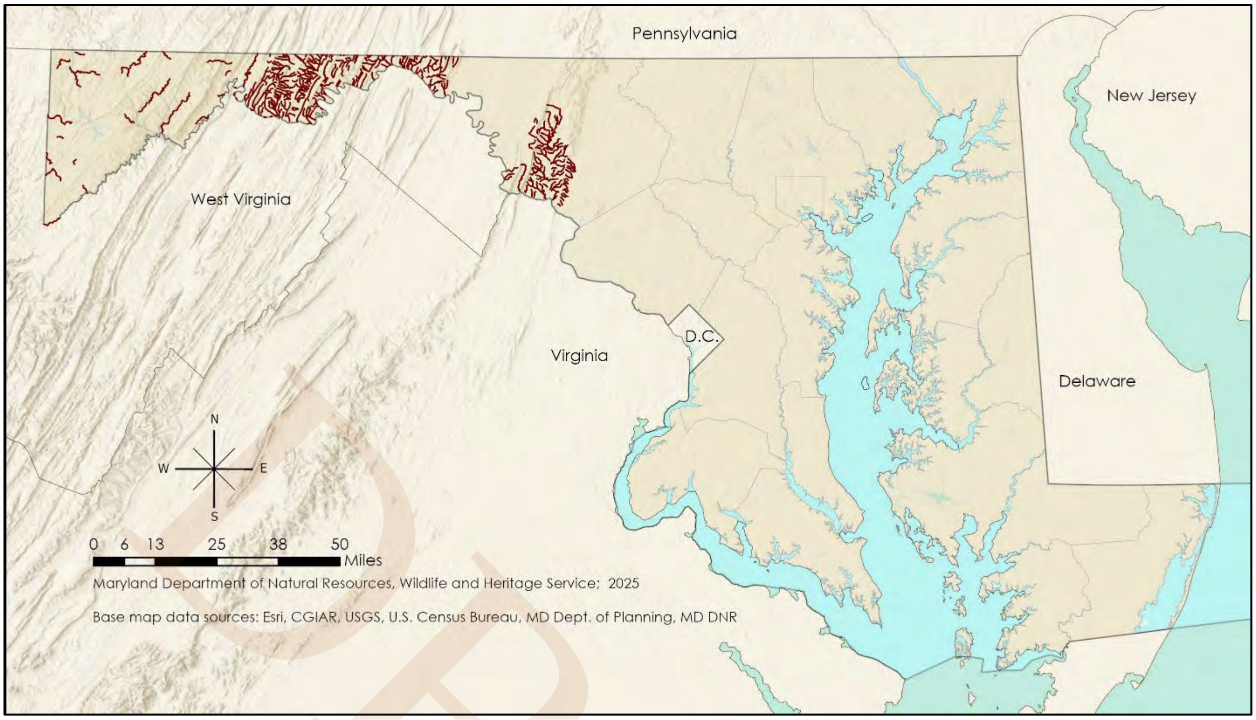


Figure 4.40 Location of Highland Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Highland Streams:

Birds
Louisiana waterthrush

Mammals
American mink
Eastern red bat
Eastern small-footed bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians
Common mudpuppy
Eastern hellbender
Longtail salamander
Mountain dusky salamander
Red salamander
Seal salamander
Spring salamander

Reptiles
Eastern ribbonsnake
Queensnake
Wood turtle

Fish
Comely shiner
Johnny darter
Longnose sucker
Mottled sculpin
Stonecat
Striped shiner

Invertebrates (Aquatic)
Allegheny crayfish
Brook floater
Creeper
Green floater
Rock crayfish
Triangle floater

Insects (Coleoptera)
Appalachian tiger beetle

Insects (Odonata)
Appalachian jewelwing
Green-faced clubtail
Harpoon clubtail
Maine snaketail
Mustached clubtail
Rapids clubtail
Ski-tailed emerald
Southern pygmy clubtail
Spine-crowned clubtail
Splendid clubtail
Uhler's sundragon
Zebra clubtail

Piedmont Stream

***Region(s):** Central*
***Habitat Group:** Streams/Rivers*
***NEAFWA:** Rivers & Streams*

Jay Kilian, MD DNR

Piedmont Streams, located from the western boundary of the Catoctin Mountains in Frederick County to the eastern border at the Fall Line, are among the most biologically productive systems in the state. The physical and chemical nature of Piedmont Streams is governed largely by the varying topography and geology of the Piedmont physiographic province. Streams along the eastern edge share similar physical characteristics with the neighboring Coastal Plain. Here, streams are typically low to moderate in gradient (1-2%) with silt, sand, and gravel substrates. High gradient streams west of the Fall Line are characterized by cobble-boulder substrates with bedrock outcrops. In certain areas, beaver activity along Piedmont Streams may represent an important form of natural disturbance and create habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife Species of Greatest Conservation Need.

Fish species commonly found in Piedmont Streams include American eel, tessellated darter, blacknose dace, Blue Ridge sculpin, common shiner, longnose dace, and bluntnose minnow. Streamside trees, roots, and submerged logs shape the stream channel and banks, creating pools, slow-water areas, and important cover habitat for a variety of aquatic species. Logs and leaf litter are also a primary source of organic matter, forming the base of the food web in these streams. River basins with Piedmont Streams draining into Chesapeake Bay include Susquehanna, Elk, Bush, Gunpowder, Patapsco, the upper portion of the Patuxent River, Middle Potomac, and the eastern portion of the Potomac-Washington Metro basins.

Maryland's Piedmont physiographic province has been the center of urban and suburban development in the state. Stream degradation associated with urbanization, including erosion, sedimentation, pollution, hydroperiod alterations (i.e., flashiness), and increased nutrients and temperatures, has reduced the biodiversity and ecological integrity of many Piedmont Streams.

County Distribution: Anne Arundel, Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery, Prince George's

Places to Visit: Gunpowder State Park, Patapsco Valley State Park, Seneca Creek State Park

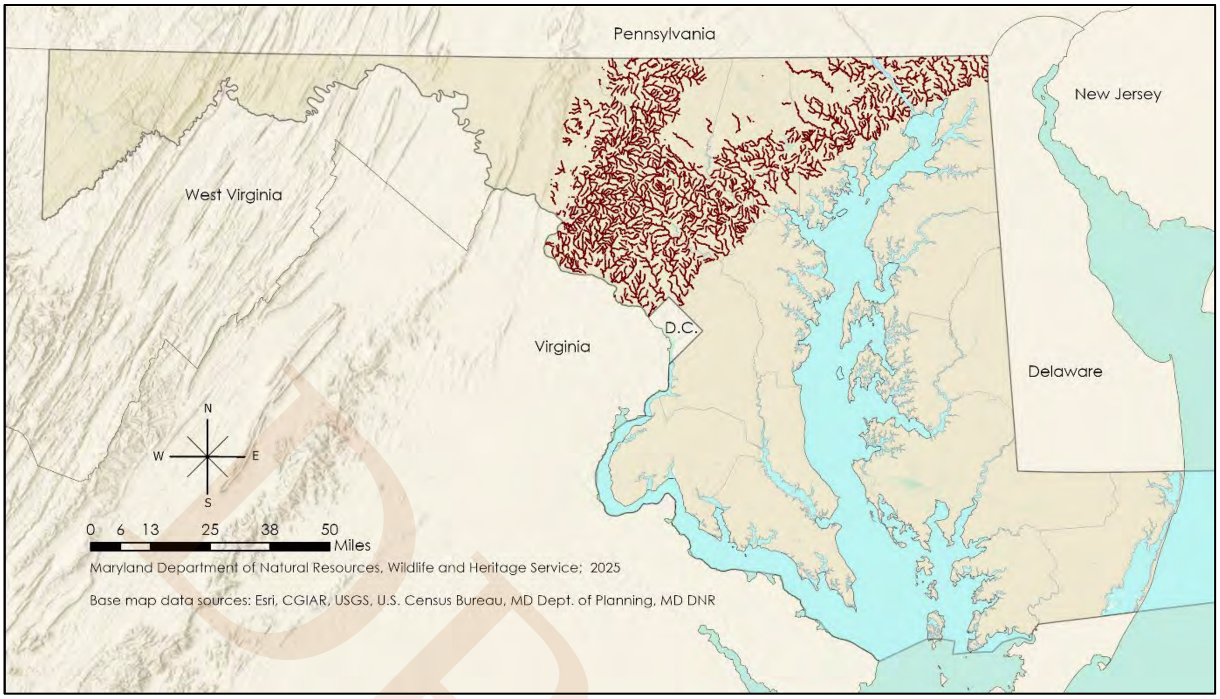


Figure 4.41Location of Piedmont Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Piedmont Streams:

Birds
Louisiana waterthrush
Yellow-crowned night heron

Mammals
American mink
Eastern red bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians
Longtail salamander
Red salamander
Spring salamander

Reptiles
Bog turtle
Eastern musk turtle
Eastern ribbonsnake
Queensnake
Spotted turtle
Wood turtle

Fish
Alewife
American shad
Blueback herring
Chesapeake logperch
Comely shiner
Hickory shad
Shield darter

Insects (Aquatic Orders)
Vernal springfly

Invertebrates (Aquatic)
Cambarus sp. C (formerly acuminate crayfish)
Allegheny crayfish
Brook floater
Creeper
Green floater
Triangle floater
Yellow lance

Insects (Odonata)
Appalachian snaketail
Laura's clubtail
Royal river cruiser
Southern pygmy clubtail
Spine-crowned clubtail

Coastal Plain Stream

Region(s): *Central, Eastern, Southern*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

MBSS, MD DNR

Maryland's Coastal Plain Streams extend from the Fall Line eastward toward the Atlantic Ocean. These streams are typically low in gradient (<1%) and found at elevations of less than 50 feet above sea level. They represent the lower non-tidal and upper fresh tidal (salinity < 0.5 ppt) sections of larger stream and river systems, and form transition zones between upper non-tidal reaches and increasingly larger, saline tidal sections. Silt, sand, gravel, and small cobble are the dominant substrates. Most Coastal Plain Streams contain only runs, glides, and pools; however, gravel riffles are common in those streams draining the rolling hills on the western and upper eastern shore. Streams on the lower eastern shore are extremely sluggish with broad floodplains and braided channels. Since Coastal Plain Streams lack stable substrates such as bedrock and boulders, wood and submerged aquatic vegetation are important channel features. Submerged logs and tree roots slow the flow of nutrients and sediment, provide cover for fishes and stream insects, and control stream bank erosion. In certain areas, beaver activity along Coastal Plain Streams may represent an important form of natural disturbance and create habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife Species of Greatest Conservation Need.

Eastern mudminnow, bluespotted sunfish, eastern creek chubsucker, and least brook lamprey are common Coastal Plain Stream fishes. These streams are also an important habitat for the American eel from the juvenile to adult stage. Sandy and gravel substrates of Coastal Plain Streams support a diverse community of freshwater mussels (*Unionidae*), many of which are listed as In Need of Conservation, Threatened, or Endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. The Chester, Choptank, Nanticoke/Wicomico, Pocomoke, Lower Potomac, Patapsco, Gunpowder, Elk, Lower Susquehanna, Bush, Potomac-Washington Metro, West Chesapeake, and Patuxent River basins all contain Coastal Plain Streams.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Harford, Howard, Kent, Prince George's, Queen Anne's, St. Mary's, Talbot

Places to Visit: Tuckahoe State Park, Millington Wildlife Management Area, Myrtle Grove Wildlife Management Area

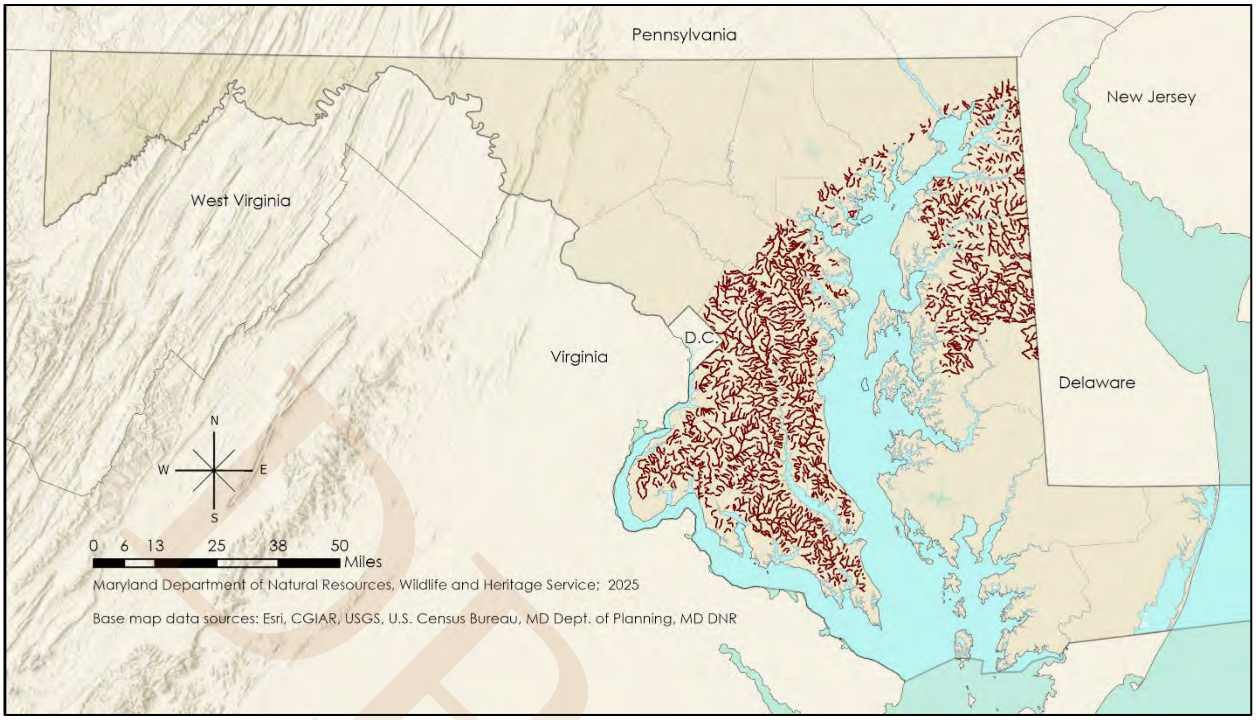


Figure 4.42 Location of Coastal Plain Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Coastal Plain Streams:

Birds
Great blue heron
Great egret
Louisiana waterthrush
Yellow-crowned night heron

Mammals
American mink
Eastern red bat
Hoary bat
Little brown bat
Silver-haired bat
Tricolored bat

Amphibians
Mud salamander
Red salamander

Reptiles
Eastern mud turtle
Eastern musk turtle
Eastern ribbonsnake
Plain-bellied watersnake
Queensnake
Rainbow snake
Spotted turtle
Striped mud turtle
Wood turtle

Fish
American brook lamprey
Bridle shiner
Chesapeake logperch
Comely shiner
Flier
Glassy darter
Ironcolor shiner
Mud sunfish
Shield darter
Stripeback darter
Swamp darter

Invertebrates (Aquatic)
Cambarus sp. C (formerly acuminate crayfish)
Alewife floater
Creeper
Dwarf wedgemussel
Eastern lampmussel
Eastern pondmussel
Northern lance
Paper pondshell
Tidewater mucket
Triangle floater

Insects (Odonata)
Appalachian snaketail
Banded spiketail
Blackwater bluet
Coppery emerald
Laura's clubtail
Royal river cruiser
Selys' sundragon
Sparkling jewelwing
Uhler's sundragon

Blackwater Stream

Region(s): *Central, Eastern, Southern*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

Jay Kilian, MD DNR

Blackwater Streams are sluggish, low gradient (<1%) systems predominantly located within the Pocomoke and Nanticoke/Wicomico basins of Maryland's Coastal Plain physiographic province. They are generally acidic, with pH levels less than 6, and dissolved organic carbon greater than 8 mg/L. In contrast to other streams, dissolved oxygen levels are low (< 5mg/L) due to increased bacterial respiration from the decomposition of organic matter. The substrate consists primarily of silt, sand, and organic matter, with minor and isolated amounts of small gravel. Because of the lack of a larger, more stable substrate, in-stream wood is of critical importance in defining hydrologic features and providing cover for the aquatic biota.

Biodiversity in Blackwater Streams is typically low and limited to only organisms that are tolerant of the naturally acidic conditions. In certain areas, beaver activity along Blackwater Streams may represent an important form of natural disturbance and create habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife Species of Greatest Conservation Need. Common fishes include eastern mudminnow, pirate perch, golden shiner, eastern creek chubsucker, tadpole madtom, and redfin pickerel. The benthic macroinvertebrate community is dominated by dragonfly, amphipod, and isopod taxa.

County Distribution: Anne Arundel, Calvert, Caroline, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Pocomoke State Park, Zekiah Swamp Natural Environmental Area

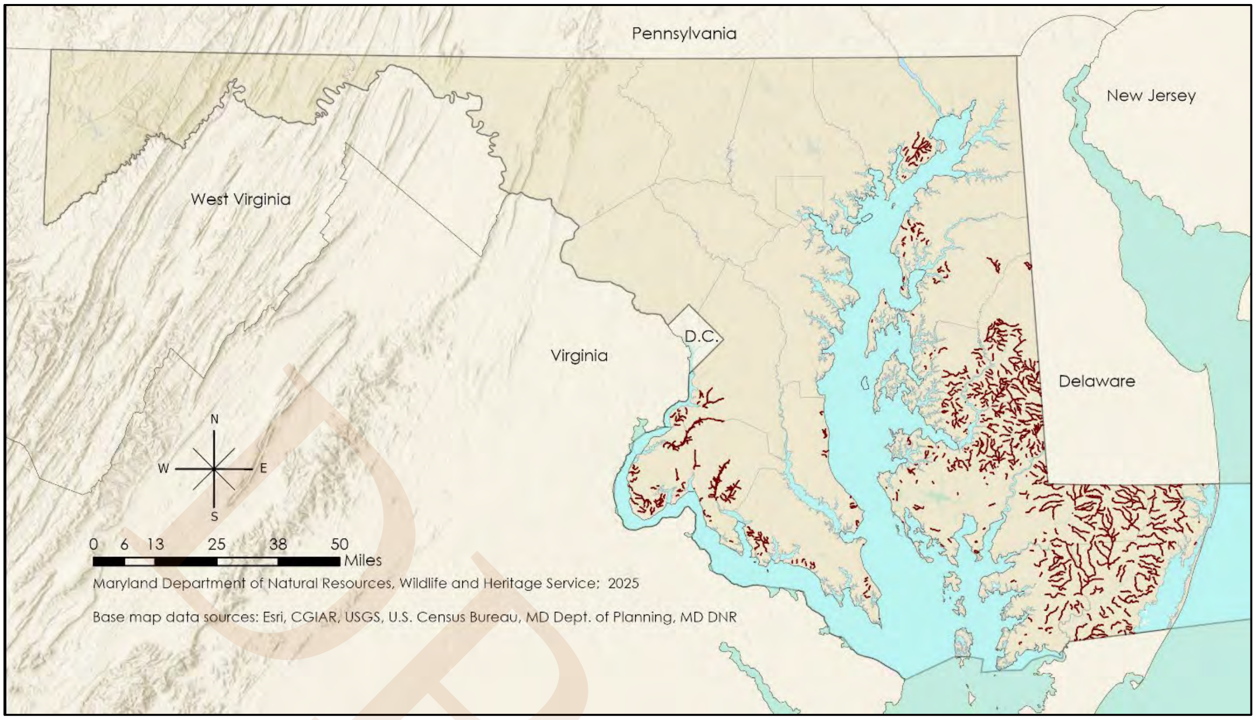


Figure 4.43 Location of Blackwater Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Blackwater Streams:

Birds
Great blue heron
Great egret
Louisiana waterthrush

Mammals
American mink
Eastern red bat
Hoary bat
Silver-haired bat
Tricolored bat

Amphibians
Mud salamander

Reptiles
Eastern mud turtle
Eastern ribbonsnake
Plain-bellied watersnake
Queensnake
Spotted turtle
Striped mud turtle

Fish
Banded sunfish
Blackbanded sunfish
Flier
Ironcolor shiner
Mud sunfish
Swamp darter

Invertebrates (Aquatic)
Alewife floater
Eastern lampmussel
Northern lance

Insects (Odonata)
Blackwater bluet
Coppery emerald
Royal river cruiser
Selys' sundragon
Sparkling jewelwing

Highland River
Region(s): *Western*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

James McCann, MD DNR

Large Highland Rivers in Maryland are located in the western portion of the state in the Youghiogheny and Potomac River basins. Highland Rivers consist of riffle/run and pool habitat sequences with substrate ranging from large boulders to sand and silt. The energy base for these systems includes large woody debris and leaf litter, as well as primary production by periphyton, phytoplankton, and aquatic macrophytes. These large river systems support a diversity of game fish species including smallmouth bass, chain pickerel, and walleye. Several gamefish species (tiger muskellunge, walleye, brown trout, and rainbow trout) are stocked in Highland Rivers. Nongame species common in these systems include redbreast sunfish, rock bass, Potomac sculpin, northern hogsucker, and margined madtom.

Degradation and loss of species associated with highland and coldwater tributaries have ultimately affected the downstream conditions of Maryland’s Highland River habitats. Highland Rivers serve as receiving waters for effluents from industrial sources and municipal sewage treatment plants. The damming of Highland Rivers for drinking water reservoirs and hydroelectric power generation has altered these habitats considerably, often reducing available habitats for many fish and mussel Species of Greatest Conservation Need.

County Distribution: Allegany, Frederick, Garrett, Washington

Places to Visit: Potomac State Forest, Green Ridge State Forest, Sideling Hill Wildlife Management Area, Swallow Falls State Park

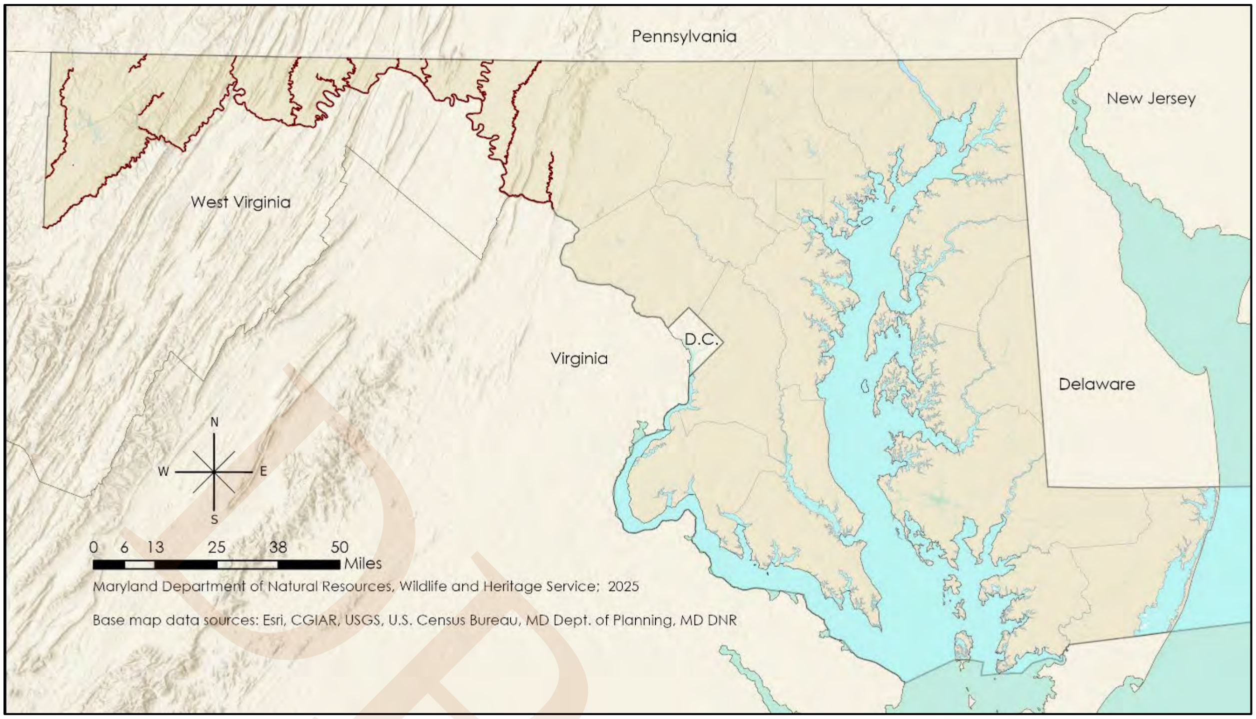


Figure 4.44 Location of Highland Rivers in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Highland Rivers:

Birds
Bald eagle
Great blue heron
Great egret
Louisiana waterthrush
Spotted sandpiper

Mammals
American mink
Eastern red bat
Eastern small-footed bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians
Common mudpuppy
Eastern hellbender

Reptiles
Eastern spiny softshell
Queensnake
Wood turtle

Fish
Johnny darter
Longnose sucker
Stonecat
Striped shiner

Invertebrates (Aquatic)
Allegheny crayfish
Brook floater
Creeper
Eastern lampmussel
Green floater
Paper pondshell
Triangle floater
Yellow lampmussel

Insects (Coleoptera)
Appalachian tiger beetle
Potomac firefly

Insects (Odonata)
Appalachian jewelwing
Green-faced clubtail
Maine snaketail
Midland clubtail
Pygmy snaketail
Rapids clubtail
Royal river cruiser
Rusty snaketail
Spine-crowned clubtail
Splendid clubtail
St. Croix snaketail

Piedmont River

Region(s): *Central*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

Large rivers of the Piedmont physiographic province represent transitional habitats between headwater streams and tidal portions of Chesapeake Bay. Physically, Piedmont Rivers consist of large riffle/run and pool sequences with substrate ranging from large boulders to sand and silt. As transition zones between upland habitats and lowlands of the Coastal Plain, Piedmont Rivers are home to a diverse aquatic fauna, often consisting of a mixture of Piedmont and lowland species. Chemical, physical, and hydrologic stability typical of large Piedmont Rivers also contributes to high species diversity.

Fish species common to Piedmont Rivers include American eel, river chub, spottail shiner, common shiner, white sucker, pumpkinseed, redbreast sunfish, bluegill, rock bass, quillback, margined madtom, and channel catfish. Popular game fishes include smallmouth bass and largemouth bass. Piedmont Rivers provide spawning habitat for many migratory fish species of the Chesapeake Bay such as blueback herring *(Alosa aestivalis)*, alewife *(Alosa pseudoharengus)*, white perch, yellow perch, striped bass, and several species of shad. Piedmont Rivers also serve as wintering habitats for migratory waterfowl. Although logs and leaf litter still play a large role in the food base of these systems, open tree canopies allow for the growth of periphyton, phytoplankton, and aquatic macrophytes, providing additional sources of energy to the food chain. Connectivity between river channels and the adjacent floodplain is important for the movement and exchange of organic matter in these systems. Floodplains also provide refuge for aquatic species during periods of high flows. Piedmont River habitat can be found in portions of the Susquehanna, Gunpowder, and Patapsco Rivers, the upper portion of the Patuxent River, and the eastern portion of the Potomac-Washington Metro, and Middle Potomac basins.

Piedmont Rivers are often located in highly urbanized portions of Maryland. Stressors associated with urbanization have negative effects on these habitats. Combined sewer overflows designed to carry domestic, commercial, and industrial wastewater often deliver untreated sewage to Piedmont Rivers during storm flows. These outflows can reduce the biological health of these habitats. As with Highland Rivers, Piedmont Rivers have also been impounded for drinking water reservoirs and for hydroelectric power generation. Impoundments have reduced the available habitat for several fish and mussel Species of Greatest Conservation Need and also reduced upstream access to spawning grounds by many migratory fishes. Furthermore, the degradation of upstream Piedmont and Coldwater Streams within the greater watershed areas has negatively affected downstream Piedmont Rivers.

County Distribution: Baltimore, Carroll, Cecil, Frederick, Harford, Howard, Montgomery

Places to Visit: Patapsco Valley State Park, Gunpowder Falls State Park, Susquehanna State Park

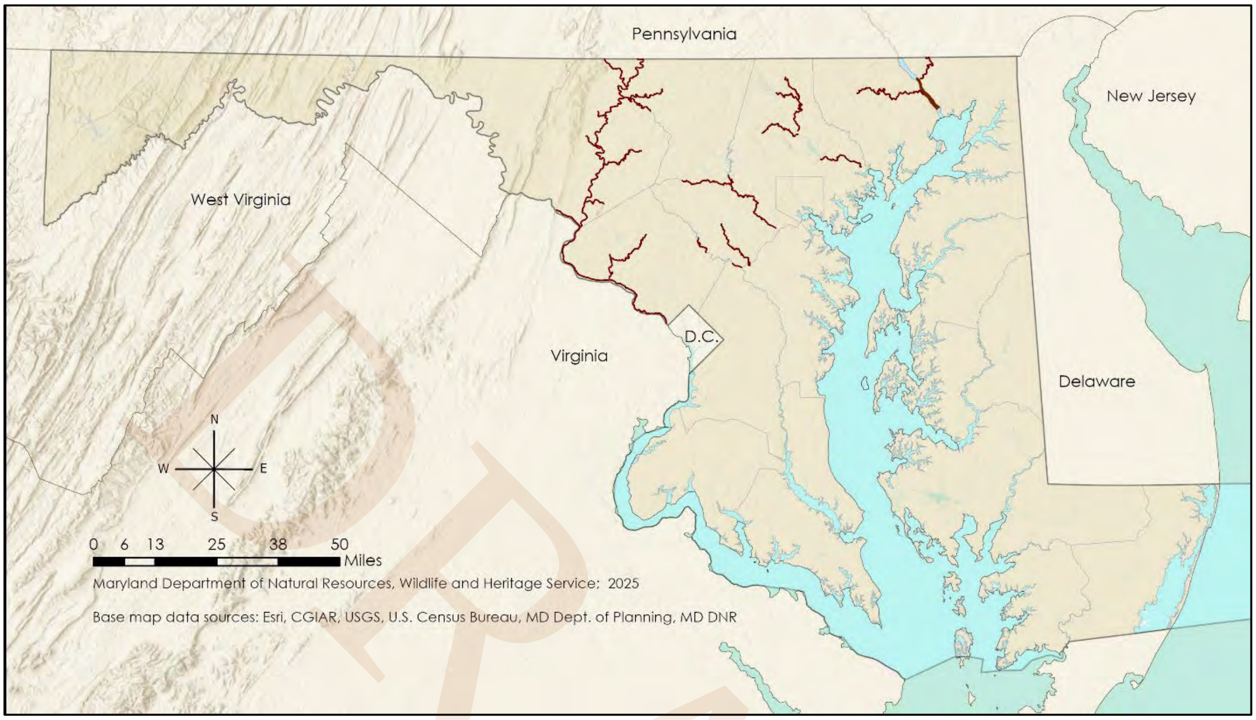


Figure 4.45 Location of Piedmont Rivers in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Piedmont Rivers:

Birds
Bald eagle
Great blue heron
Great egret
Horned grebe
Louisiana waterthrush
Pied-billed grebe
Spotted sandpiper
Yellow-crowned night heron

Mammals
American mink
Eastern red bat
Hoary bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians
Eastern hellbender

Reptiles
Northern map turtle
Queensnake
Wood turtle

Fish
Alewife
American shad
Blueback herring
Chesapeake logperch
Comely shiner
Hickory shad
Shield darter

Invertebrates (Aquatic)
Alewife floater
Allegheny crayfish
Brook floater
Creeper
Eastern lampmussel

Invertebrates (Aquatic, continued)
Green floater
Paper pondshell
Tidewater mucket
Triangle floater
Yellow lampmussel
Yellow lance

Insects (Aquatic Orders)
Vernal springfly

Insects (Odonata)
Appalachian snaketail
Green-faced clubtail
Laura's clubtail
Midland clubtail
Rapids clubtail
Royal river cruiser
Rusty snaketail
Spine-crowned clubtail
St. Croix snaketail

Coastal Plain River

Region(s): *Central, Eastern, Southern*
Habitat Group: *Streams/Rivers*
NEAFWA: *Rivers & Streams*

Jason Harrison, MD DNR

Coastal Plain Rivers are low-gradient, slow-flowing rivers (typically fifth order and larger) in the Lower and Upper Coastal Plain physiographic provinces. They represent the lower non-tidal and upper fresh tidal (salinity < 0.5 ppt) sections of larger river systems, and form transition zones between upper non-tidal river sections and increasingly larger, saline tidal sections that eventually flow into and form part of the Chesapeake Bay. Coastal Plain Rivers consist of predominantly pool/glide habitat with sand and silt substrates. Large woody debris is a prominent element in structuring pool habitat and serves as an important source of coarse organic matter to riverine food webs. Open tree canopies allow for the growth of microorganisms (e.g., periphyton, phytoplankton) as well as aquatic plants, which serve as primary producers within these habitats. Connectivity between river channels and the adjacent floodplain is important for the movement and exchange of organic matter in Coastal Plain River systems. Floodplains provide refugia for aquatic species during periods of high flows and for prey species from main channel fish predators. The extensive pool habitat common in Coastal Plain Rivers is home to many large predator fish species, typically uncommon in headwater Coastal Plain Streams.

Fish species common to Coastal Plain Rivers include American eel, pumpkinseed, redbreast sunfish, bluegill, shorthead redhorse, quillback, longnose gar, and warmouth. Popular game fishes in these rivers include largemouth bass, chain pickerel, and black crappie. Coastal Plain Rivers also provide spawning habitat for many migratory fish species of Chesapeake Bay, such as Atlantic sturgeon *(Acipenser oxyrinchus)*, striped bass, blueback herring *(Alosa aestivalis)*, alewife *(Alosa pseudoharengus)*, white perch, yellow perch, American shad (*Alosa sapidissima*), and hickory shad (*Alosa mediocris*). Sand and gravel substrates of Coastal Plain Rivers support a diverse community of freshwater mussels (*Unionidae*), many of which are listed as In Need of Conservation, Threatened, or Endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. Coastal Plain Rivers also serve as wintering habitats for migratory waterfowl. Coastal Plain River habitats can be found in portions of the Chester, Choptank, Nanticoke, Lower Potomac, Patapsco, Patuxent, Pocomoke, Potomac-Washington Metro, and Wicomico river basins.

Degradation and loss of species associated with Coastal Plain and Blackwater Stream tributaries upstream have ultimately affected the downstream conditions of Maryland's Coastal Plain River habitats. Maryland Coastal Plain Rivers also tend to be located in predominantly agriculturally focused watersheds, meaning that nutrient enrichment and sedimentation associated with agricultural land-use practices have reduced habitat quality and quantity available to many fish and mussel Species of Greatest Conservation Need. Stream blockages have also reduced upstream access to spawning habitats for migratory fishes.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Tuckahoe State Park, Idylwild Wildlife Management Area, Pocomoke State Park

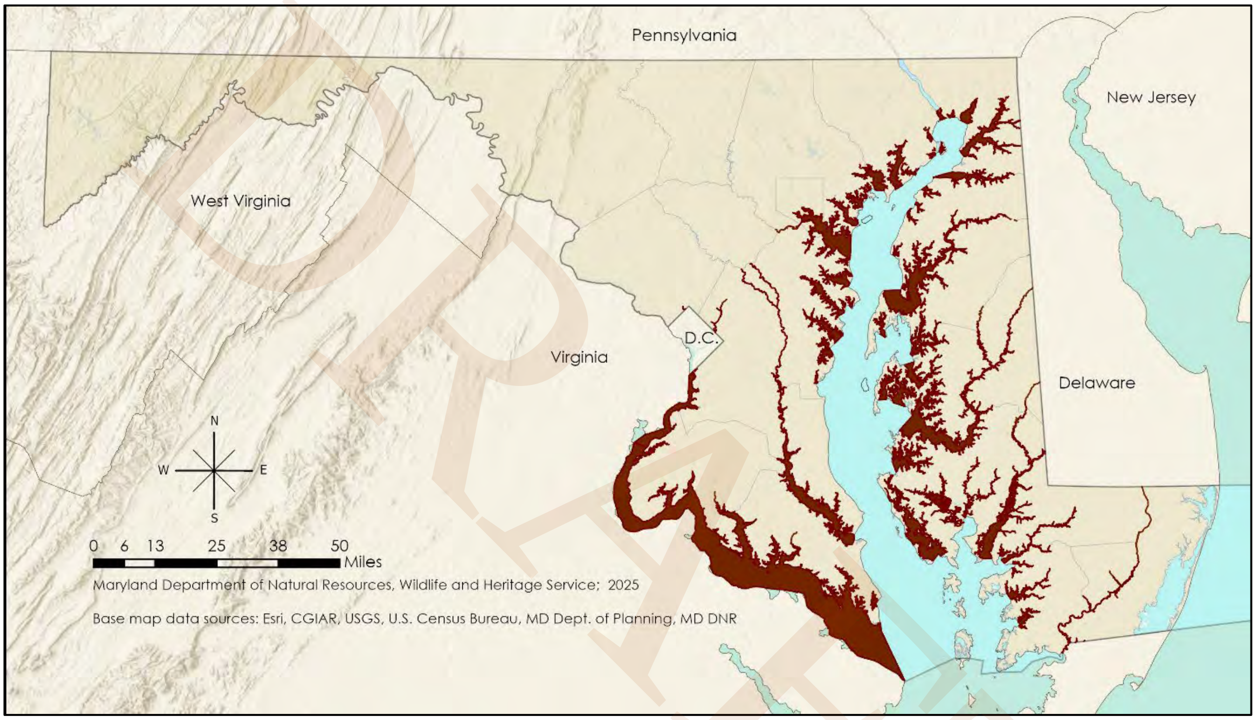


Figure 4.46 Location of Coastal Plain Rivers in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Coastal Plain Rivers:

Birds
American black duck
Bald eagle
Bank swallow
Black scoter
Blue-winged teal
Canvasback
Common goldeneye
Common loon
Forster's tern
Gadwall
Great blue heron
Great egret
Greater scaup

Mammals
American mink
Bottlenose dolphin
Eastern red bat
Hoary bat
Little brown bat
Silver-haired bat
Tricolored bat

Reptiles
Green sea turtle
Kemp's ridley sea turtle
Leatherback sea turtle
Loggerhead sea turtle

Invertebrates (Aquatic)
Alewife floater
Creeper
Eastern lampmussel
Eastern pondmussel
Northern lance
Paper pondshell
Tidewater mucket
Triangle floater
Yellow lampmussel
Yellow lance

Insects (Odonata)
Appalachian snaketail

Horned grebe
Laughing gull
Least tern
Lesser scaup
Long-tailed duck
Louisiana waterthrush
Pied-billed grebe
Red-throated loon
Redhead
Spotted sandpiper
Surf scoter
White-winged scoter

Diamond-backed terrapin
Northern map turtle
Plain-bellied watersnake
Queensnake
Rainbow snake
Wood turtle

Fish

Alewife
American shad
Atlantic sturgeon
Blueback herring
Bridle shiner
Chesapeake logperch
Flier
Glassy darter
Hickory shad
Shortnose sturgeon
Swamp darter

Coppery emerald
Laura's clubtail
Royal river cruiser

Bay and Ocean

Chesapeake Bay

Region(s): *Central, Eastern, Southern*
Habitat Group: *Bay/Ocean*
NEAFWA: *Estuaries*

SAV in the Chesapeake Bay (Peter McGowan, USFWS)

The Chesapeake Bay drainage area extends into six states: Maryland, Virginia, West Virginia, Pennsylvania, Delaware, and New York, making it the largest estuary in the country. An estuary is a partly enclosed waterbody where freshwater from rivers mixes with saline water from the ocean, forming brackish water of 0.5-25 parts per thousand (ppt). This dynamic, highly productive ecosystem is affected by changes in freshwater input, tides, winds, and sub-surface currents that create variable salinity, temperature, water clarity, nutrient availability, and oxygen concentration. The Chesapeake Bay plays a vital role in the cycling and movement of nutrients between its tributaries, the Bay itself, and the Atlantic Ocean. The phytoplankton and zooplankton that subsist on these nutrients are important food sources for fish and other aquatic organisms, which themselves become food for larger fish, seabirds, ducks, marine mammals, and turtles. Critical sub-habitats that play an important role in the estuary include:

> ***Shellfish Beds***
> Bivalve mollusks such as oysters, razor clams, and hard clams aggregate in large numbers to form beds that provide critical habitat for a wide array of organisms. Shellfish beds, such as oyster reefs, create vertical heterogeneous structure on otherwise featureless soft bottom areas of Chesapeake Bay. This structure is important for barnacles, anemones, sea squirts, sponges, sea stars, tube-building worms, snails, crabs, and many other invertebrates. Cracks and crevices formed by shellfish beds provide refuge for small, reclusive fishes like gobies and blennies as well as juvenile fishes of many species. The plethora of organisms associated with shellfish beds attracts larger fishes and other predators. Shellfish beds also provide important ecological services by assimilating nutrients and carbon, improving water quality, and reducing suspended sediments.
>
> ***Submerged Aquatic Vegetation (SAV)***
> SAV refers to the underwater flowering plants that flourish in the shallow waters of the Chesapeake and Coastal Bays and their tidal tributaries. These rooted vascular plants form large beds in waters below the mean low-tide line to depths of around 10 feet. SAV, also known as seagrass, serves a vital ecological role in estuaries, absorbing nutrients and increasing oxygen concentrations in surrounding waters. Dense SAV beds also slow currents, reduce wave action, stabilize sediments, and reduce shoreline erosion. The vertical structure created by the stems and leaves within these dense beds provides substrate and a rich food supply for isopods and other invertebrates. These submerged

aquatic plants are also a bountiful food source on which many species of migratory waterfowl depend; geese and ducks rely on the grasses, as well as the tubers, as a primary food source. Even decaying SAV plant matter can be an important food source for other animals such as amphipods, shrimp, and other detritivores. SAV beds also serve as critical habitat for blue crabs, especially during the molting process, and provide cover and habitat for a rich diversity of smaller fish and foraging grounds for larger fish.

Salinity is an important determinant of the distribution of estuarine aquatic organisms. Aquatic community composition gradually changes from freshwater species, in the low salinity tidal-fresh areas at the northern end of the Chesapeake, towards marine species, in the higher salinity areas closer to Virginia at the mouth of the Chesapeake. Some species, however, are found in both. The spawning and nursery areas of these anadromous fish, including American shad *(Alosa sapidissima)* and Atlantic sturgeon *(Acipenser oxyrinchus)*, are located in tidal-fresh areas; for some species (e.g., hickory shad *[Alosa mediocris]*), they even extend into non-tidal streams. As these spawning and nursery areas are sensitive to suburban and urban development, rural watersheds tend to provide better habitat.

Temperature is also a major driver of important biological functions including metabolism, migration, reproduction, and feeding. Increasing temperatures over the past several decades have shifted anadromous fish spawning to earlier in the year. As a result, eggs and larvae are subject to more volatile weather conditions during the winter–spring transition. Furthermore, increasing summer temperatures have made shallower waters less suitable, both in extent and duration, during warmer months. Due in part to this outsized threat facing shallow water habitats, organizations like the Chesapeake Bay Program have recently highlighted these shallower waters of the Bay as a conservation focus area. Efforts are underway to assess these habitat areas and the populations they support—particularly fish—in order to determine the scale and scope of needed conservation and restoration work.

Excessive nutrient pollution (especially nitrogen and phosphorus) has reduced the quality of the Chesapeake Bay's waters in recent decades. Large expanses of the deep waters of the Chesapeake Bay often become devoid of life-giving oxygen during summer months and some subestuaries exhibit depleted oxygen even at shallower depths. Low oxygen can form "dead zones" and make Bay waters uninhabitable to most subsurface and benthic aquatic species. Improvements in sewage treatment plants, stormwater retention, and reduction of impervious surfaces and runoff of fertilizers have been a major focus of Chesapeake Bay cleanup efforts.

County Distribution: Anne Arundel, Baltimore, Baltimore City, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Queen Anne's, Prince George's, Somerset, St. Mary's, Talbot, Wicomico, Worcester

Places to Visit: Sandy Point State Park, Point Lookout State Park, Chesapeake Bay

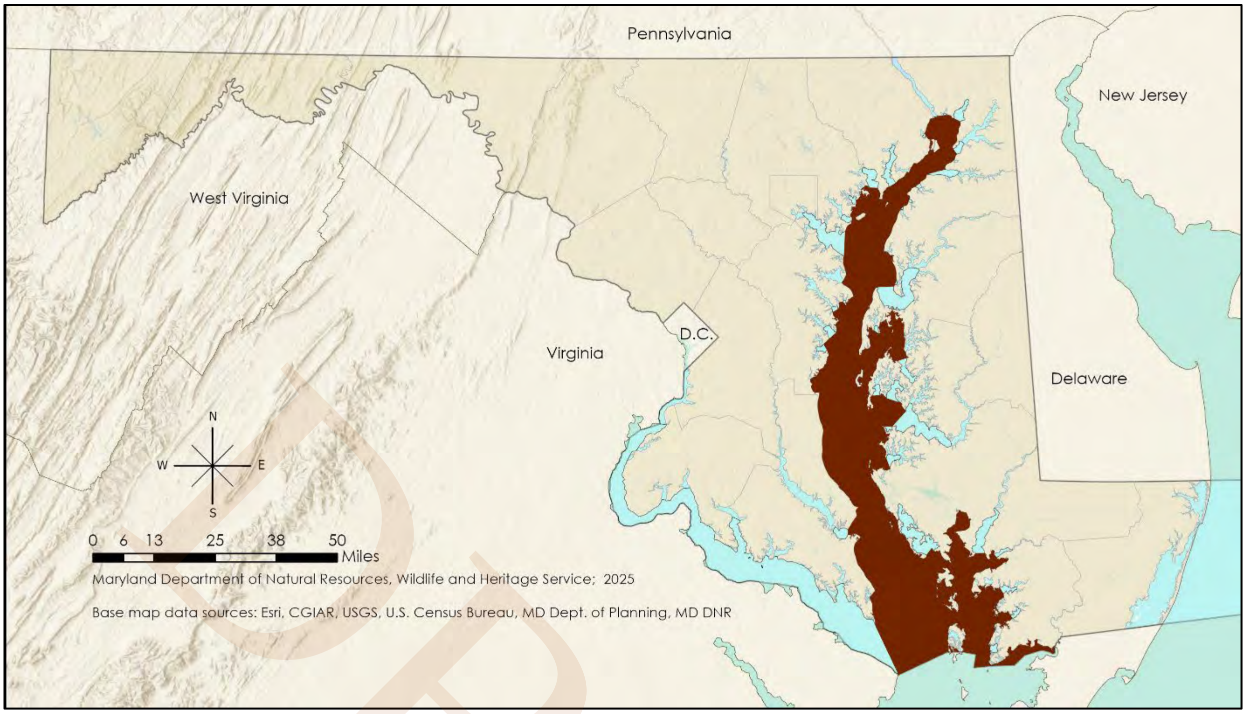


Figure 4.47 Location of Chesapeake Bay in Maryland. Sources: MD DNR and CBP.

Species of Greatest Conservation Need Associated with the Chesapeake Bay:

Birds
American black duck
Bald eagle
Black scoter
Black skimmer
Black-legged kittiwake
Brown pelican
Canvasback
Common goldeneye
Common loon
Gadwall
Greater scaup
Horned grebe
Lesser scaup
Long-tailed duck
Northern gannet

Birds (continued)
Pied-billed grebe
Red phalarope
Red-necked phalarope
Red-throated loon
Redhead
Surf scoter
White-winged scoter

Reptiles
Green sea turtle
Kemp's ridley sea turtle
Leatherback sea turtle
Loggerhead sea turtle
Diamond-backed terrapin
Northern map turtle

Mammals
Bottlenose dolphin
West Indian manatee

Fish
Alewife
American shad
Atlantic sturgeon
Blueback herring
Hickory shad
Shortnose sturgeon

Invertebrates (Aquatic)
Horseshoe crab

Coastal Bays

Region(s): *Eastern*
Habitat Group: *Bay/Ocean*
NEAFWA: *Estuaries*

Chincoteague Bay (Angel Willey, MD DNR)

There are a total of five Coastal Bays in Maryland. From north to south, they are: Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague. Although they are all narrowly separated from the Atlantic Ocean by Fenwick and Assateague Islands, the Ocean City and Chincoteague Inlets provide oceanic influences on these bays. Generally higher than within the lower Chesapeake Bay, salinity within the Coastal Bays often exceeds 20-30 parts per thousand (ppt), which is closer to the Atlantic Ocean salinity, around 35 ppt.

Covering approximately 363 square kilometers (140 square miles), these bays and associated tributaries average only 0.9 meters (3 feet) in depth and are influenced by a watershed of 453 square kilometers (175 square miles). The surrounding land varies in use and population density. To the east, Fenwick Island is heavily developed, whereas Assateague Island has been left in a much more natural state thanks to protection from Assateague State Park and Assateague Island National Seashore. The mainland varies as well, being much more urbanized to the north, rural to the south, and moderately developed between.

Coastal Bays provide vital habitat for various fishes, invertebrates, marine mammals, birds, and turtles. This is partially because, though shallow and relatively small, Coastal Bays contain many sub-habitats that support a wide variety of plants and animals. These include:

Submerged Aquatic Vegetation (SAV)
Two species of SAV are found in Maryland's Coastal Bays: eelgrass *(Zostera marina)* and widgeon grass *(Ruppia maritima)*. SAV beds used to be found in all of the Bays, though they are currently limited to the Bays south of the Ocean City Inlet. They provide shelter and food for a variety of fishes, other vertebrates (e.g., turtles), and invertebrates. See the Chesapeake Bay Key Wildlife Habitat for more information.

Macroalgae
Over 20 genera of macroalgae have been documented in the Coastal Bays, including species found in Chlorophyta (green), Phaeophyta (brown), Rhodophyta (red), and Xanthophyta (yellow-green). Macroalgae are considered good food and shelter habitat for many species, though it can be a detriment at times. Too much macroalgae can smother SAV and reduce dissolved oxygen during its decomposition.

Small Islands
Though they are considered a separate Key Wildlife Habitat (see the Small Coastal Plain Islands section), islands are difficult to fully separate from the Coastal Bays due to their abundance within the Bays. The remaining islands within the Bays provide vital, fast-

disappearing nesting ground for colonial waterbirds, many of which are growing increasingly rare due in part to this decline in suitable habitat. Horseshoe crabs (*Limulus polyphemus*) also rely heavily upon these islands for spawning grounds, and diamond-backed terrapins (*Malaclemys terrapin*) use them for nesting as well.

County Distribution: Worcester

Places to Visit: Assateague State Park, Assateague Island National Seashore

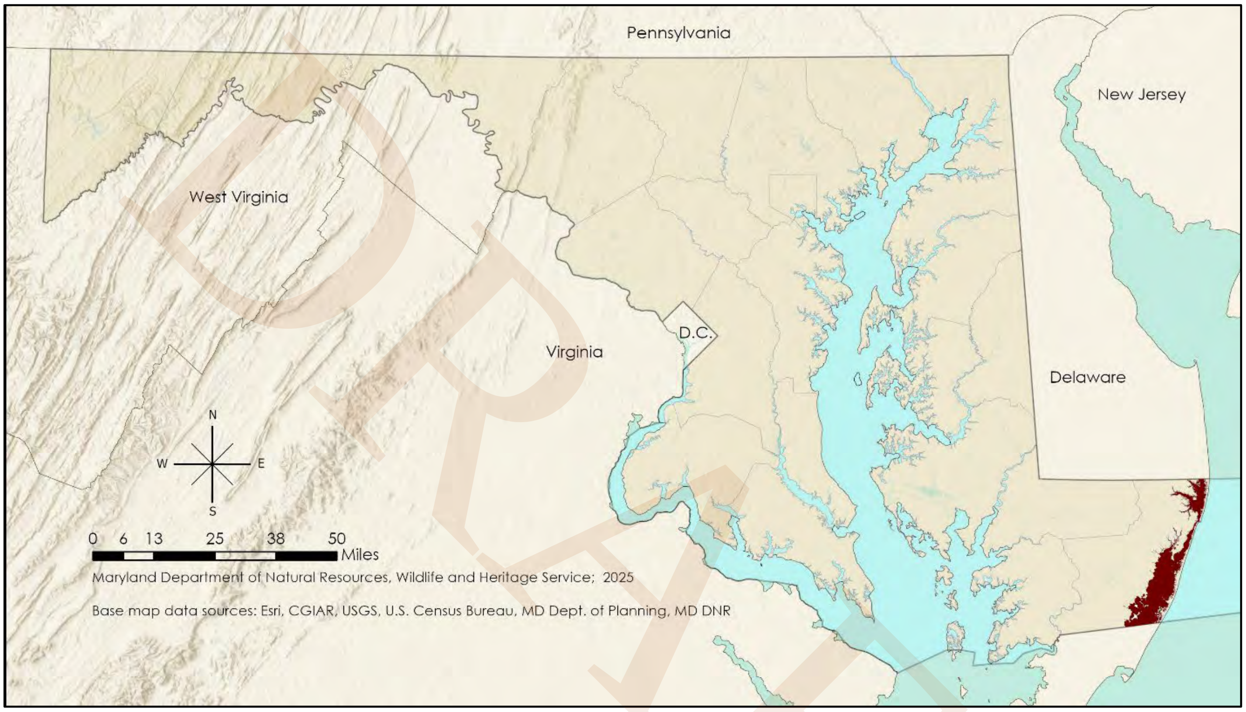


Figure 4.48 Location of Coastal Bays in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Species of Greatest Conservation Need Associated with Coastal Bays:

Birds
American black duck
Bald eagle
Black scoter
Black skimmer
Black-legged kittiwake
Brant
Brown pelican
Canvasback
Common goldeneye
Common loon
Gadwall
Greater scaup
Horned grebe
Lesser scaup

Birds (continued)
Long-tailed duck
Pied-billed grebe
Red phalarope
Red-necked phalarope
Red-throated loon
Redhead
Surf scoter
White-winged scoter

Mammals
Bottlenose dolphin
West Indian manatee

Reptiles
Green sea turtle
Kemp's ridley sea turtle
Leatherback sea turtle
Loggerhead sea turtle
Diamond-backed terrapin

Fish
Alewife
Blueback herring

Invertebrates (Aquatic)
Horseshoe crab

Jason Harrison, MD DNR

Atlantic Ocean

Region(s): *Eastern*
Habitat Group: *Bay/Ocean*
NEAFWA: *Marine Nearshore; Marine Offshore & Oceanic*

The Atlantic Ocean off the coast of Maryland contains a variety of important marine sub-habitats including benthic, canyons, corals, nearshore, and pelagic. The chemical and physical properties (e.g., temperature, salinity, dissolved oxygen, pH, and suspended sediments) of open water affect the distribution and abundance of aquatic species. Changes in ocean temperatures and resulting shifts in weather and currents have impacted the distribution of marine animals in recent decades. Expanded use of our oceans for transport, renewable energy, tourism, and fisheries has resulted in an increased need for regional ocean planning to improve understanding of how resources and places are used, managed, and conserved. Emerging concerns about ocean acidification, microplastic transport, and other contaminants such as Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) have been the focus of recent research.

These sub-habitats, in general order of distance from shore (closest coming first), are as follows:

Nearshore

Nearshore oceanic habitat encompasses the part of the ocean closest to the coast. The nearshore sea bottom consists of sandy substrate with shoals, sand ridges, and slews. It is dynamic in nature due to waves breaking on the sand bars and surf zone. Various species of bony fishes, sharks, marine mammals, and sea turtles frequent this area just off the coast of Maryland.

Corals

While Maryland isn't known for extensive coral reefs like those found in tropical regions, coral gardens are indeed found off the coast of Ocean City. These are considered artificial reefs created by sinking materials like ships, concrete rubble, and other objects to provide habitat for marine life. These reefs are then colonized by fouling animals like barnacles, mussels, and coral, creating a living reef ecosystem that supports a variety of marine life.

Benthic

Benthic habitat refers to the bottom of the ocean. The benthic habitat off the coast of Maryland is a dynamic environment with a mixture of sandy and silty sediments. It supports a diverse array of bottom-dwelling organisms that play a crucial role in the coastal ecosystem. The specific kinds of benthic organisms present can vary depending on factors like depth, sediment type, water temperature, and salinity. One such organism is the horseshoe crab *(Limulus polyphemus*), which requires a healthy benthic zone in order to thrive.

Pelagic

Open water is also known as the pelagic zone, the largest habitat on earth. The pelagic zone is used by species that live in the water column (i.e., away from shore and not on the bottom). Open water plays a vital role in the cycling and movement of nutrients from nearshore to offshore areas and at upwellings of deeper water toward the surface. The phytoplankton and zooplankton that live on these nutrients provide important food sources for fish and other aquatic organisms, which in turn become food for seabirds, marine mammals, sea turtles, sharks, and other large marine species. These waters also support a number of recreational and commercial fisheries.

Canyons

The Baltimore Canyon, located approximately 60 miles off the coast of Maryland, is a significant underwater canyon known for its steep drop-offs, nutrient-rich waters, and rich marine life. It is a popular spot for offshore big game and commercial fishing, as its deep waters attract tuna, marlin, mahi-mahi, and wahoo. Marine mammals such as dolphins and whales also frequent the area.

County Distribution: Worcester

Places to Visit: Atlantic Ocean

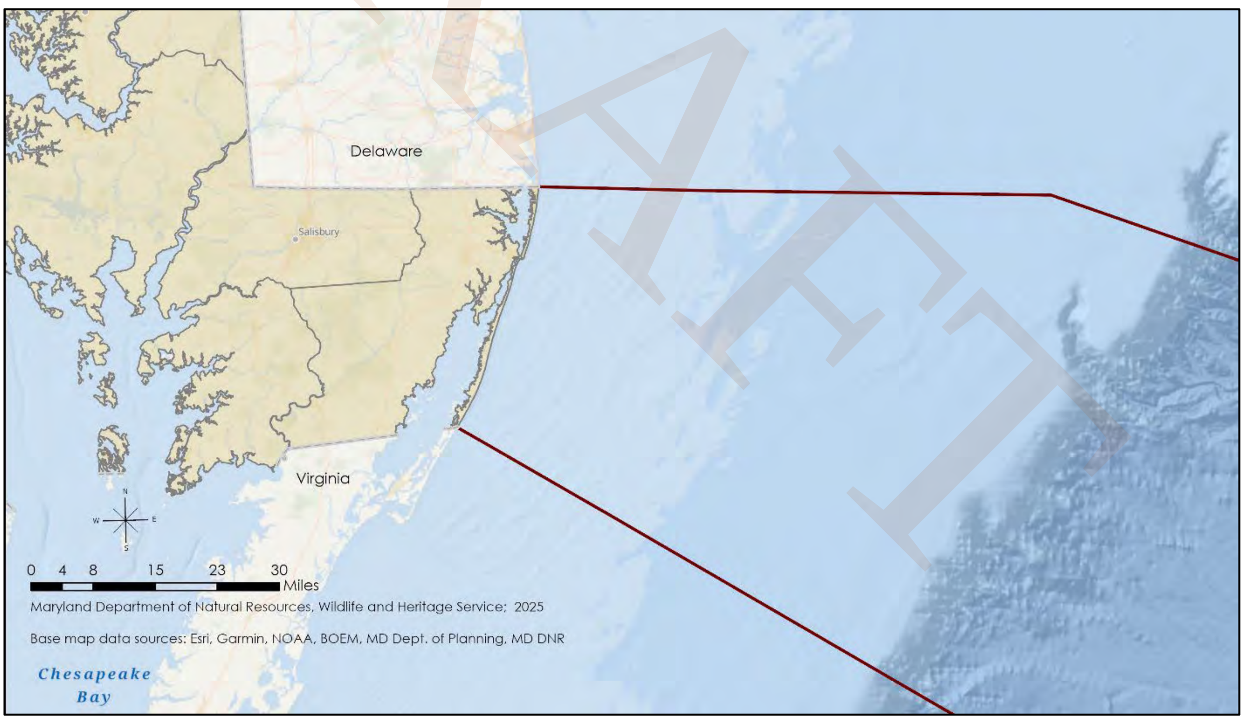


Figure 4.49 Location of Atlantic Ocean in Maryland. Sources: MD DNR and SDI-BOEM.

Species of Greatest Conservation Need Associated with the Atlantic Ocean:

Birds

Bald eagle
Black scoter
Black skimmer
Black-legged kittiwake
Brant
Brown pelican
Canvasback
Common goldeneye
Common loon
Cory's shearwater
Greater scaup
Horned grebe
Leach's storm-petrel
Lesser scaup
Long-tailed duck
Northern gannet
Red phalarope
Red-necked phalarope
Red-throated loon
Redhead
Sargasso shearwater
Surf scoter
White-winged scoter

Mammals

Blue whale
Bottlenose dolphin
Fin whale
Harbor porpoise
Humpback whale
Minke whale
North Atlantic right whale
Sei whale
Sperm whale

Reptiles

Green sea turtle
Kemp's ridley sea turtle
Leatherback sea turtle
Loggerhead sea turtle

Invertebrates (Aquatic)

Horseshoe crab

Fish

Alewife
American shad
Atlantic angel shark
Atlantic sturgeon
Blueback herring
Dusky shark
Hickory shad
Longfin mako
Sand tiger shark
Sandbar shark
Shortnose sturgeon
Whale shark
White shark

Small Coastal Plain Island

Region(s): *Central, Eastern, Southern*
Habitat Group: *Bay/Ocean*
NEAFWA: *N/A*

Peter Stango, MD DNR

Small Coastal Plain Islands are isolated islands in the tidal Chesapeake Bay and Coastal Bays. These islands vary in size from tiny (<10 m^2) to up to one to two hectares and do not support forested habitats. Large, forested islands (e.g., Poole's, Coaches, and Barren Islands; and the large salt marsh islands of the lower Chesapeake Bay) are not included in this Key Wildlife Habitat (KWH). These small islands serve as critical breeding sites for many of Maryland's colonial nesting waterbirds and are essential to maintaining a robust and sustainable guild of these species. Other than great blue herons *(Ardea herodias)* and the occasional colony of black-crowned night herons *(Nycticorax nycticorax)*, yellow-crowned night herons *(Nyctanassa violacea)*, and least terns *(Sternula antillarum)*, colonial nesting waterbirds generally do not breed within most other KWHs.

The vegetation of the Small Coastal Plain Islands KWH is simple and not compositionally diverse. Plant species composition varies but is primarily salt marsh cordgrass (*Spartina alterniflora*), salt marsh hay (*Sporobolus pumilus*), salt marsh spikegrass (*Distichlis spicata*), black needle rush (*Juncus roemerianus*), bigleaf marsh-elder *(Iva frutescens*), groundsel tree (*Baccharis halimifolia*), northern bayberry (*Morella pensylvanica*), and wax myrtle (*Myrica cerifera*). Patches of open sand and shell, especially at the upper elevations of beaches and berms, are essential to barren habitat nesting species of colonial waterbirds. Clumps of groundsel, bayberry, and wax myrtle are frequently used by colonial nesting wading birds, including herons, egrets, and ibis. Other species that require sandy habitats for reproduction include diamond-backed terrapin *(Malaclemys terrapin*) and a number of bee species.

These islands are critically threatened by erosion due to a combination of sea-level rise and land subsidence. When they become too small, breaching and overwash occurs during storm surges, eliminating them as safe nesting habitats. In the Coastal Bays, concentrated placement of sandy dredge spoil to create artificial small islands has met with some success. However, these efforts have been limited and lack sufficient reinforcement to provide for long-term establishment in this dynamic estuarine environment. Therefore, the construction and deployment of an anchored floating platform, or raft, has been used successfully for several years to provide a nesting artificial island for hundreds of common terns *(Sterna hirundo)* in the early 2020s. This project is seen as a stop-gap measure until additional dredge spoil islands can be created and maintained.

County Distribution: Anne Arundel, Baltimore, Calvert, Cecil, Charles, **Dorchester**, Kent, Prince George's, Queen Anne's, **Somerset,** St. Mary's, Talbot, and Wicomico, and **Worcester**

Places to Visit: Cedar Island Wildlife Management Area, Sinepuxent Bay Wildlife Management Area

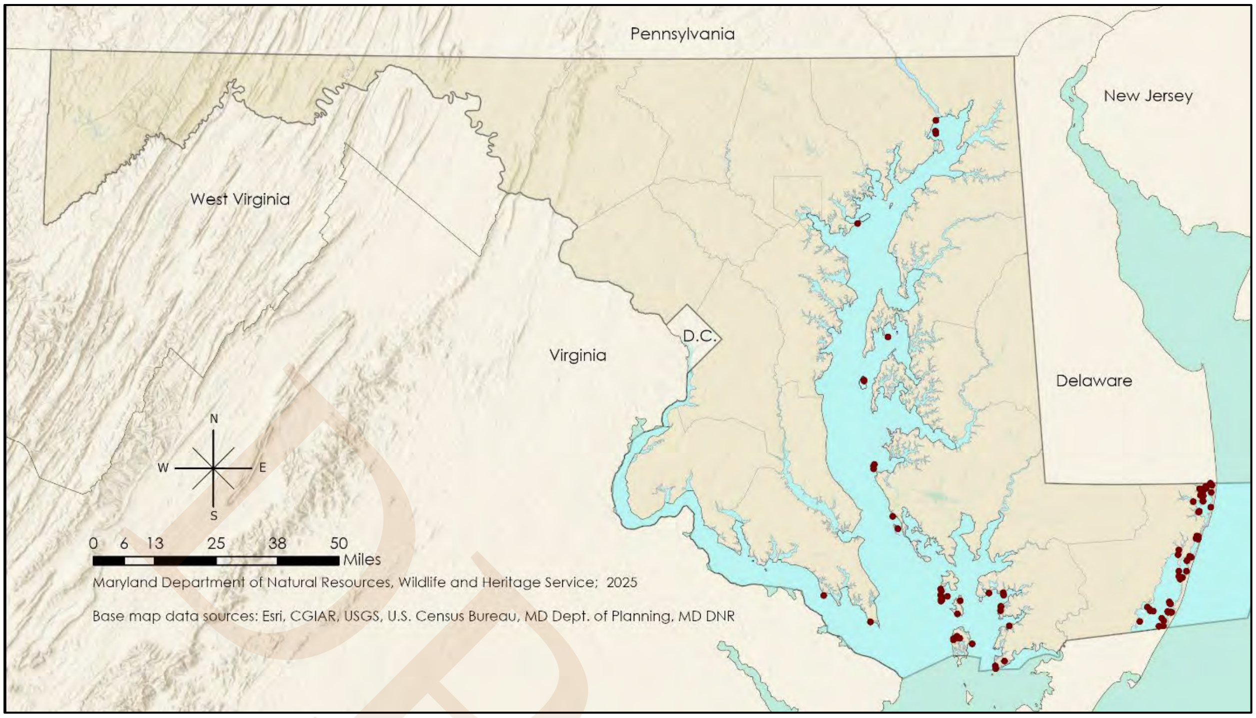


Figure 4.50 Location of Small Coastal Plain Islands in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Small Coastal Plain Islands:

Birds
American bittern
American black duck
American oystercatcher
Bald eagle
Black rail
Black skimmer
Black-bellied plover
Black-crowned night heron
Blue-winged teal
Boat-tailed grackle
Brant
Brown pelican
Coastal Plain swamp sparrow
Common gallinule
Common tern
Dunlin
Forster's tern
Gadwall
Glossy ibis
Great blue heron
Great egret
Greater yellowlegs

Birds (continued)
Gull-billed tern
Ipswich sparrow
Laughing gull
Least bittern
Least tern
Lesser yellowlegs
Little blue heron
Marsh wren
Nelson's sparrow
Northern harrier
Pied-billed grebe
Piping plover
Roseate tern
Royal tern
Ruddy turnstone
Rufa red knot
Saltmarsh sparrow
Sanderling
Sandwich tern
Savannah sparrow
Seaside sparrow
Semipalmated sandpiper
Short-billed dowitcher

Birds (continued)
Short-eared owl
Snowy egret
Sora
Spotted sandpiper
Swamp sparrow
Tricolored heron
Whimbrel
Willet
Wilson's plover
Yellow warbler
Yellow-crowned night heron

Reptiles
Diamond-backed terrapin

Insects (Coleoptera)
Eastern beach tiger beetle

Insects (Odonata)
Atlantic bluet

Insects (Hymenoptera)
A cellophane bee *(Colletes speculiferus)*
A mason bee *(Osmia chalybea)*

Subterranean Habitats

Cave and Karst

Region(s): *Central, Western*
Habitat Group: *Subterranean*
NEAFWA: *Caves & Karst*

Dan Feller, MD DNR

Caves are natural, underground cavities or tunnels. They contain unique, fragile environments that support highly specialized animal communities and a variety of rare species. Over 100 caves have been documented in Maryland, most of which are located in the Ridge and Valley and Appalachian Plateau physiographic regions, with occasional smaller caves occurring in the Piedmont. Caves are most numerous in Washington County, followed by Allegany, Garrett, and Frederick Counties, the largest of which is Crabtree Cave in Garrett County with over 1,200 m of passages. Two types of caves exist in Maryland: solutional and non-solutional caves. The latter are formed by mechanical (tectonic) processes and are known as fissure caves, occurring as joints, faults, or fractures in bedrock. They are less numerous than solutional caves and are usually relatively small, shallow, and lack extensive passageways. They occur in a variety of rock formations, including the Pottsville Sandstone Formation in Garrett County, Tuscarora Sandstone Formation in Allegany and Washington Counties, and Weverton Quartzite Formation in Frederick County.

Solutional caves can be quite deep and extensive, representing by far the largest caves in Maryland. They are formed by the dissolving action of groundwater, which is naturally slightly acidic, with soluble, carbonate rock (usually limestone). Over millennia, these and related processes lead to the development of complex passages or tunnels and various speleothems or “formations” (carbonate deposits on cave surfaces) such as stalagmites, stalactites, helictites and cave “coral.” Some caves also contain subterranean streams, water-filled sinkholes, and springs. Solutional caves and other karst features are most numerous in the Tomstown Limestone Formation in Washington County, which contains massive dolomites and limestones over 300 m thick. Other important cave-bearing formations include the Greenbrier Formation in Garrett County and the Tonoloway, Waynesboro, Beekmantown and Stones River formations in Washington County.

County Distribution: Allegany, Baltimore, Carroll, Frederick, Garrett, Howard, Washington

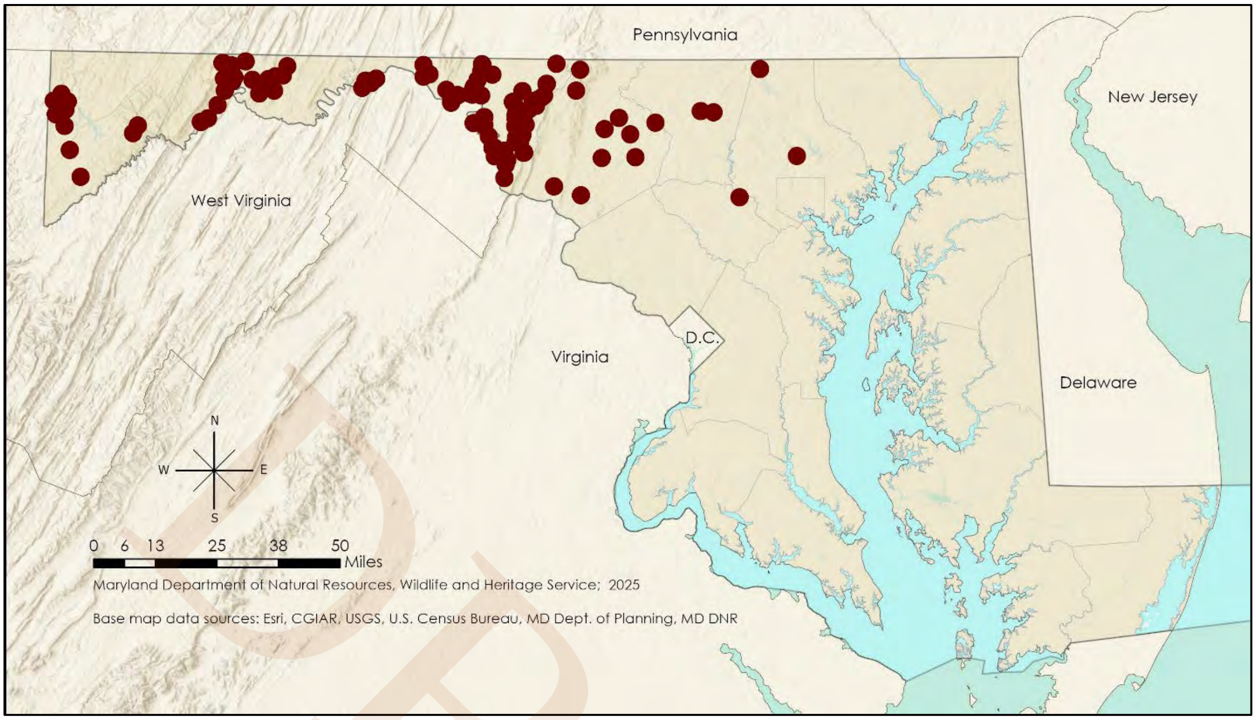


Figure 4.51 Location of Caves and Karsts in Maryland. Source: MD DNR.

Species of Greatest Conservation Need Associated with Caves and Karsts:

Mammals
Allegheny woodrat
Eastern small-footed bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians
Longtail salamander

Invertebrates (Snails)
Appalachian springsnail
Blue Ridge springsnail

Invertebrates (Cave and Groundwater)
A cave obligate planarian *(Sphalloplana buchanani)*
Allegheny spring isopod *(Caecidotea alleghenyensis)*
Biggers' cave amphipod *(Stygobromus biggersi)*
Franz's cave isopod *(Caecidotea franzi)*
Friendly cave amphipod *(Stygobromus amicus)*
Greenbrier cave amphipod *(Stygobromus emarginatus)*
Hoffmaster's cave planarian *(Sphalloplana hoffmasteri)*
Holsinger's cave isopod *(Pseudobaicalasellus holsingeri)*
Maus' cave isopod *(Pseudobaicalasellus mausi)*
Pennsylvania cave amphipod *(Crangonyx dearolfi)*
Price's cave isopod *(Conasellus pricei)*
Shenandoah Valley cave amphipod *(Stygobromus gracilipes)*
Vandel's cave isopod *(Pseudobaicalasellus vandeli)*

Artificial Structure: Mine and Tunnel

Region(s): *Western*
Habitat Group: *Subterranean*
NEAFWA: *Mines & Tunnels*
Additional Notes: *An artificial or human-made habitat*

Richard Orr

Mines are man-made, underground tunnels from which coal and other mineral resources (e.g., limestone, copper, gold, chromium) are extracted. In Maryland, most are located on the Appalachian Plateau, with some smaller, now inactive mines in the Ridge and Valley and Piedmont regions. Most cave-dwelling species of conservation concern are absent in these artificial habitats, but abandoned mines and railroad tunnels can provide a surrogate, cave-like habitat for a limited number of cave-dwelling species. This is especially true for more mobile vertebrates such as bats that utilize abandoned mines and railroad tunnels, which are currently the most significant overwintering habitat remaining for a number of rare and declining bat species. The habitat suitability of these abandoned mines and railroad tunnels for cave-dwelling animals depends on a variety of factors, including the level of human disturbance, size and/or depth, passage complexity, rock formation type, temperature, humidity, and the presence or absence of groundwater.

County Distribution: Allegany, Frederick, Garrett, Washington

Places to Visit: Brush Tunnel, Paw Paw Tunnel

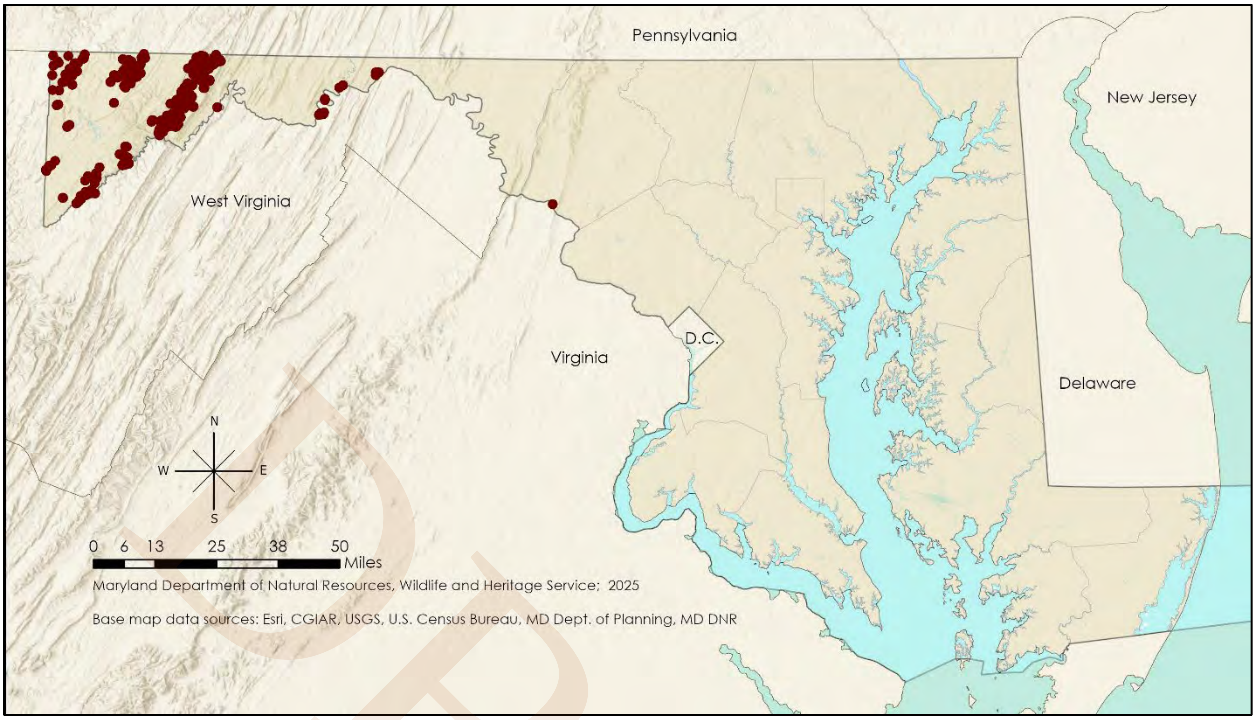


Figure 4.52 Location of Mines and Tunnels in Maryland. MD DNR, Maryland Department of the Environment, USGS.

Species of Greatest Conservation Need Associated with Mines and Tunnels:

Mammals

Allegheny woodrat
Eastern small-footed bat
Indiana bat
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Invertebrates (Snails)

Appalachian springsnail

Invertebrates (Cave and Groundwater)

Franz's cave isopod
Hoffmaster's cave planarian
Maus' cave isopod
Vandel's cave isopod

Other Habitats
Working Lands

Managed Successional Forest

Region(s): *All*
Habitat Group: *Working Lands*
NEAFWA: *Agriculture: Plantations/ Orchards*
Additional Notes: *An artificial or human-made habitat*

James McCann, MD DNR

Managed Successional Forests are primarily upland areas, occasionally wetlands, that are in an early successional forest state (i.e., dominated by shrubs and small trees [< 8 m tall]) due to forest management practices, land use change, or some other form of human disturbance. This habitat occurs statewide in three broad settings:

1. **Recently Logged Forests.** In this setting, early successional forest begins to develop within one year of a timber harvest and may persist for 10–20 years or more. This partially depends on pre-harvest forest conditions, soil type, the size and type of regeneration cut (e.g., clearcutting, single-tree selection, shelterwood), post-harvest silvicultural treatments (e.g., seedling plantings vs. natural regeneration, thinnings), and the degree to which deer herbivory and invasive plant species impede native plant establishment and growth. Habitat suitability for most early successional species of conservation concern tends to peak 5–15 years following harvest. Many species that require early successional forests are no longer present once tree canopy closure is attained.

2. **Succeeding Non-forested Land.** These are areas that were converted to agriculture or some other non-forested condition and have been recently allowed to succeed or are otherwise managed in a way that has led to the development of early successional forest habitat. Examples include former cropland and pasture, old fields, and reclaimed strip mines that are reverting to a forested state via natural succession or plantings. Early successional forest habitat may persist for 10–20 years or longer depending, in part, on prior land use, soil conditions, the size of the opening, surrounding habitat conditions, and the degree to which deer herbivory and invasive plant species impede native plant establishment and growth.

3. **Forest Edges.** Forest edges are usually abrupt, narrow (typically 1–10 m wide), linear ecotones between a forested and nonforested habitat (e.g., cropland, road, transmission line right-of-way, backyard) or between two dissimilar forest age classes (e.g., a mature forest and a recent clearcut). These conditions can provide early successional forest habitat for some of the early successional wildlife species, especially if a “soft” edge or

gradual transition between the two adjoining habitats is present and is wider than is often found along a forest edge. However, Species of Greatest Conservation Need (SGCN) that require early successional forests and shrublands are often not found along forest edges because they require larger habitat patches than the narrow band of shrubs along the narrow forest edge ecotone. Also, these ecotones suffer greatly from excessive deer herbivory to the extent that a “browse line” is often evident along forest edges, rendering them unsuitable for shrubland breeders, as well as from increased rates of predation and nest parasitism from brown-headed cowbirds. Some shrubland species, such as yellow-breasted chat *(Icteria virens)*, are area-sensitive and require larger habitat patches for increased nesting success. Much as forest interior breeding bird specialists avoid forest edges, shrubland breeding birds avoid edges as well (Rodewald &Vitz 2005).

The historical extent of early successional forest in Maryland is uncertain, and the origin, distribution, and characteristics of today’s forms of this habitat are likely to be quite different in many cases. Prior to widespread European colonization, fires set by Native Americans and settlers—and lightning strikes, to a lesser degree—played a major role in creating and sometimes perpetuating forest conditions dominated by shrubs and small trees. Herbivores (e.g., beaver, bison, and elk), topography, edaphic conditions and storm-related events (e.g., floods, ice storms, and tropical storms) also played a significant role. Together, these agents of change maintained a shifting mosaic of early successional habitat embedded within a landscape that was likely dominated by old growth forest and a variety of grassland, shrubland, and wetland habitats. The degree to which these factors affected the landscape varied by region and with local conditions (e.g., soil type, forest type, slope, and aspect). According to the United States Department of Agriculture (USDA) and the United States Forest Service (USFS), there were approximately 118,000 acres of small diameter forest lands in Maryland as of 2024 (USDA 2024). The small diameter forest type can be defined as live trees 1.0 to 4.9 inches (2.5–12.5 cm) in diameter and can be considered early successional forest.

County Distribution: Statewide

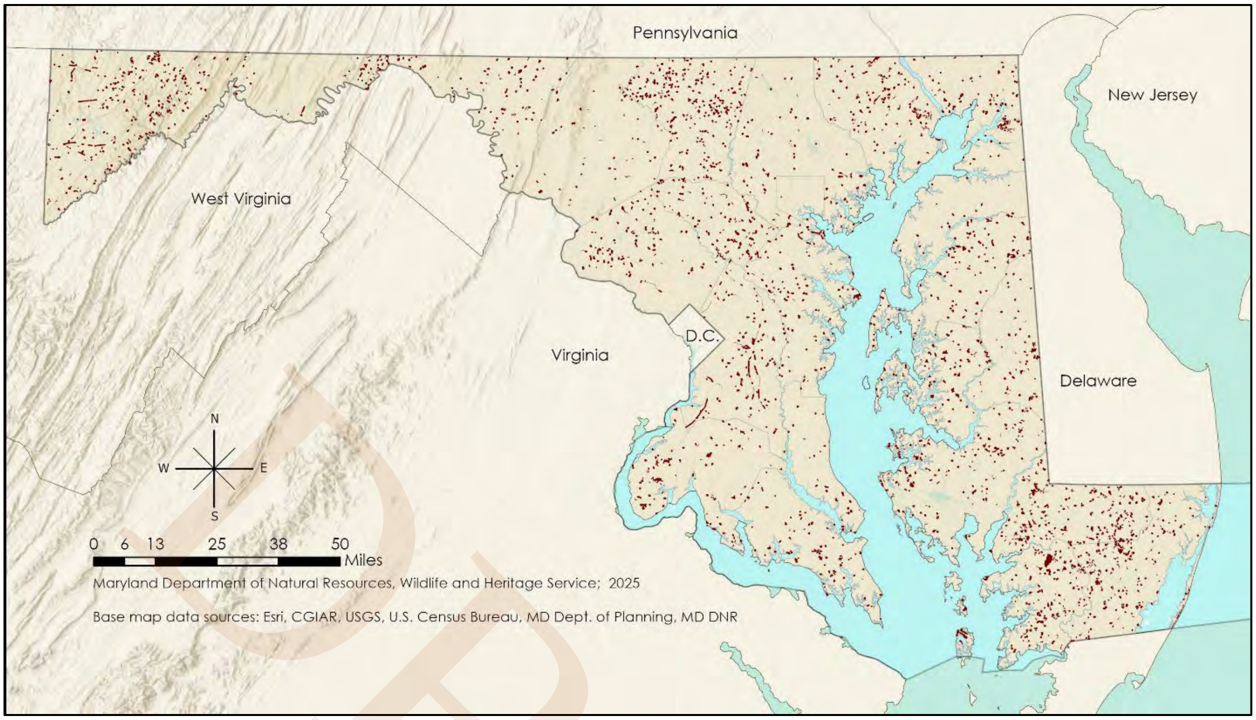


Figure 4.53 Location of Managed Successional Forests in Maryland. Source: Maryland Department of Planning's Land Use/Land Cover 2010.

Species of Greatest Conservation Need Associated with Managed Successional Forests:

Birds
American woodcock
Black-billed cuckoo
Blue-winged warbler
Common nighthawk
Golden-winged warbler
Least flycatcher
Mourning warbler
Northern bobwhite
Prairie warbler
Swamp sparrow
Willow flycatcher
Yellow warbler
Yellow-breasted chat

Mammals
Appalachian cottontail
Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Least weasel
Little brown bat
Northern long-eared bat
Silver-haired bat
Southeastern shrew
Southern bog lemming
Tricolored bat

Reptiles
Copperhead
Eastern box turtle
Plain-bellied watersnake
Rainbow snake
Scarletsnake
Smooth greensnake
Timber rattlesnake

Insects (Lepidoptera)
Indian skipper

Managed Grassland

Region(s): *All*
Habitat Group: *Working Lands*
NEAFWA: *Grasslands*
Additional Notes: *An artificial or human-made habitat*

Bonnie Ott

Managed Grasslands are anthropogenically created, open, upland areas dominated by grasses and other herbaceous vegetation. The vegetation can vary in height (~0.15–2 m tall), structure, and composition, and may include a mix of both native and non-native species. However, those dominated by native species tend to have greater conservation value. Some scattered shrubs and small trees (<8 m tall) may be present, but they are usually limited (<25% cover), patchy, and/or confined to the outer periphery of the opening as a soft forest edge or ecotone. Generally, grassland suitability as habitat for wildlife increases with size and area-to-edge ratio. Grasslands at least 4 hectares (ha) in size to well over 100 ha are needed to support a number of area-sensitive grassland Species of Greatest Conservation Need (SGCN), particularly birds. In addition to grassland size, other patch metrics (e.g., shape, degree of fragmentation) and landscape metrics (e.g., proximity to other grasslands, percentage of grassland, and openings in the surrounding landscape), as well as vegetation composition, height, and structure, can be important predictors of the presence and abundance of these species.

Historically, tens of thousands of acres of grasslands and savanna-like habitats once stretched across Maryland, with grass species forming a continuous ground cover with patches of scattered trees such as blackjack *(Quercus marilandica)* and post (*Quercus stellata*) oak, as well as an assortment of shrub species. Prior to European settlement, much of central Maryland, including Baltimore, Harford, and Carroll counties and adjacent counties in Pennsylvania, was covered by this prairie-like grassland intermingled among wooded valleys (Mayre 1920). Further west, accounts from the eighteenth and nineteenth centuries also depict large natural grasslands in the Hagerstown, Middletown, and Frederick valleys (Mayre 1955), and around The Glades area of Garrett County. It is believed that these openings were created and maintained by a combination of soil conditions, large grazing mammals (e.g., woodland bison, elk), and periodic fires. These grassland ecosystems have nearly vanished due to habitat loss resulting from development, agriculture, solar electricity production, fire suppression, and the disappearance of large ungulates. The largest remaining native grassland is the Serpentine Barren woodland complex at Soldiers Delight Natural Environment Area in Baltimore, which has been under restoration for over 25 years.

Most of the state's remaining grassland fauna persist in one or more of the following settings: (1) active pastures and hayfields; (2) fallow fields and grass plantings; (3) mowed edges of airports and military airfields; (4) reclaimed strip mines on the Appalachian Plateau. Managed grasslands occur statewide in these broad settings:

1. **Active pasture and hayfields.** These active agricultural fields are dominated by a mix of native and non-native herbaceous vegetation. They are managed or maintained primarily through livestock grazing, mowing, haying, and, in some cases, prescribed burns. The Monocacy Grasslands Important Bird Area, identified by Audubon Mid-Atlantic, includes the largest remaining stronghold with the most diverse assemblage of grassland and associated shrubland species in the state.
2. **Fallow fields and grass plantings.** This includes former agricultural land and other forms of anthropogenically created open land that is in the earliest stages of natural succession and dominated by a mix of native and non-native herbaceous vegetation. It includes some of the agricultural land management practices used in the U.S. Department of Agriculture (USDA) Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP). Unlike hayfields and pasture, these areas typically receive little or no active management. In the absence of human intervention, they become increasingly dominated by shrubs and small trees and, over time, would succeed to a forested condition. Grassland habitat may persist for approximately 10–20 years depending, in part, on prior land use, soil conditions, the size of the opening, surrounding habitat conditions, and the degree to which deer herbivory and invasive plant species impede woody plant establishment and growth.
3. **Airfields.** Areas surrounding airfields must be maintained, usually via mowing, in some form of grass-dominated state to prevent woody plant growth and comply with airport safety regulations. Although airfields are typically under a strict mowing regime that limits their habitat suitability for many grassland-associated wildlife, areas along the periphery that are mowed infrequently or seasonally can provide substantial habitat for some species of conservation concern, including grassland nesting birds and migratory species, like upland sandpiper *(Bartramia longicauda)* and eastern meadowlark *(Sturnella magna).*
4. **Reclaimed strip mines.** This includes large acreages of reclaimed coal-strip mined lands in the Appalachian Plateau physiographic region that have been planted in grasses, usually fescue, and are now dominated by herbaceous vegetation. Grasses and other herbaceous plants grow best in these areas due to the compacted soils causing poor water infiltration, as well as low soil nutrient content from the loss of organic matter. Thus these areas function as barrens with natural succession prevented or greatly delayed. Although strip mining destroys or severely degrades natural forested terrestrial and aquatic ecosystems, these large anthropogenic grasslands now provide the best remaining habitats for Henslow's sparrow *(Centronyx henslowii),* as well as being significant for many other grassland SGCN, including frosted elfin *(Callophrys irus),* American kestrel *(Falco sparverius),* bobolink *(Dolichonyx oryzivorus),* and grasshopper sparrow *(Ammodramus savannarum).*

County Distribution: Statewide

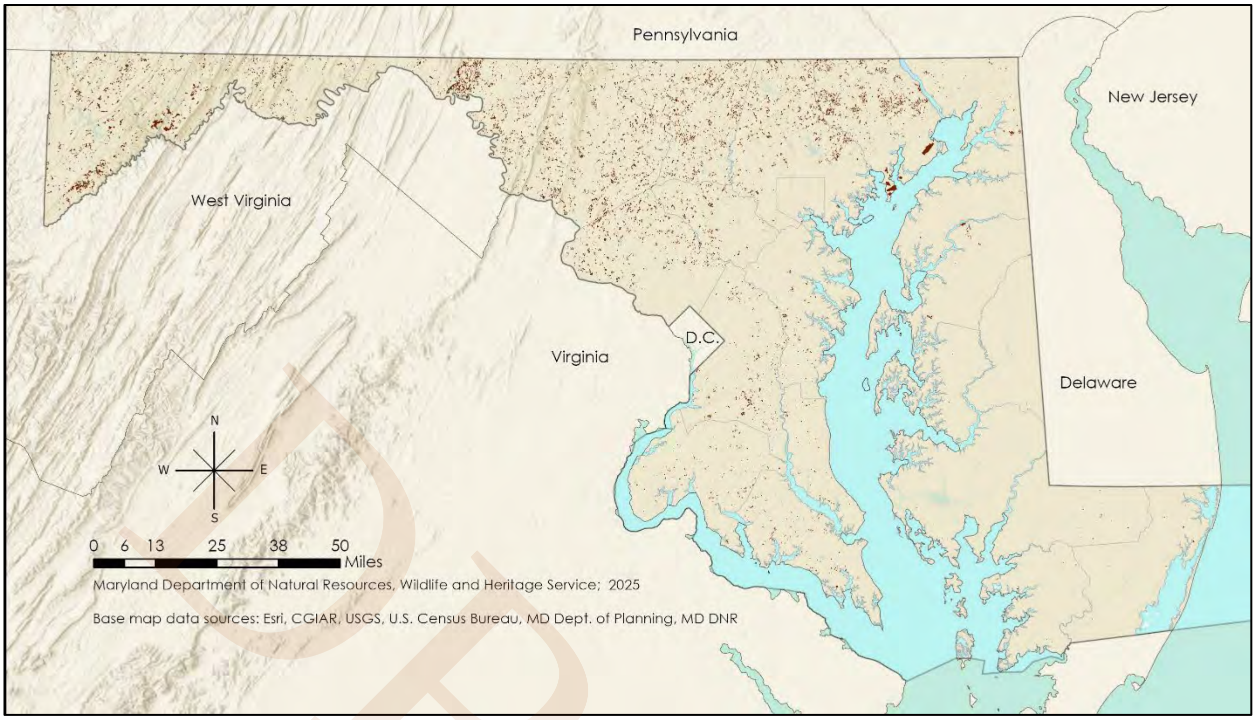


Figure 4.54 Location of Managed Grasslands in Maryland. Source: Maryland Department of Planning's Land Use/Land Cover 2010.

Species of Greatest Conservation Need Associated with Managed Grasslands:

Birds

American barn owl
American kestrel
American woodcock
Black-billed cuckoo
Bobolink
Common nighthawk
Dickcissel
Eastern meadowlark
Golden eagle
Golden-winged warbler
Grasshopper sparrow
Henslow's sparrow
Loggerhead shrike
Long-eared owl
Northern bobwhite
Northern harrier
Savannah sparrow
Sedge wren
Short-eared owl
Swamp sparrow
Upland sandpiper
Vesper sparrow
Yellow-breasted chat

Mammals

Bobcat
Eastern red bat
Hoary bat
Indiana bat
Least shrew
Least weasel
Little brown bat
Silver-haired bat
Tricolored bat

Reptiles

Bog turtle
Eastern box turtle
Smooth greensnake
Wood turtle

Insects (Hymenoptera)

A cemolobus bee *(Cemolobus ipomoeae)*
A cuckoo bee *(Nomada seneciophila)*
Howard's cuckoo nomad bee *(Epeolus howardi)*
Sunflower miner bee *(Andrena helianthi)*

Insects (Lepidoptera)

Cobweb skipper
Frosted elfin
Indian skipper
Leonard's skipper

Roadside and Utility Right-of-Way

Region(s): *All*
Habitat Group: *Working Lands*
NEAFWA: *Grasslands*
Additional Notes: *An artificial or human-made habitat*

Jason Harrison, MD DNR

These habitats comprise a mixture of managed grasslands and shrub-dominated early successional forest areas that are maintained along roadsides, gas pipelines, and in powerline rights-of-way. Vegetation composition includes both native and non-native species and varies across the region. Depending on site conditions (e.g., soils, geology, slope, aspect, etc.) and how vegetation along the roadside or right-of-way is managed, these areas may, to some degree, mimic the natural disturbances and early successional phases of adjacent natural systems. Because these areas are usually rather narrow, although long, strips of habitat, they are typically not suitable for vertebrates that are area-sensitive and require the interior of large habitat patches for optimal breeding conditions. Therefore, these areas are more valuable as habitat for species, especially invertebrates, which may not require large habitat patches, as migratory or dispersal corridors for birds and other vertebrates, or as additional "linkage" habitat that connects and expands the size of adjacent patches of managed successional forests or grasslands. In highly fragmented or mosaic landscapes, connectivity between habitat patches may be important for the survival of wildlife on a species-specific basis.

There are 15 plant Species of Greatest Conservation Need (SGCN) that occur only along powerline and utility rights-of-ways and roadsides. This may seem a surprising number of plant SGCN for seemingly anthropogenic meadows, which contrast with the focus on natural communities in the State Wildlife Action Plan. However, these plants are often obligate heliophytes, meaning that they require full sun. They are often associated with fire-prone pine and oak savannas, as well as woodlands that were historically more widespread in the southeastern U.S. Most savannas were fire-maintained, but with widespread fire suppression in the nineteenth and twentieth centuries, most became overgrown and succeeded to forests. While roadsides and utility rights-of-way that capture remnants of these historically occurring natural communities have no formally recognized ecological community name within the Maryland State or National Vegetation Classifications, these meadows are regarded as significant natural features and often have high species diversity. An example of such a meadow in Dorchester County contained >70 species in a single 400 square meter plot and had populations of rare species such as low showy aster (*Eurybia spectabilis*), which is common in the New Jersey Pine Barrens; pale false foxglove (*Agalinis skinneriana*), a species commonly occurring in Midwestern Prairies; and shortleaf beardgrass (*Gymnopogon brevifolius*), a species of southern Pine Barrens.

County Distribution: Statewide

Species of Greatest Conservation Need Associated with Roadsides and Utility Rights-of-Way:

Birds

Baltimore oriole
Black-billed cuckoo
Blue-winged warbler
Golden-winged warbler
Prairie warbler
Swamp sparrow
Willow flycatcher
Yellow warbler
Yellow-breasted chat

Mammals

Eastern red bat
Hoary bat
Indiana bat
Least shrew
Little brown bat
Northern long-eared bat
Silver-haired bat
Tricolored bat

Amphibians

Eastern narrow-mouthed toad
Upland chorus frog

Reptiles

Bog turtle
Copperhead
Mountain earthsnake
Rainbow snake
Smooth greensnake
Timber rattlesnake

Insects (Coleoptera)

Common claybank tiger beetle
Cow path tiger beetle
Northern barrens tiger beetle
Splendid tiger beetle

Insects (Hymenoptera)

A cemolobus bee *(Cemolobus ipomoeae)*
A leafcutter *bee (Paranthidium jugatorium)*
A sweat bee *(Sphecodes brachycephalus)*
Golden Alexanders miner bee *(Andrena ziziae)*
Nude plasterer bee *(Colletes nudus)*
Sunflower miner bee *(Andrena helianthi)*

Insects (Lepidoptera)

Cobweb skipper
Edwards' hairstreak
Frosted elfin
Harris's checkerspot
Indian skipper
Leonard's skipper
Northern metalmark
Northern oak hairstreak
Olympia marble
Pepper and salt skipper
Silvery blue

Plants

Pale false foxglove *(Agalinis skinneriana)*
Purple giant-hyssop *(Agastache scrophularifolia)*
Wand-like three-awn grass *(Aristida virgata)*
Purple milkweed *(Asclepias purpurascens)*
Field sedge *(Carex conoidea)*
Rigid sedge *(Carex tetanica* var. *canbyi)*
Velvety sedge *(Carex vestita)*
Slender plume grass *(Erianthus strictus)*
Low showy aster *(Eurybia spectabilis)*
Stiff gentian *(Gentianella quinquefolia)*
Shortleaf beardgrass *(Gymnopogon brevifolius)*
Dwarf iris *(Iris verna* var. *verna)*
Hairy ludwigia *(Ludwigia hirtella)*
Slender rattlesnake-root *(Nabalus autumnalis)*
Pink milkwort *(Polygala incarnata)*

(Sub)urban

Artificial Structure: Buildings and Other Structures

Region(s): *All*
Habitat Group: *(Sub)urban*
NEAFWA: *Developed Areas*
Additional Notes: *An artificial or human-made habitat*

This habitat includes buildings, bridges, and other man-made structures that, in some specific cases, provide important surrogate habitat for a small number of Species of Greatest Conservation Need (SGCN). These species have adapted over time to use artificial structures in the absence of sufficient suitable natural features or habitats. Examples include the American peregrine falcon's *(Falco peregrinus anatum)* use of tall buildings and bridges as nest sites in place of undisturbed cliff faces with sufficient prey populations nearby; least tern *(Sternula antillarum)* use of building rooftops with suitable substrates (i.e., loose, light-colored gravel) near tidal waters in place of natural sandy islands and sand bars lacking predators and human disturbance; and little brown bat *(Myotis lucifugus)* use of houses and barns as maternity sites to raise their young in place of undisturbed, large, old hollow trees. Some species, such as chimney swifts *(Chaetura pelagica)*, have virtually no natural alternatives remaining, while other species can still use natural alternatives, but have a much higher chance for survival or reproductive success using man-made alternatives because of the changed landscape.

In aquatic environments, man-made reefs composed of concrete, fabricated reef structures, sunken ships/barges, or other materials attract reef-associated species in areas where shellfish beds and other natural reefs have declined or have been lost to siltation. These artificial structures provide attachment substrate for algae, sponges, oysters, and other invertebrates, and serve as shelter, nursery, and feeding habitat for many aquatic species, including some SGCN.

County Distribution: Statewide

Species of Greatest Conservation Need Associated with Buildings and Other Structures:

Birds	**Birds (continued)**	**Mammals**	**Reptiles**
American barn owl	Greater scaup	Indiana bat	Diamond-backed terrapin
American peregrine falcon	Least tern	Little brown bat	
Black scoter	Lesser scaup	Northern long-eared bat	**Plants**
Canvasback	Long-tailed duck	Silver-haired bat	Tennessee bladderfern
Chimney swift	Redhead	Tricolored bat	*(Cystopteris tennesseensis)*
Common goldeneye	Surf scoter		
Common loon	White-winged scoter		
Common nighthawk			

Urban and Suburban Environment

Region(s): *All*
Habitat Group: *(Sub)urban*
NEAFWA: *Developed Areas*
Additional Notes: *An artificial or human-made habitat*

The National Aquarium's Harbor Wetland in Baltimore (Dave Harp, Bay Journal)

Urban and suburban areas are places where human developments are more densely concentrated into large and small cities, towns, and other local municipalities. Although Maryland is sectioned into 23 counties, it also has 157 incorporated municipalities. The Urban and Suburban Environment Key Wildlife Habitat includes these areas and their vicinities, where housing densities often range from 0.2 to 8 units per acre. Urban and Suburban Environments are scattered across Maryland, but are concentrated in areas along the Fall Line, including the sprawling, merged metropolis areas of Baltimore City and around Washington DC. In urban and suburban areas, remnant woodlands, shrublands, and meadows such as along streams, between developments, and within parks can be critical patches of refugia, especially for migrant and highly mobile wildlife. These areas act as oases in otherwise unsuitable landscapes. These habitat remnants can concentrate migrant birds and other passage wildlife in areas that offer what they need (i.e., food, water, and shelter) along their route.

Public park in Hagerstown
(City of Hagerstown Parks and Recreation)

Urban and Suburban Environments also may act as surrogate wildlife habitat, where the human-built structures and spaces mimic the functionality of natural landforms and habitats. Ecosystem composition and structure are shaped by the land manager's wishes and often by local ordinances, and so can change over time, although structurally they tend to be regular across the landscape. In general, urban or high-density environments are characterized by a high percentage of impermeable surfaces like roads, roofs, and walkways with low levels of widely spaced vegetation like street trees or shrubs. Open spaces, like parks, are found dotted throughout the landscape. These small patches are used by a limited number of resident wildlife species generally adapted to omnivorous diets, the heat island effect, and regular human disruption.

Suburban environments and rural towns are lower density and often include large areas of low growing, often cold season grasses as lawn. Other common plants include annual and perennial vegetation such as forbs, ferns, and graminoids, interspersed with trees and woody shrubs. Small patches of landscape may approximate woodlands. Suburbs also tend to include higher proportions of edge habitat, between surrounding forest or grassland and yard, or golf course, or linear roadside vegetation.

Water is often a component of urban, suburban, and rural towns, as many are built along rivers and streams, but water quality is impacted by the high proportion of impermeable surface. Contaminated runoff, increased temperatures, higher flow rates compared to forested streams, and increased non-native aquatic plant and animal species can reduce the quality of both flowing and non-flowing water.

Urban, suburban, and rural towns include surrogate habitat features, either as part of the built environment, such as chimneys as snags for chimney swift *(Chaetura pelagica)* breeding and migration, or tall buildings and bridges mimicking cliffs for raptor nesting sites (see the Artificial Structure: Buildings and Other Structures Key Wildlife Habitat), or provided as intentional habitat features. Bat boxes and bird boxes simulate cavities as do warped boards or loose siding on buildings. Landscaping choices may also provide for small patch habitat needs in the form of pollinator gardens, fish ponds, rock gardens, or bird baths. Seasonality and appropriate maintenance may also govern the availability of these habitats. Regular mowing or pruning can maintain these habitats in a given seral stage, depending on the landowner's management. Plant species are often used without regard to natural range and so may include species native to the mid-Atlantic or anywhere else in the world, climate permitting. Current state regulations and cultural shifts encourage the use of native plants and the removal of invasive species, with the expectation that more native wildlife species will benefit from increased patches of functional habitat.

County Distribution: Statewide

Places to Visit: Patterson Park, Druid Hill Park, Leakin Park, and Greenbelt Park

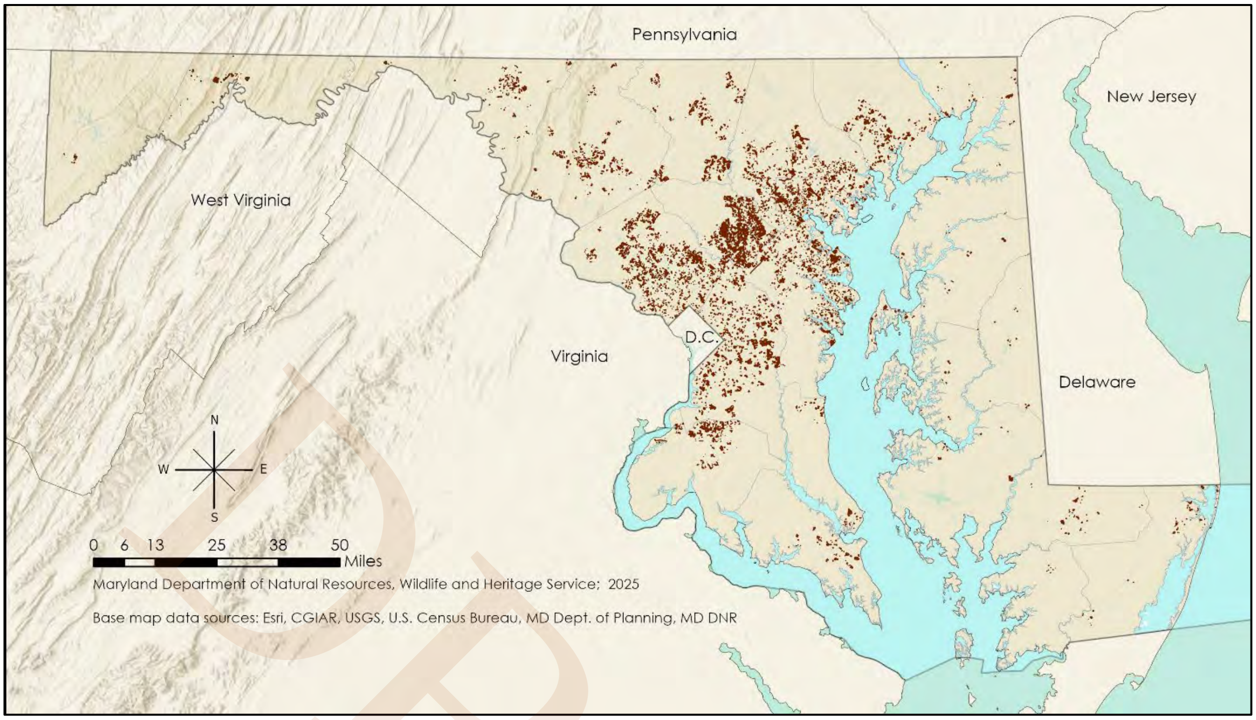


Figure 4.55 Location of Urban and Suburban Environments in Maryland. Sources: MD DNR and MDP.

Species of Greatest Conservation Need Associated with Urban and Suburban Environments:

Birds
Acadian flycatcher
American peregrine falcon
American redstart
American woodcock
Bald eagle
Baltimore oriole
Bicknell's thrush
Black-and-white warbler
Black-billed cuckoo
Black-throated blue warbler
Black-throated green warbler
Blackburnian warbler
Blue-winged warbler
Brown creeper
Canada warbler
Cerulean warbler
Chimney swift
Golden-winged warbler
Hooded warbler
Kentucky warbler
Least flycatcher
Louisiana waterthrush
Magnolia warbler
Mourning warbler

Mammals
Eastern red bat
Gray fox
Little brown bat

Invertebrates (Mites)
Ash flower gall mite *(Aceria fraxiniflora)*
Ash key gall mite *(Aceria fraxinivora)*
Ash leaf gall mite *(Aceria fraxini)*

Insects (Coleoptera)
An ash seed weevil *(Lignyodes bischoffi)*
An ash seed weevil *(Lignyodes fraxini)*
An ash seed weevil *(Lignyodes helvolus)*
An ash seed weevil *(Lignyodes horridulus)*
Charlie Brown's flea beetle *(Capraita sexmaculata)*
Eastern ash bark beetle *(Hylesinus aculeatus)*
Encircled borer *(Agrilus subcinctus)*

Insects (Hymenoptera)
A cemolobus bee *(Cemolobus ipomoeae)*

Insects (Diptera)
Ash bullet gall midge *(Dasineura pellex)*
Swollen ash gall midge *(Dasineura tumidosae)*

Insects (Hemiptera)
Fringetree lace bug *(Leptoypha mutica)*
Riley's 13-year cicada *(Magicicada tredecim)*

Insects (Lepidoptera)
Angel moth
Ash borer moth *(Podosesia syringae)*
Ash leaf cone roller moth *(Caloptilia fraxinella)*
Ash sphinx *(Manduca jasminearum)*
Ash tip borer moth *(Papaipema furcata)*
Banded ash clearwing moth *(Podosesia aureocincta)*
Cobweb skipper

Nashville warbler
Northern parula
Northern saw-whet owl
Northern waterthrush
Olive-sided flycatcher
Ovenbird
Prairie warbler
Rusty blackbird
Savannah sparrow
Scarlet tanager
Veery
Wood thrush
Worm-eating warbler
Yellow warbler
Yellow-throated vireo

A leafcutter bee *(Paranthidium jugatorium)*
A long-horned bee *(Epimelissodes comptus)*
Azalea mining bee *(Andrena cornelli)*
Blackheaded ash sawfly *(Tethida barda)*
Golden Alexanders miner bee *(Andrena ziziae)*
Nude plasterer bee *(Colletes nudus)*
Sunflower miner bee *(Andrena helianthi)*
Sunflower sweat bee *(Dieunomia heteropoda)*
Texas mason bee *(Osmia texana)*

Frosted elfin
Gray comma
Great ash sphinx *(Sphinx chersis)*
Great purple hairstreak
Grote's sallow moth
Indian skipper
Inkblot palpita moth *(Palpita illibalis)*
Leonard's skipper
Northern oak hairstreak
Palamedes swallowtail
Pepper and salt skipper
Purple plagodis moth *(Plagodis kuetzingi)*
Splendid palpita moth *(Palpita magniferalis)*

This chapter provided extensive descriptions of the Key Wildlife Habitats (KWHs) that exist in Maryland, including KWH distributions, conditions, and associated Species of Greatest Conservation Need (SGCN). (**Element #2**). The next chapter will discuss threats facing Maryland's wildlife species and their habitats (**Element #3**).

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Chapter 5

Threats to Maryland's Species and Their Habitats

Table of Contents

Introduction

Many challenges confront our native fish, wildlife, and plant populations and the places they need to survive. Threats to these populations can be local, statewide, regional, national, or global in scale. They may be direct, affecting a species or habitat directly, or indirect, affecting a species or habitat through one or more intermediary actors or processes. Some threats are the direct result of human activities; others take the form of more natural processes. Threats can also manifest in the absence of something rather than its presence. For example, lack of sufficient legal protection for a vulnerable species or habitat can be just as damaging as more "traditional" threats such as pollution, resource extraction, and climate change. The same can be said for other "scarcities," including inadequate or ineffective coordination between agencies, insufficient data for many species and their habitats, and inadequate funding to deal with the numerous threats.

This chapter identifies these threats to Maryland's Species of Greatest Conservation Need (SGCN) and their associated key wildlife habitats (KWHs), whether they be local or global in scale, direct or indirect, natural or artificial, or problematic in presence or absence. This chapter provides information about key threats (**Element #3**) identified by the Maryland Department of Natural Resources (MD DNR) and its partners. The subsequent chapter then describes conservation actions (**Element #4**) to address these threats in Maryland and the other states of the Northeast region. The content of these two chapters was co-developed throughout the State Wildlife Action Plan (SWAP or Plan) revision process, as Maryland developed its SWAP so that every threat has a specific associated action. However, they have been split into separate chapters for the sake of organization.

The chapter begins with a brief explanation as to how Maryland updated its list of threats and actions for the 2025 SWAP revision. Then, the comprehensive threat classification system used by all 14 Northeast states is explained. Finally, state and regional priority threats are highlighted at the end of the chapter. In the interest of saving space, species- and habitat-specific threats are not included in the text of this chapter. The full list of threats and their associated actions can be found in Appendices 6a and 6b. An overview of species group-specific threats and actions can also be found in the text of Chapter 3.

Threats in the 2025 SWAP Revision

After updating the SGCN list, one of the first steps in revising Maryland's SWAP was reviewing, editing, and adding to the list of threats and actions from the previous 2015 SWAP revision. This needed to be done for both SGCN-specific and KWH-specific threats and actions. Throughout 2025, nearly 150 people contributed to the SGCN-specific list and 100 to the KWH-specific list, though there is some overlap between the two groups. These groups included MD DNR staff, other government organization staff, partner organization staff, academics, community scientists, and more. For a more comprehensive overview of partner participation in the SWAP revision process, please see Chapter 8. For a full list of which organizations participated in Maryland's 2025 SWAP revision, see Appendix 8a.

MD DNR and its partners combed through every threat and associated action listed in the 2015 SWAP revision, flagging those that were completed, in need of revision, or no longer appropriate. After needed updates and removals were made, staff and partners worked together to "fill in the gaps" by referring to various resources that have been made available since the

2015 SWAP revision. This included academic literature, non-governmental organization (NGO) and government reports, datasets and data analysis results, recent regulations, and much more. Staff and partners then worked to incorporate these emerging or previously overlooked concerns into the 2025 SWAP, either by combing them with existing threat–action pairs or creating new line items. This resulted in two updated sets of threats and actions—one for SGCN, one for KWHs—that can be found in Appendices 6a and 6b, respectively.

Though spearheaded by MD DNR, the Department made efforts to conduct these updates in a collaborative manner. Threats and actions in the 2025 SWAP revision are therefore the result of many hours of discussion involving both partners and staff. Although much of the resulting work can be found in Appendices 6a and 6b, these frequent meetings, workshops, and other forms of contact between MD DNR and its partners highlighted a number of topics that came up repeatedly over the course of the revision process. This chapter therefore pays special attention to these topics; they are further discussed in the "Priority Threats for Maryland" section.

Threat Classification System

Following the development of the 2015 SWAPs, the *Northeast State Wildlife Action Plan Synthesis: Regional Conservation Priorities* report synthesized the threats to both species and habitats identified in the 14 individual SWAPs (TCI & NEFWDTC 2017). The Conservation Measures Partnership (CMP) and the International Union for Conservation of Nature (IUCN) have developed several threat classification systems, which were advanced by Lamarre et al. (2021) for use in Quebec. The classification system used in the Northeast states' 2025 SWAP revisions is heavily based upon these works, with some modifications that include relevant threats for the Northeast.

Maryland uses this classification system to categorize threats facing its species and habitats. When possible, all threats are categorized using a three-level approach. The first, Level 1, broadly categorizes the threat into one of 12 categories. The second, Level 2, is slightly more specific, breaking the broad Level 1 category into more specific sub-categories. The third, Level 3, allows for an even higher degree of specificity. Every threat listed in Appendices 6a and 6b has a corresponding "IUCN Code" according to this system. Further threat descriptions are occasionally included for clarity, but in most cases, this three-level approach is sufficient to properly articulate threats to species or habitats.

The following text is taken almost directly from this classification system, as recommended in the 2022 Northeast Lexicon (Crisfield & NEFWDTC 2022). Not all threat categories or subcategories are relevant to Maryland—for example, category 10, "Geological Events"—but have been included in the text for the sake of accuracy. The only modification Maryland made to this classification system is the reinstatement of sub-categories for category 12, "Other Options." This is because Maryland's 2025 SWAP revision contains many threats that fall under this category, and it was felt that a higher degree of categorization was needed. These additions are marked below with an asterisk.

Category 1: Residential & Commercial Development

This threat category refers to all human settlements (cities, towns, etc.) or non-agricultural land uses with a substantial ecological footprint. It includes habitat conversion that is associated with early phases of development (deforestation, filling/excavation, drainage, etc.), as well as infrastructure use, maintenance, and subsequent impacts that are related to the presence of infrastructure (e.g., birds flying into windows). This category excludes issues related to transportation (threat 4) and pollution (threat 9).

1.1 Housing & Urban Areas: Anything that is related to or integrated with urban or housing structures. Includes urban areas (cities), suburbs, villages, cottages, shopping areas, offices, schools, hospitals, and urban parks, among others.

1.1.1 Dense housing & urban areas: Medium- to high-density urban development for residential use and buildings for related services. Allows very little to no maintenance of ecological functions. E.g., urban areas, suburbs, villages, schools, libraries, seniors' housing, hospitals.

1.1.2 Low-density housing areas: Extensive development that is residential (including resorts), where the spacing allows ecological functions to continue to some extent. This type of development is seen particularly in rural and agroforestry areas. E.g., residential buildings in agricultural areas, cottages, vacation homes near water bodies, ecotourism lodges, fishing resorts, backcountry ski lodges.

1.2 Commercial & Industrial Areas: Anything that is related to or integrated with commercial or industrial structures, as well as designated areas for storing waste material. Includes animal deterrence activities, which are needed near certain infrastructures.

1.2.1 Commercial & industrial areas: E.g., industrial parks, manufacturing plants, offices, shopping centers, all military base facilities, power plants, seaports, shipyards, airports.

1.2.2 Open dump sites: Open-air facilities that are used to dispose of materials or to store them prior to recycling. E.g., automobile junkyards, metal recycling centers.

1.2.3 Landfills

1.2.4 Nuclear waste disposal facilities

1.3 Tourism & Recreation Areas: Tourist sites or recreational facilities with a significant ecological footprint. Excludes residential infrastructures (threat 1.1).

1.3.1 Parks and sports fields: Areas that are intensively managed (e.g., grass-cutting, thinning of woodlands) and are primarily designed for recreation activities, such as walking in urban parks and sports. Also includes outdoor sites that are managed for prayer or mourning (cemeteries). E.g., large spaces that are mown/maintained for walking, picnics, children's activities, mourning (cemeteries), golf courses, driving ranges, shooting ranges, sports fields/courts.

1.3.2 Campgrounds: Sites that are maintained for camping activities, for which the facilities may have some ecological impact. To be distinguished from wilderness camping without amenities (threat 6.1.5). E.g., car or RV camping areas, with or without services; camping with site management and/or facilities.

1.3.3 Ski resorts: Rights-of-way of ski trails (managed areas of the hills) and service facilities (ski lifts, visitor centers, etc.).

1.3.4 Recreational trails: Creation of trails in parks (see Parks and sports fields, threat 1.3.1) or areas outside the urban environment for walking and recreation. Includes the creation and maintenance of trails in recreational parks as well as private properties. Excludes activities that are related to the use of the trail (e.g., hiking, threat 6.1.2).

1.3.5 Docks & marinas: High-impact infrastructures that are associated with recreational boating. To be distinguished from the activity of recreational boating itself (threat 6.1.4) and includes local dredging. E.g., docks, marinas, boat launches.

Category 2: Agriculture & Aquaculture

This threat category encompasses threats from agricultural activities, such as the expansion and intensification of agriculture and livestock farming, including silviculture, mariculture, and aquaculture, and related infrastructures. This includes the initial conversion of habitat (deforestation, filling/excavation, draining of wetlands, etc.) that is associated with cultivation or infrastructure development, as well as uses and practices (intensification of agricultural practices, use of machinery, etc.), but not the transport of the resources that are produced (threat 4), crop irrigation (threat 7.2.4), or pollution (threat 9.3).

2.1 Annual & Perennial Non-Timber Crops: Non-timber crops that are planted for food, fodder, fuel, or other uses; farms, crop fields, vineyards, mixed agroforestry systems, etc. For rotational crops, it is necessary to refer to the most intensive practice that is used. Considering the diversity of agricultural practices and related impacts, some specialty cultures will be pooled into a generic threat category (2.1.3).

2.1.1 Annual cropping systems (field crops): Wide-row crops that require the most intensive agricultural practices and which have the most significant impacts. E.g., maize (corn), soybean, barley, vegetable crops, oats, wheat, canola, hemp.

2.1.2 Perennial cropping systems: Crops that are associated with less intensive agricultural practices that have less of an ecological impact than do annual crops. E.g., pastures, forage crops, hay, alfalfa, clover.

2.1.3 Other types of agriculture: Specialty crops for which the ecological impacts may vary depending on the practices that are used. E.g., cranberry bogs, vineyards, berry fields, sod production, greenhouse farming.

2.2 Plantations: Wood plantations that produce timber, fiber, or other non-timber products that are made from trees and which maintain a certain amount of forest cover year-round. This type of plantation is generally located outside of natural forests and often consists of non-native tree species.

2.2.1 Plantation of pulpwood: Cultivation of hybrid poplars and other species that are used for pulp production.

2.2.2 Ornamental tree plantations: E.g., cultivation of ornamental cedars, Christmas tree farms.

2.2.3 Non-timber products from plantations: Cultivation of trees outside of natural forests for the production of fruits, nuts, bark or sap. E.g., orchards, walnut production, rubber production.

2.3 Livestock & Poultry Farming: Farming of various domestic (cows, pigs, chickens, sheep, goats, turkeys, ducks, etc.) or semi-domesticated animals (llamas, alpacas, etc.); livestock rearing in outdoor pens (farms) or extensive rearing in natural habitat (pastures, ranching).

- **2.3.1 Outdoor extensive livestock operation (on pasture)**
- **2.3.2 Outdoor intensive livestock operation (high-density)**
- **2.3.3 Indoor livestock operation**

2.4 Marine & Freshwater Aquaculture: Aquaculture that is conducted in different types of facilities (finfish aquaculture in the ocean, in tanks, in pens, along the shoreline, etc.). Farming fish for the purpose of stocking natural lakes falls under this category. It also includes the construction, maintenance, and use of facilities, but not the transport of resources (threat 4) and contaminants (threat 9).

- **2.4.1 Marine finfish aquaculture**
- **2.4.2 Finfish aquaculture in outdoor tanks**
- **2.4.3 Finfish aquaculture in indoor tanks**
- **2.4.4 Algae cultivation**
- **2.4.5 Marine shellfish cultivation**

Category 3: Energy Production & Mining

This threat category encompasses threats from the production/development of non-biological resources, including the conversion of the original habitat, development of necessary infrastructure, and associated uses and practices (use of machinery, exploration, excavation, drilling and storage of ore or drill cuttings, tailings ponds, settling ponds, site reclamation after development, etc.). It excludes the transport of resources (threat 4) and contaminants (threat 9). This category also includes the impacts of wildlife collisions with the related infrastructures, such as wind turbines.

3.1 Oil & Gas Drilling: Exploring for, developing, and producing petroleum or other hydrocarbons.

- **3.1.1 Onshore oil development**
- **3.1.2 Offshore oil development**
- **3.1.3 Oil development in freshwater**
- **3.1.4 Onshore natural gas development**
- **3.1.5 Offshore natural gas development**
- **3.1.6 Natural gas development in freshwater**

3.2 Mining & Quarrying: Exploring for, developing, and producing minerals, rocks, and various other substrates (sand, gravel, etc.). Includes tailings treatment (settling and tailings ponds), site expansion, and site reclamation after development. E.g., coal mines, mining of various sources of metals (gold, copper, nickel, magnesium, etc.), quarries, sand pits. Peat harvesting is also included in this category. This threat does not include the transportation of resources (threat 4) and acid mine drainage (threat 9.2.2).

3.2.1 Underground mines

3.2.2 Open-pit mines

3.2.3 Quarries & sand pits

3.2.4 Peat harvesting

3.2.5 In-stream mining

3.2.6 Near-shore & off-shore mining

3.3 Renewable Energy: Exploring, developing infrastructure for, and producing renewable energy; excludes its transport (threat 4).

3.3.1 Hydroelectric dams

3.3.2 Wind farms

3.3.3 Hydrokinetic turbines

3.3.4 Solar farms

Category 4: Transportation & Service Corridors

This threat category includes threats from developing, using, and maintaining transportation corridors (roads, pipelines, power lines, etc.) and their rights-of-way. These types of facilities may create obstacles or hinder the natural movement of species in addition to causing disturbances during maintenance (e.g., disturbance of falcon nests during bridge maintenance). This threat also includes vegetation control during rights-of-way maintenance, as well as collisions with wildlife.

4.1 Roads & Railroads: Development, maintenance, and presence of the surface transportation network. The impact of rights-of-way may vary according to their size.

4.1.1 Roads

4.1.2 Railroads

4.1.3 Bridges: Includes road and rail network bridges.

4.1.4 Logging roads

4.2 Utility & Service Lines: Linear networks for transporting energy and various resources, including their rights-of-way. Possible impacts include electrocution, barrier to dispersal, habitat modification/loss, and fatal collisions.

4.2.1 Power & service lines: Networks of buildings, towers, pylons, and poles that are associated with electricity distribution and telecommunications, excluding hydroelectric dams or power plants (threat 3.3.1). The scope of rights-of-way may vary according to their size.

4.2.2 Oil & gas pipelines: Infrastructure network for transporting oil and natural gas products aboveground or underground, including seismic lines, but excluding extraction sites (threat 3.1).

4.3 Shipping Lanes: Threats associated with transporting people and goods on water (oceans, estuaries, rivers, etc.), as well as waterway development. This category does not include activities that are related to recreational boating (threat 6.1.4).

4.3.1 Shipping: Ships striking wildlife, damage associated with wake waves, disturbance caused by the presence of vessels transporting people and goods.

4.3.2 Dredging of shipping lanes: Dredging in order to facilitate the transit of boats. Excludes dredging within marinas and docks (threat 1.3.5) and dredging for locks and canals (threat 4.3.3).

4.3.3 Locks & canals: Creation, maintenance, and use of locks and canals. Includes the associated dredging.

4.4 Flight Paths: Using air space to transport people and goods, excluding recreational activities such as hang-gliding (threat 6.1.3) and drones (threat 6.1.6).

4.4.1 Flight paths: Flying airplanes, paragliders, helicopters, or ultralight aircraft at low altitudes, which could lead to collisions with birds or disturbance of other wildlife. E.g., disturbance of wildlife by low-altitude training flights.

Category 5: Biological Resource Use

This category encompasses threats that are due to the use/consumption of wild biological resources, including the impacts of legal, illegal, and unintentional harvesting. The disturbance and control of certain species fall under this threat category, which includes habitat conversion and degradation, the development of related infrastructure, and the uses and practices that are associated with the latter (e.g., use of machinery, wood storage, soil management). Excludes the transport of resources (e.g., logging roads, threat 4.1.4) and peat harvesting (threat 3.2.4).

5.1 Hunting & Collecting Terrestrial Animals: Hunting animal species or collecting animal products for commercial, recreational, subsistence, cultural, or control purposes. Includes hunting terrestrial species and trapping semi-aquatic species. This category also covers incidental captures, control, and persecution, but excludes harvesting for research purposes (threat 6.3.1).

5.1.1 Hunting: Harvesting of wild animal species by hunting for recreation or subsistence that is governed by management measures. Includes incidental killing, but illegal harvesting or killing is classified under "Poaching/Persecution of terrestrial animals" (threat 5.1.4). Excludes contamination of habitats due to solid lead from hunting ammunition (threat 9.4.2). E.g., hunting with firearms, bows or crossbows, or blunt objects for sport or subsistence, taxidermy, trophies.

5.1.2 Trapping: Harvesting of wild terrestrial or semi-aquatic animal species (e.g., beavers) by trapping that is governed by management measures. Includes incidental killing, but animal control by trapping is classified under "Management/control of terrestrial animals" (threat 5.1.5). E.g., trapping of wild terrestrial or semi-aquatic animals for fur, meat, taxidermy, trophies, non-target birds of prey caught in traps.

5.1.3 Non-lethal harvesting of terrestrial animal products: Harvesting of terrestrial animal products that does not require the killing of individuals and that is governed by management measures. E.g., down collection, guano collection.

- **5.1.4 Poaching/persecution of terrestrial animals:** Illegal harvesting of terrestrial animals or animal products (e.g., feathers) for personal, commercial, or persecution purposes, or actions that would be interpreted as abuse or harassment of wildlife. E.g., hunters killing coyotes or birds of prey, people deliberately harming snakes out of fear, illegal collection of seabirds or shorebird egg collection, illegal wildlife trade for skins, meat, or the pet trade.
- **5.1.5 Management/control of terrestrial animals:** Deliberately killing individuals of a terrestrial species for human gain that is governed by management measures. E.g., cormorant culling.

5.2 Gathering Terrestrial Plants or Fungi: Harvesting and gathering wild plants, mushrooms, or other non-animal/non-timber species for commercial, recreational, subsistence, cultural, or control purposes, but excludes research (threat 6.3.1).

- **5.2.1 Recreational or subsistence harvesting:** Harvesting of plant or fungi species that has a lethal effect on the individual and is governed by management measures. Illegal harvesting is classified as “Poaching/eradication of terrestrial plants or fungi” (threat 5.2.4). E.g., recreational or subsistence harvesting of wild leeks.
- **5.2.2 Commercial harvesting:** Commercial harvesting of plants or fungi species that has a lethal effect on the individual and is governed by management measures. Excludes peat harvesting (threat 3.2.4) and products from plantations (threat 2.2). E.g., commercial harvesting of fiddleheads.
- **5.2.3 Non-lethal harvesting of terrestrial plant products:** Sub-lethal harvesting of plants or fungi related products, which is governed by management measures. E.g., collecting of cedar bark, tree tapping for sugar maple production.
- **5.2.4 Poaching/eradication of terrestrial plants or fungi:** Deliberate and illegal harvesting of plants or fungi for personal or commercial purposes, or eradication due to prejudices against the species. E.g., illegal gathering of American ginseng, eradication of cow parsnip because of its similar appearance to giant hogweed, an invasive alien species.
- **5.2.5 Management/control of terrestrial plants or fungi:** Deliberately destroying a plant species or fungi for human gain. Includes indirect or unintended impacts on other species, but excludes cutting or vegetation management due to maintenance activities or early phases of development. E.g., herbicide spray drift from residential areas.

5.3 Logging & Wood Harvesting: Harvesting trees/other forest species in natural environments for timber or fiber outside of plantations (threat 2.2). Includes cutting and the use of machinery, as well as wood storage and debris management, excluding their transport (threat 4.1.4) and associated erosion (threat 9.3.2.).

- **5.3.1 Complete removal of the forest cover:** Cuttings removing the majority of the forest cover. E.g., clear-cutting and related cuts (CT, CRS, CPRS, CPHRS, CPPTM).

5.3.2 Partial removal of the forest cover: Partial cutting of the forest leaving a certain amount of cover. E.g., shelterwood cutting, selection cutting.

5.3.3 Improvement cutting in natural forests: Silvicultural treatments that alter the composition of the forest to increase the growth of certain plant species. These interventions alter wildlife habitat by affecting the availability of food and shelter. E.g., pre-commercial thinning, tending felling.

5.3.4 Artificial regeneration of forest stands: Planting of trees in natural forests (as opposed to planting taking place outside of natural forests, threat 2.2) to promote the regeneration of stands that are composed of species of commercial interest where natural regeneration is absent or insufficient.

5.3.5 Management of cutting areas: Management of the area and debris during a cutting or afterwards. E.g., scarification, formation of windrows from woody debris.

5.4 Fishing & Harvesting Aquatic Resources: Harvesting aquatic species (wild plants and animals) for commercial, recreational, subsistence, cultural, or control/scaring purposes. This category also covers incidental capture (bycatch) but excludes research activities (threat 6.3.1).

5.4.1 Recreational or subsistence fishing: Harvesting of aquatic species for recreation or subsistence that is governed by management measures. Illegal harvesting by fishing is classified under "Poaching/persecution of aquatic species" (threat 5.4.4). Includes bycatch and damage to released individuals but excludes contamination of habitats due to solid lead from fishing gear (threat 9.4.2). E.g., recreational fishing of sturgeon, accidental catching of rare species during ice fishing, turtles ingesting hooks, personal collection for fishkeeping with authorized species.

5.4.2 Commercial fishing: Harvesting of aquatic species for commercial purposes that is governed by management measures for which the environmental impact is primarily on the species (as opposed to habitat damage from sea bottom trawling, threat 7.3.6). Includes bycatch but excludes ghost fishing gear entangling wildlife (threat 9.4.4). E.g., commercial fisheries, use of nets and fishing gear for eels, factory ships, marine mammals caught in industrial fishing nets.

5.4.3 Poaching/persecution of aquatic species: Deliberate and illegal harvesting of aquatic animals for personal or commercial purposes or persecution, harassment, abuse, or to cause deliberate harm due to prejudices against the species. E.g., poaching of glass eels.

5.4.4 Management/control of aquatic species: Deliberately killing individuals of an aquatic species for human gain that is governed by management measures. E.g., control of lampreys using lampricides, control of mosquitoes in their aquatic larval stage (BTi), water weed cutting.

Category 6: Human Intrusions & Disturbance

This threat category includes threats from human activities (unrelated to the use of biological resources) that disturb, alter, or destroy habitats and their species.

6.1 Recreational Activities: Activities with generally low ecological impact that are conducted in natural areas for recreational purposes away from road networks (threat 4). To be distinguished from threat 1.3 (tourism and recreation areas with a significant footprint), which is a source of pressure primarily on habitats, whereas recreational activities (6.1) have a more direct impact on individuals of species (disturbance, mortality) and, to a lesser extent, habitats.

- **6.1.1 Motor vehicles:** Using recreational motor vehicles. E.g., ATVs, motocross motorcycles, snowmobiles.
- **6.1.2 Hiking:** Walking, cycling, or horseback riding on or off trails in natural environments. Includes opportunistic observation of nature but excludes disturbance by intensive observation/photography that is oriented towards one of several target species (threat 6.1.8). E.g., walking, jogging, running, dirt biking, geocaching, orienteering, disturbance from users or their domestic animals.
- **6.1.3 Recreational use of cliffs & rock faces:** E.g., rock climbing, hang-gliding.
- **6.1.4 Recreational boating:** Use of recreational boats and watercraft that disturb wildlife, incur collisions with animals, and induce wake damage. Excludes the spread of invasive species (threat 8.1). E.g., yacht, zodiac boats, watercraft.
- **6.1.5 Wilderness camping without amenities:** Temporary camping without amenities, away from dedicated networks. Distinguished from threat 1.3.2 (campgrounds) by the lack of amenities.
- **6.1.6 Drones**
- **6.1.7 Caving**
- **6.1.8 Wildlife observation/photography:** Wildlife observation activities without any gathering that disturb the target species due to harassment or through the use of attractants and lures. E.g., photographers attracting birds of prey with domestic rodents.
- **6.1.9 Special events in natural environments:** Outdoor performances or gatherings in natural settings that cause trampling and disturbance of habitat. Does not include noise pollution (threat 9.6.3). E.g., outdoor concerts, gatherings on beaches that incur some trampling, outdoor sports competitions in natural habitats.

6.2 War, Civil Unrest & Military Exercises: Military and paramilitary activities that do not have a permanent ecological footprint. To be distinguished from the construction and use of permanent military bases (threat 1.2.1).

- **6.2.1 War:** E.g., military intervention in conflicts, transportation using military vehicles, minefields.
- **6.2.2 Riots**
- **6.2.3 Military exercises:** Off-base military training activities with a local footprint. E.g., unexploded ordnance, trampling from military training activities, firing ranges, military equipment testing.

6.3 Work & Other Activities: Activities carried out in natural areas (undeveloped areas) for purposes other than recreational or military activities.

6.3.1 Research activities: Research activities that are governed by management measures that can affect species by causing a disturbance, by collecting individuals, or by degrading the environment. E.g. Research fisheries requiring mortality, trampling by research teams.

6.3.2 Illegal activities: Illegal activities that are unrelated to the harvesting of wild animal or plant species. Also includes habitat or species disturbance during related law enforcement interventions. E.g., illegal activities or law enforcement intervention, drug trafficking.

6.3.3 Vandalism: Deliberate and illegal destruction of structures that are of benefit to animal and plant species. E.g., destruction of gates limiting access to bat caves.

Category 7: Natural System Modifications

This category encompasses threats from activities that are generally carried out to improve human welfare, but may result in habitat degradation or destruction. It includes the development or redevelopment (management) of natural and semi-natural habitats, as well as certain natural processes that can act as threats. Stopping a conservation action or a practice that is conducive to conservation (threat 7.4) is not interpreted as a threat in and of itself, but as a return to the source threat (e.g., vegetation succession affecting pioneer species). Excludes meteorological or climate change-related threats that may modify natural systems (threat 11).

7.1 Fire & Fire Suppression: Suppression or increase in fire frequency, severity, or scope; changes in the natural fire regime that are directly related to human activity.

7.1.1 Increase in the fire regime: Increase in fire frequency/scope/severity due to human activities. E.g., out of control agricultural burning, campfires.

7.1.2 Suppression in the fire regime: Interventions aimed at preventing and putting out forest fires (fire management). E.g., putting out forest fires, controlled burning, creating firebreaks and trenches, and other measures. Also includes the loss of natural fire regime in fire-dependent habitats.

7.2 Dams & Water Management / Use: Facilities or activities that alter the natural water regime (flow or water levels).

7.2.1 Water level management using dams: Construction, operation, and water management using non-power dams. Includes the dismantling of man-made dams but excludes dams used for power generation (threat 3.3.1) and lock systems (threat 4.3.3) E.g., dams and weirs for containing water.

7.2.2 Beaver dam management: Structures (dams) built by beavers create habitats for a number of species; however, these dams may be dismantled by humans. Dismantling of dams results in habitat loss by drying out the beaver-created basin and flooding lands downstream. It could also potentially cause loss of accumulated sediments due to increased flow in streams farther downstream. E.g., dismantling of dams, development of infrastructure that promotes the free flow of water (installation of drains), decision to maintain dams.

7.2.3 Water management using culverts: The design, installation, and management of culverts that are used to permit water flow under roads or railroads can cause discontinuities in streams and promote erosion.

7.2.4 Drainage in agricultural environments: Construction and maintenance of channels that drain surface waters in agricultural environments. Excludes the use/management of culverts (threat 7.2.3). Excludes erosion/sedimentation associated with this drainage system (threat 9.3.2).

7.2.5 Drainage in forest environments: Construction and maintenance of channels that drain surface waters in forest environments. Excludes the use/management of culverts (threat 7.2.3). Excludes erosion/sedimentation associated with this drainage system (threat 9.3.2).

7.2.6 Withdrawal of surface water: Withdrawal of fresh surface water for human consumption, crop production, or other purposes. E.g., withdrawal by municipalities, spring water bottling companies, and farmers; reservoirs for firefighting, creation of man-made lakes.

7.2.7 Withdrawal of groundwater: Withdrawal of groundwater for human consumption, crop production, or other purposes. E.g., pumping water from the water table.

7.3 Other Ecosystem Modifications: Other activities that contribute to habitat alteration or loss by redeveloping natural systems to improve human welfare. To be distinguished from the development and maintenance of urban parks (threat 1.3.1).

7.3.1 Shoreline alteration: E.g., shoreline hardening, riprap along shorelines, breakwaters, concrete walls, shoreline filling.

7.3.2 Vegetation succession: Natural vegetation succession causing habitat loss for species of early successional habitats.

7.3.3 Natural erosion and sedimentation: Removal, transport, and deposition of sediments caused by natural erosional processes. To be distinguished from the transport of sediments that is associated with tides (threat 4.3.1), or by drainage systems in agriculture (threat 7.2.5) and forestry (threat 7.2.6).

7.3.4 Beach development: Creation of beaches, their nourishment (substrate replenishment), and maintenance.

7.3.5 Removal of snags in watercourses: Removal of snags and other structures that are used by wildlife within watercourses to promote water flow, embellish the landscape, or facilitate boating. Excludes the maintenance of road ditches (4.1.1) and agricultural ditches (7.2.4), as well as shoreline clean-ups that are performed as a conservation action. E.g., removal of rocks or snags that are used by river turtles for basking.

7.3.6 Sea bottom trawling: Trawling of the sea bottom that alters marine habitats. Excludes the impact of harvesting on target species (threat 5.4.2).

7.4 Removing / Reducing Human Maintenance: As noted above, this subcategory is better defined as a return to the original threat rather than its own distinct threat.

- **7.4.1 Reducing or ceasing vegetation control:** E.g., reducing, removing, or ceasing prescribed fire, removal of invasive species, maintenance of early successional vegetation.
- **7.4.2 Reducing or ceasing hydrology control:** E.g., reducing, removing, or ceasing waterfowl impoundments and dam flow regimes.
- **7.4.3 Reducing or ceasing human disturbance control:** E.g., reducing, removing, or ceasing bat gats, seasonal beach closures to ORV, fencing to rope off nesting areas.
- **7.4.4 Reducing or ceasing predator control:** E.g., reducing, removing, or ceasing predator exclosures on shorebird nests, APHIS activities.
- **7.4.5 Reducing or ceasing other management activities:** E.g., reducing, removing, or ceasing fisheries seasons or harvest limits, seasonal limitations for ecosystem modifications, fish passage or ladders at dams, species propagation.

Category 8: Invasive & Other Problematic Species, Genes, & Diseases

This threat category includes threats posed by non-native and native species (plants, animals, pathogens, or genetic materials) that have or are expected to have harmful effects on biodiversity following their introduction, spread, or increase in population (abundance).

8.1 Invasive Non-Native / Alien Plants & Animals: Harmful plants and animals that were not originally present within an ecosystem but were directly or indirectly introduced into or spread in the ecosystem as a result of human activities. The concept of exotic species includes species that are not native to a specific habitat; it can therefore include the introduction of species that are considered native to a different region of the same general area of the country. Domestic species are also considered non-native, whether they are feral or semi-domesticated (e.g., domestic cats going outside). Also includes introduction of wildlife due to "mercy releases."

- **8.1.1 Terrestrial animals**
- **8.1.2 Terrestrial plants**
- **8.1.3 Aquatic animals**
- **8.1.4 Aquatic plants**

8.2 Problematic Native Plants & Animals: Plants and animals that were originally present in ecosystem(s), but whose populations have increased to a level where they are now "out of control" or overabundant as a direct or indirect result of certain human activities.

- **8.2.1 Habitat alteration by beavers:** Flooding/drainage of habitats caused by beavers.
- **8.2.2 Increased grazing by vertebrates:** E.g., increased grazing by white-tailed deer and resident geese.
- **8.2.3 Localized increase in invertebrate grazing:** E.g., increased grazing of American ginseng by native slugs.

- **8.2.4 Insect pest epidemics:** Increases in insect pest density, resulting in large-scale impacts on the ecosystem. To be distinguished from localized increases in invertebrate grazing (threat 8.2.3).
- **8.2.5 Increased predation by mesopredators:** E.g., racoons, striped skunks, foxes, coyotes.
- **8.2.6 Increased predation by large predators:** E.g., increased predation by seals, intentional reinforcement of predator populations.
- **8.2.7 Ectoparasites:** E.g., fleas, ticks, mites.
- **8.2.8 Interspecific competition with a favored species:** Direct competition with a favored species.

8.3 Introduced Genetic Material: Human modified or altered organisms/genes that pose a threat to biodiversity in natural environments by competing with wild populations or hybridizing with them and altering their gene pool.

- **8.3.1 Genetic material from agriculture:** E.g., pesticide-resistant cereals/forages, use of genetically modified insects for biocontrol.
- **8.3.2 Genetic material from silviculture:** E.g., genetically modified trees.
- **8.3.3 Genetic material from aquaculture:** E.g., genetically modified salmon.

8.4 Pathogens: Diseases caused by various taxa of pathogenic micro-organisms living within hosts.

- **8.4.1 Bacterial pathogens**
- **8.4.2 Viral pathogens:** E.g., ranavirus in amphibians, rabies in raccoons.
- **8.4.3 Fungal pathogens:** E.g., white-nose syndrome (WNS) in bats, snake fungal disease (SFD), salamander chytrid disease (Bsal).
- **8.4.4 Worm-induced disease:** Any diseases directly induced by a worm (helminthiases). E.g., flatworms, nematodes, nemertean worms.
- **8.4.5 Protozoan-induced diseases**
- **8.4.6 Prion diseases:** E.g., chronic wasting (CWD).

8.5 Intrinsic Biological Limitations

- **8.5.1 Loss of genetic diversity:** E.g., population isolation, inbreeding, bottlenecks.
- **8.5.2 Depends on another species that has declined:** E.g., pollinators with specific host plants, fish-glochidia relationships, parasitic hosts, red knot dependent on horseshoe crab

Category 9: Pollution

This category encompasses threats that are associated with the introduction of foreign or excess material/energy from point and non-point sources. Threats that are posed by pollution are typically correlated with other human activities listed in the other sections (e.g., air pollution from cars, water pollution from sewage, agricultural effluents). Although there is a direct correlation between pollution and these other threats, their impact (scope and severity) is often evaluated separately from the source activity.

9.1 Domestic & Urban Wastewater: Point or non-point source wastewater from residential and urban areas; these discharges (may) contain nutrients, sediments, toxic substances, chemicals, etc.

9.1.1 Domestic wastewater: Liquid domestic waste that is produced by urban centers and discharged primarily by the sewage system. E.g., discharges from municipal waste treatment plants, leaks from sewers/septic tanks, untreated discharges, pit toilets, medical components in water (birth control hormones, antidepressants, antibiotics), toxoplasmosis, etc.

9.1.2 Runoff: Effluents resulting from urban activities that are separate from the water supply system. For oils and other hydrocarbons, refer to threat 9.2.1. E.g., salt/sand used to de-ice roads, fertilizers and pesticides used for lawns, parks, golf courses.

9.2 Industrial & Military Effluents: Wastewater (pollutants) from industrial and military sectors, including mines, energy production sectors, and other resource extraction industries. These effluents may result from deliberate or accidental spills that are legal or illegal and (may) contain various nutrients, sediments, toxic substances and chemicals, among others. Considering the difficulty in identifying contaminants or contaminant "cocktails" that are responsible for environmental damage, other unknown contaminants from industries are listed within 9.2.7. This section excludes natural sources of contaminants that are found in the environment (e.g., mercury found in soils or in river substrates). Intoxication due to natural sources of these contaminants is likely to result from an indirect threat increasing exposure and to which conservation actions can be matched.

9.2.1 Oil spills: Spills from vehicle fuel tanks or from facilities that are associated with hydrocarbon extraction and transportation. E.g., oil spills from grounded vessels, military vehicles, pipeline failures.

9.2.2 Acid mine drainage

9.2.3 Flame retardant

9.2.4 Polychlorinated biphenyls (PCBs)

9.2.5 Mercury

9.2.6 Industrial lead: Lead released into the environment by industrial effluents. Excludes lead contamination due to hunting ammunition or fishing gear (9.4.2).

9.2.7 Other industrial discharges: Unidentified or mixed toxic liquid chemicals that are released from industrial plants.

9.3 Agricultural & Forestry Effluents: Wastewater (pollutants) that is generated by agricultural, silvicultural, and aquacultural activities. These discharges are transported primarily in drainage systems, runoff, and eroded soil; they (may) contain various nutrients, toxic substances, chemicals, etc. Excludes erosion and sedimentation that is associated with drainage systems in agriculture (threat 7.2.4) and forestry (threat 7.2.5), or oil spills from machinery (9.2.1).

9.3.1 Nutrient loads: E.g., manure, compost, chemical fertilizers.

9.3.2 Soil erosion, sedimentation: Erosion and sedimentation that are due to agricultural or silvicultural activities, regardless of the presence of local drainage systems (threat 7.2.4 and 7.2.5).

9.3.3 Herbicides & pesticides: Includes the use of inputs for controlling crop pests. E.g., herbicides, insecticides, fungicides.

9.4 Garbage & Solid Waste: Garbage and solid waste, including materials that can intoxicate or entangle plants and animals (strangulation/asphyxiation from plastic bags, elastic materials, ropes, etc.).

9.4.1 Garbage: Garbage and solid waste in the environment. Excludes waste in open dumpsites (threat 1.2.2), landfills (threat 1.2.3), and ashore or adrift in the ocean (threat 9.4.4). E.g., municipal waste, litter discarded on roads from vehicles, floating waste from recreational boats, construction debris/waste, etc.

9.4.2 Solid lead: Lead released into the environment in a solid form (e.g., pellets) from a source other than industrial effluents (threat 9.2.6). E.g., lead from ammunition or fishing gear contaminating the environment, ammunitions from shooting ranges.

9.4.3 Asbestos

9.4.4 Drifting plastic & entanglement rubbish: Plastic garbage adrift or ashore of oceans or large water bodies that intoxicate or entangle wildlife. E.g., floating rubbish, nets, ropes, buoys, ghost or derelict fishing gear, plastic bags.

9.5 Air-Borne Pollutants: Air contaminant emissions from a point or non-point source.

9.5.1 Acid rain

9.5.2 Smog: Smog caused by air pollutant emissions from vehicles.

9.5.3 Ozone: Atmospheric nitrogen deposition.

9.5.4 Dust & ashes: Fine particles carried by the wind that pollute the environment when deposited or taken in by organisms. Excludes ash from volcanic eruptions (threat 10.1.1). E.g., radioactive fallout, wind dispersion of pollutants/sediments, smoke from forest fires or wood burning.

9.6 Excess Energy: Inputs of heat, sound, or light that disturb wildlife or ecosystems.

9.6.1 Light pollution: E.g., lamps that attract insects or birds, lights on beaches that disorient turtles.

9.6.2 Thermal pollution: E.g., heated water discharges from power plants (coal, gas, nuclear, etc.), atmospheric radiation resulting from ozone layer thinning.

9.6.3 Noise pollution: E.g., noise from highways and air traffic, submarine sonar that disturbs whales and other marine mammals, loud music from outdoor events, and engine noise from marine traffic.

Category 10: Geological Events

This category includes all threats from catastrophic geological events. It is worth noting that none of these have been identified as major threats to Maryland's species or habitats.

10.1 Volcanoes: Volcanic activities, eruptions, emissions of volcanic gases.

- **10.1.1 Eruptions**
- **10.1.2 Emissions of volcanic gases**

10.2 Earthquakes / Tsunamis: Earthquakes and associated events (tsunamis, etc.).

- **10.2.1 Earthquakes**
- **10.2.2 Tsunamis**

10.3 Avalanches / Landslides

- **10.3.1 Avalanches**
- **10.3.2 Landslides & mudslides**

Category 11: Climate Change

This category encompasses threats from major changes in ecosystems and severe climate/weather events outside of the natural range of variation that could harm species or habitats. Generally related to climate change, though not always.

11.1 Habitat Shifting & Alteration: Major changes in habitat composition or location.

- **11.1.1 Changes in vegetation communities:** Major changes in an ecosystem resulting in changes to vegetation communities. To be distinguished from natural vegetation succession, which may threaten open-country species (threat 7.3.2). E.g., migration of deciduous trees towards the boreal forest, rising sea levels, desertification, coral bleaching.
- **11.1.2 Phenological mismatch:** Behaviors that have evolved to adapt to seasonal changes become unsynchronized due to irregularities or delays in the cycle of the seasons.

11.2 Changes in Geochemical Regimes: Large-scale changes in an ecosystem's physio-chemical makeup.

- **11.2.1 Changes in pH of habitats:** E.g., ocean acidification.
- **11.2.2 Changes in salinity**

11.3 Changes in Temperature Regimes: Periods in which temperatures of the air, water, or soil either exceed or fall below the normal range of variation.

- **11.3.1 Heat waves**
- **11.3.2 Extreme cold spells**
- **11.3.3 Gradual temperature change**: E.g., altered sex-ratio in species relying upon a temperature dependent sex determination, reduction of dissolved oxygen that is

available to fish species, earlier ice-free dates, thawing of permafrost affecting bird breeding sites.

11.3.4 Increase in temperature fluctuations: Increase in temperature fluctuations, which disturbs the phenological responses of wildlife. E.g., rise in the frequency of freeze-thaw events, rain-on-snow events, etc.

11.4 Changes in Precipitation & Hydrological Regimes: Periods in which the amount and frequency of precipitation either exceed or fall below the normal range of variation. Excludes periods that are associated with storms and heavy weather (threat 11.5).

11.4.1 Overabundant rains

11.4.2 Droughts

11.4.3 Gradual change in the precipitation regime

11.4.4 Increase of fluctuations in the precipitation regime: Increase in the fluctuations that are related to the precipitation regime, which have impacts on the hydrology of natural habitats.

11.5 Storms & Severe Weather: Strong winds and extreme weather events or a major change/shift in the storm season.

11.5.1 Storms & severe weather: E.g., thunderstorms, tropical storms, hurricanes, cyclones, tornadoes, hailstorms, ice storms, blizzards, dust storms.

11.5.2 Storm surges: E.g., erosion of shorelines/beaches during storms.

Category 12: Other Options

This threat category includes all threats not addressed above. Though only Levels 1 and 2 are included for this category in the original classification system, Maryland has added Level 3 back in for certain subcategories. This is because this category encompasses most of the “absence” or “scarcity” threats described in the opening paragraph of this chapter, of which there are many, and another level of classification was deemed necessary for the sake of organization. This added third level is based on the classification system used in the 2015 SWAP revision; additions are marked with an asterisk.

12.1 Other Threats: Threats are known but not listed elsewhere.

12.2 Resource Needs: Includes data collection, monitoring, and funding needs.

***Management decision needs:** Includes the need for fish, wildlife, and/or habitat planning

***Resource information collection needs:** Includes lack of sufficient data (both baseline and current), lack of or inadequate surveying efforts, unanswered research questions, etc.

12.3 Education & Outreach: Includes gaps in education and outreach efforts, both to targeted groups and the general public.

***Education needs:** Generally related to insufficient understanding or appreciation of a topic, habitat, or (group of) species.

***Outreach needs:** Generally related to stakeholder and public engagement needs, lack of volunteers, inadequate visibility, needed lobbying efforts, etc.

12.4 Administrative Needs: Needed improvements to administration and coordination of conservation organizations, programs, and projects.

***Coordination/administration needs:** Inefficient or insufficient coordination, administration, etc. that make conservation efforts less effective.

***Infrastructure needs:** Inadequate technical coordination efforts, such as the efficient sharing of data between different databases.

12.5 State Specific Issues: Needed changes to state regulations, policies, programs, etc.

12.6 Unknown: Threats are unknown.

Priority Threats for Maryland

Throughout the process of revising Maryland's SWAP, a number of topics were raised repeatedly by different groups of partners, experts, and MD DNR staff. The repeated nature of these conversations—along with the fact that concerns were raised by those working across different species groups and habitats—signaled that particular attention should be paid to these topics going forward. Fourteen topics were identified in this manner: eight threat categories, and six resource need categories. Most of the topics identified are long-standing issues (e.g., invasive species, habitat loss, inadequate funding); others are not necessarily new, but their urgency has greatly increased in recent years (e.g., threats to coastal habitats).

Individual threats and actions associated with these fourteen topics are not necessarily marked as high priority in the SWAP (see Appendices 6a and 6b for the list of actions, Chapter 6 for an explanation of the prioritization scheme). Instead, these areas of concern have been highlighted as topics to pay special attention to in the next 10 years or longer. In other words, to build on the momentum that the 2025 SWAP revision process has helped create, MD DNR and its partners intend to further efforts in these areas through continued conversation, outreach, and coordination to strengthen capacity to address these concerns. Some of this work has already begun; for example, in late 2025, MD DNR collected detailed information from partners regarding their work in these 14 areas. This included which of the 14 topic areas each partner works in, as well as the type of work (e.g., advocacy, land preservation, data collection, education). Virtual meetings were then held for seven of these 14 areas to collect more detailed information on what work is already being done, what needs to be done in the future, and what would make such work easier to accomplish. Though not all of these results are included in the 2025 SWAP revision, it is the intention of MD DNR to continue working in these areas.

The following subsections summarize concerns in the eight threat categories; an additional subsection is also included to summarize the six major resource need categories. Examples of actions that address these topics are included in the "Addressing Priority Threats for Maryland" subsection of Chapter 6.

Priority Threat: Threats to Urban and Suburban Habitats

Urban and suburban areas are not typically thought of as "traditional" areas for conservation work. However, the denser, more populated areas of Maryland can serve as important habitat for a variety of species—if properly managed. For example, many migratory bird species rely upon street trees and small urban parks as stopover habitat during their long journeys in the spring and fall, and the degradation of these trees or areas can have an outsized impact on their journey's success. Major threats identified for these habitats include lack of biodiversity due to overreliance on non-native plant species, frequently mowed grassy areas, and pesticides and herbicides; increases in impervious surfaces, which leads to increased temperatures and pollution via runoff; urban and suburban sprawl, which is a driving factor behind habitat loss and fragmentation; and lack of awareness, appreciation, or understanding regarding these habitats and the species that rely on them. The new Urban and Suburban Environment KWH was created for the 2025 SWAP revision in part to assist in addressing this last concern.

Priority Threat: Threats to Coastal Habitats

Habitats such as Maryland's Coastal Bays, marshes, and small islands are of particular concern in the 2025 SWAP revision. These are some of Maryland's most unique and at-risk habitats in the state. Additionally, some SGCN—including the federally Threatened eastern beach tiger beetle *(Habroscelimorpha dorsalis dorsalis)*, the globally imperiled saltmarsh sparrow *(Ammospiza caudacuta)*, and multiple species of nesting terns—are found only in these parts of the state, where sandy beaches and wetlands turn into the brackish or saline waters of the Coastal Bays, Chesapeake Bay, and Atlantic Ocean. These habitats face multiple threats, including increasing coastal development; pollution, sedimentation, and excessive nutrient input via runoff; and, perhaps most urgently, sea-level rise and increased flooding. This is especially true for Maryland's Small Coastal Plain Islands, a new KWH in the 2025 SWAP revision. Many of these islands have already disappeared due to a combination of factors, especially sea-level rise and land subsidence. While restoration efforts (i.e., placement of sandy dredge material) have had some success, the process is costly, difficult to coordinate, and requires frequent upkeep.

Priority Threat: Threats to Working Lands

Maryland once had tens of thousands of acres of grasslands and savanna-like habitats across the state (Mayre 1920, 1955). These ecosystems have nearly vanished due to habitat loss resulting from development, agriculture, solar electricity production, fire suppression, and the disappearance of large grazing mammal species. Now, strongholds of this habitat type exist nearly exclusively in the form of working lands, reclaimed strip mines, and utility rights-of-way. This habitat group includes anthropogenic lands such as agricultural fields, recently logged forests, and reclaimed strip mines that, if properly managed for biodiversity, can provide critical habitat for grassland- and shrubland-dependent SGCN. Threats to these habitats include incompatible management practices (e.g., over-mowing, tree planting, herbicide and pesticide use); habitat loss due to land conversion, especially to low-density residential development and solar farms; and lack of awareness, appreciation, or understanding regarding these habitats and the species that rely on them, similar to urban and suburban habitats. Some KWHs in the 2025 SWAP revision were restructured under the new "Working Lands" subcategory in part to address this last concern.

Priority Threat: Managed Species

Managed species of concern include white-tailed deer, resident Canada geese, and beavers. Although more commonly referred to as "nuisance" species, the Maryland 2025 SWAP revision uses this term because these species are not considered nuisances in every instance; rather, they can act as boon or threat depending on the circumstance. Though threats posed by each managed species can vary, major ones include overgrazing on the part of deer and geese, which can lead to food source loss and the spread of invasive plants; and detrimental changes to the hydrological regime on the part of beavers when they settle in habitats where their work as "ecosystem engineers" does more harm than good. In the case of deer and geese, the main objective is to reduce these negative impacts, partially though reducing their populations. In the case of beavers, it is more a matter of determining where and when beavers are beneficial versus detrimental.

Priority Threat: Invasive (Plant) Species

Although invasive fish and wildlife are also major concerns in Maryland, the threat of invasive plant species was raised in almost every meeting throughout the 2025 SWAP revision process. This is because invasive plants negatively impact nearly every habitat and species in Maryland. Invasive plants are closely tied to other threats as well, including managed species and climate change. Specific threats posed by invasive plant species include the loss of food sources and host plants, as invasive plants tend to out-compete natives once established; loss of trees or declining tree health, as a number invasive plants are vines that can strangle trees; and difficulty in managing invasive plants, as they spread quickly and are difficult to remove once present in an ecosystem. This is due to the labor-intensive way that invasive plants must be removed, the inherent difficulty in eradicating a species that rapidly spreads, and the logistics of coordinating such efforts. Improved coordination has been identified as a priority for managing invasive plants, as county- or even state- or region-wide management efforts can provide much-needed sharing of knowledge, labor, and other resources for this massive effort.

Priority Threat: Pollution

Pollution is another threat that negatively impacts nearly every habitat and species in Maryland, although it is of particular concern for aquatic and semi-aquatic species. Because this threat is discussed in detail below in the Regional Threat: Pollution subsection, having been identified as the number one threat facing species and habitats in the Northeast region, please refer to the Regional Threat text for more information. In addition to the threats articulated there, pollution, much like invasive plant species, is a threat that is closely tied to and exacerbated by other threats. This includes climate change, development, transportation, agriculture, and more.

Priority Threat: Climate Change

Climate change is also addressed below in the Regional Threat: Climate Change subsection. In Maryland in particular, climate change impacts are most commonly tied to water-related issues such as sea-level rise, saltwater intrusion, increased storm severity, and increased flooding. Change in the temperature regime is also a major issue, resulting in problems such as phenological mismatch and species range shifts. As with invasive plant species and pollution, climate change is closely tied to and exacerbated by other threats. One of these threats is development, as an increase in shoreline hardening and impervious surfaces combined with worsening rain events results in increased stormwater and flooding impacts.

Priority Threat: Habitat Loss and Fragmentation

Habitat loss and fragmentation is tied to every other threat articulated in Maryland's 2025 SWAP revision. It affects every region, habitat, and species in Maryland, whether terrestrial or aquatic. The threat presented by habitat loss speaks for itself. Threats associated with habitat fragmentation include the loss of large-scale habitat connectivity and corridors, which makes it more difficult for species to migrate and shift their ranges in response to climate change; the isolation of populations, which can result in reduced population sizes, genetic erosion, and inbreeding; and increased mortality, as animals are forced to navigate human-dominated landscapes and roads in order to find food, migrate, and breed. Habitat loss and fragmentation is a particularly difficult threat to address, as most changes must be made on a larger scale in order to have any impact. The most effective ways to address this threat are through regulation/policy change and land preservation, both of which require a large amount of money, time, effort, and political will.

Priority Threat: Scarce Resources

As stated in the opening paragraph of this chapter, threats can also take the form of the absence of something rather than its presence. While this is true of natural phenomena—for example, the lack of a once-present fire regime in a fire-dependent habitat—it can also take the form of the inadequate resources available to conduct needed conservation work. Six resource need categories were identified during the 2025 SWAP revision process as areas of particular concern:

- Funding
- Coordination
- Policy and regulations
- Education and outreach
- Research
- Monitoring

All these concerns have associated threats and actions in Appendices 6a and 6b. It is also important to note that vital work is already being done in all these areas; the issue is not so much of the total lack of these resources than it is the ongoing struggle to obtain enough resources to continue this work. Furthermore, as additional species become rare and the SGCN list continues to grow, the amount of funding and other resources is not sufficiently increasing to keep pace. Funding and coordination were highlighted as particular areas of concern, and it is MD DNR's intention to continue having in-depth conversations with stakeholders and partners, as improvements in these two areas will positively affect all other aspects of conservation work in the State of Maryland.

Regional Threats

The Northeast Regional Conservation Synthesis for 2025 State Wildlife Action Plans (TCI & NEFWDTC 2023) summarizes the issues and challenges identified in the 14 Northeast SWAPs (TCI & NEFWDTC 2017) that may adversely affect regional SGCN (RSGCN) or their habitats. It also describes the priority research and survey efforts needed to support restoration and improved conservation of these species and habitats. Included in these efforts was the identification of the top five threats to Northeast RSGCN; the threats with the highest number of associated RSGCN are ranked higher. According to the 2023 synthesis, these are:

1. Pollution
2. Climate Change

3. Invasive and Other Problematic Species, Genes, and Diseases
4. Biological Resource Use
5. Natural System Modifications
6. *Residential and Commercial Development: Not listed in the top five but included in the document's text as another high-ranking threat.

Certain portions of the 2023 synthesis have been included below regarding these six threat categories. Their complete descriptions can be found in the full document. Much of the text included focuses on which RSGCN taxonomic groups are most impacted by each threat. For a list of Maryland SGCN that are also considered RSGCN, please see Appendix 3a.

Regional Threat: Pollution

Pollution is by far the most common regional threat, impacting 81% (338 species) of the RSGCN and Proposed RSGCN on the 2023 list. Many of the taxonomic groups that are most heavily impacted are aquatic; pollution imperils the entire diversity of the stonefly, mayfly, marine invertebrate, freshwater mussel, firefly, and diadromous fish taxonomic groups. Additionally, though pollution does not impact all freshwater fish or lepidopterans, these two groups contribute the largest number of species impacted.

Pollutants come from point and non-point sources. Point source pollutants can be traced back to a single identifiable discharge point, such as a pipe, ditch, ship, or smokestack. Non-point source pollutants cannot be traced to a single specific source, as point-source pollutants can. Instead, these pollutants come from many sources throughout the landscape. For example, as water moves overland or through the ground, it collects many different pollutants from many different places and brings them all together to more concentrated areas, such as rivers and streams.

Another important aspect of many pollutants is that they can bioaccumulate. Bioaccumulation is the gradual buildup of chemical substances, such as pesticides, in an organism. The body is unable to rid itself of these compounds, so concentrations increase over time, even if the amount of the compounds in the environment is very low. As the concentration of the compounds in the body increases, individuals may suffer from a wide variety of symptoms, or may die, depending on the chemical. Bioaccumulation has important impacts on food webs, since the compounds continue to aggregate in higher trophic levels as predators consume contaminated individuals, a process known as biomagnification.

Many aquatic RSGCN are highly sensitive to pollution; therefore, their presence or absence makes them indicators of water quality. Eastern hellbenders *(Cryptobranchus alleganiensis)*, mayflies, stoneflies, caddisflies, and mussels thrive in high-quality water conditions. Pollution acutely impacts aquatic species because these contaminants are ubiquitous within the habitat. Pollutants are found in the water column, sediments, and potential food sources. By contrast, contaminant distribution is less homogenous in terrestrial systems; combined with the ability of terrestrial species to move away from pollutants, contaminant exposure is a function of concentration and repeated exposure (Smith et al. 2007). In both aquatic and terrestrial systems, exposure from the environment occurs via ingestion, absorption through the skin, accumulation on gills or filters, inhalation, or a combination (Smith et al. 2007; Honda & Suzuki 2020). Some pollutants, including heavy metals, polychlorinated biphenyls (PCBs), pharmaceutical compounds, per- and polyfluoroalkyl substances (PFAS), and certain pesticides, persist for extremely long periods in the environment or hardly break down at all (i.e., "forever chemicals"), resulting in long-term contamination of the environment and bioaccumulation of these pollutants throughout the ecosystem (McKinney et al. 2015; Ali et al. 2019; Honda & Suzuki 2020).

Regional Threat: Climate Change

Climate Change is a rapidly growing concern in the region, impacting 73% (305 species) of the RSGCN and Proposed RSGCN. All of the species in the stonefly, reptile, mayfly, marine invertebrate, mammal, and caddisfly taxonomic groups are considered vulnerable to climate change impacts, highlighting these groups' sensitivity to future changes. As knowledge of climate change and its impacts on species and habitats is still evolving, it is likely additional species are impacted by this threat in ways we do not yet understand.

At the time of the 2015 Northeast SWAPs, climate change was considered one of the highest priorities of all threats identified. Climate change is considered to be one of the most impactful threats in the Northeast because of uncertainty about the full effects on individual species, variability in species responses, the infeasibility of addressing sources of climate change at local and state scales, and the irreversibility of some impacts (TCI & NEFWDTC 2017).

The Northeast Climate Adaptation Science Center (NECASC), a consortium of the Unites States Geological Survey (USGS) and university researchers housed at the University of Massachusetts, Amherst, is a crucial resource for climate-related information, research, and planning in the Northeast. One of the USGS' nine regional Climate Adaptation Science Centers, their goal is to deliver science to help fish, wildlife, water, land, and people adapt to a changing climate. NECASC produced a regional synthesis that compiled a summary of the current literature, strategies and actions, tools, and case studies for addressing multiple and simultaneous threats from climate and non-climate stressors to natural and cultural resources into searchable databases (Staudinger et al. 2015). This report analyzed how climate has and is expected to change; the relative vulnerability of fish and wildlife species and their habitats; likely responses of species of concern to these changes; and the approaches, strategies, and actions that could sustain fish, wildlife, and their habitats across the region. In 2024, NECASC updated and released this document for the 2025 SWAP revision process (Staudinger et al. 2024).

Regional Threat: Invasive and Other Problematic Species, Genes, and Diseases

More than half of the species on the 2023 RSGCN and Proposed RSGCN list—55%, or 228 species—are imperiled by interactions with invasive or problematic species, face complications due to genetic integrity, are impacted by disease, or have natural biological limitations that reduce recovery potential. This includes all reptiles and marine invertebrates, and all but one mammal. Though not all freshwater fish, mussels, and lepidopterans are associated with this threat, these taxonomic groups contribute as many species, if not more, as mammals. Many invertebrate groups have five or fewer species for which this threat is known to be a cause of decline. This is likely due to data deficiencies and a limited understanding of how these threats impact these groups, rather than an indication that these groups are not sensitive to these threats.

The subjects categorized under this threat are incredibly diverse, touching on invasion ecology, competition and predation, parasitism, population and conservation genetics, epizoology, and other ecological and biological concepts. The breadth of these topics makes it difficult to generalize about the overall trends and patterns within the Northeast region at this topmost level. The impacts of these threats are not concentrated within certain habitat types or taxonomic groups; instead, they are found universally. More in-depth descriptions of the different threats and discussions of the trends and patterns in the Northeast are discussed in the full document, linked above.

Regional Threat: Biological Resource Use

Biological Resource Use impacts 48% (200) of the species included as RSGCN and Proposed RSGCN in the 2023 list. This includes all members of the marine invertebrate, reptile, and marine fish taxonomic groups. Mammals, amphibians, and diadromous fish are also largely included in the species impacted by this threat. Most of the species known to be impacted by biological resource use are vertebrates or are harvested for human consumption. This threat likely has less impact on most terrestrial invertebrate species, but the smaller numbers may also reflect data deficiencies in these groups.

Biological resource use refers to the removal of biotic components of the environment for human consumption or benefit. This includes hunting and fishing, bycatch in regulated animal harvest, persecution and management of species considered dangerous or problematic, unregulated collection of wildlife for any purpose, and the harvest of timber and other plant products. The impacts of biological resource use on RSGCN and Proposed RSGCN are often direct, physically removing individuals from the ecosystem. The exception to this is logging, which indirectly impacts many species by removing, fragmenting, and otherwise altering habitat. Regardless, these removals have major impacts on the individual, population, community, and ecosystem levels.

The individuals removed are intended for human use or benefit, as opposed to the mortality of flora and fauna as a result of some other threat factor. These removals can be either intentional, where the species is the target, or unintentional, where the species is collected incidentally along with a target species. Many of these forms of biological resource use are regulated, but some species, especially invertebrates and amphibians, may lack formalized protection at state, national, or international levels. Other species are targeted despite legal prohibitions on their collection. Due to the human dimensions of this threat coordinated actions, consistent messaging, and shared regulatory decisions are needed across the Northeast for successful management.

Historically, many species in the Northeast were negatively impacted by forms of biological resource use. Hunting for sustenance led to significant declines in many iconic mammals and birds in the region (Foster et al. 2002). Persecution of large predators and other "nuisance" species, including bounty systems, led to declines and regional extirpations (Foster et al. 2002). Historic overfishing contributed to population crashes and declines of many marine fish species and coastal ecosystems (Jackson et al. 2001). Logging and the collection of plant species altered habitat on large scales across the region, contributing to widespread species declines and shifting wildlife communities better suited to agricultural landscapes (Foster et al. 2002). Human use of biological resources has had a strong influence on the ecosystems in the Northeast.

Regional Threat: Natural System Modifications

A total of 198 species (47%) on the 2023 RSGCN and Proposed RSGCN list are impacted by Natural System Modifications. Diadromous fish, reptiles, tiger beetles, and odonates are the most heavily impacted, with more than 80% of the species in each of these groups known to be imperiled by these threats. The largest number of species impacted are lepidopterans, freshwater mussels, and freshwater fish. For the other invertebrate groups and marine fish, very few species are associated with this threat, both in terms of total numbers and proportion of the taxonomic group. This is likely due to data deficiencies and a limited understanding of how natural system modifications can impact these groups, rather than an indication that these groups are not sensitive to these threats.

Natural system modifications are a threat to many RSGCN and Proposed RSGCN species because, while they may not eliminate a habitat, they alter the structure and function of these ecosystems. Habitat degradation or other impacts on quality and condition can make some habitats unsuitable for more sensitive species. Some of these modifications can alter important processes, such as disturbance and succession, changing the functionality of a habitat over long time scales. Other modifications may fragment habitats, preventing species movements and isolating populations.

Many species in the Northeast RSGCN and Proposed RSGCN list are considered indicator species, where their presence or absence is indicative of habitat condition at that site. These indicator species can be related to the presence of pollutants or other contaminants (Evers et al. 2003), management history (Blossey et al. 2019), or overall ecosystem health (Edsall et al. 2005; Jones et al. 2009). In particular, aquatic insects such as mayflies, caddisflies, and stoneflies are frequently considered indicators of water quality and are sensitive to changes in streamflow. Many insects, such as the northern barrens tiger beetle *(Cicindela patruela),* are closely associated with pine barrens habitats and often decline in the absence of fire.

Regional Threat: Residential and Commercial Development

Residential and Commercial Development does not rank as highly as the other threats discussed previously. However, it impacts at least 40% (169) of the species on the RSGCN and Proposed RSGCN lists and remains a major concern in the Northeast. All eight tiger beetles are impacted by this threat, as are most reptiles and bees. Lepidopterans, birds, and mammals provide the largest number of species impacted by development, though smaller proportions of these groups are impacted. Aquatic species appear to be less impacted by this threat, potentially since development more directly impacts terrestrial habitats, and indirect threats, such as those from impervious surfaces, may need additional research. Data deficiencies for many invertebrate taxonomic groups likely make it appear that development is not a concern for these species when in reality we are uncertain what the impacts truly are.

The most direct impact of development is habitat loss and alteration. Habitat loss can eliminate key areas or result in decreased habitat area, which in turn restricts the number of individuals and species able to be supported by the remaining habitat. Development also fragments habitats into smaller patches. Fragmentation alters the arrangement of habitat such that it results in reduced habitat area, increased patch isolation, and the creation of more edge habitats. Smaller habitat patches support less diverse wildlife communities and fewer individuals as a result of limited resource availability (Laurance et al. 2002; Haddad et al. 2015). Isolation between patches restricts the movement of individuals between patches, which has consequences for metapopulation dynamics and genetic integrity (Lande 1988; Laurance et al. 2002). Increased edge habitat can change the community structure by altering patterns of energy flows and resource availability while also creating space for unique interactions between species that do not usually interact (Laurance et al. 2002; Ries et al. 2017). All of these changes to habitat structure impact ecosystem processes, such as nutrient cycles, pollination, and succession, and change the resilience of the ecosystem (Haddad et al. 2015).

Studying wildlife interactions with development is complicated because not all species respond in the same way (Birnie-Gauvin et al. 2016). Responses are often contextual and dependent on the reason for habitat loss, the surrounding landscape matrix—the patterns and organization of habitat types—and the intensity of human activity and use. Many species change their behavior in response to development, either avoiding areas of anthropogenic disturbance or changing their behaviors in ways that allow them to utilize these areas (Lowry et al. 2013; Ritzel & Gallo 2020). Others adapt and evolve to be better able to utilize anthropogenically altered environments (Cheptou et al. 2017; Johnson & Munshi-South 2017). Even in species that can utilize developed areas, factors such as increased stress levels, lesser nutritional content of available food resources, anthropogenic noise interfering with communication, and increased exposure to hazards such as pollution and disease can have negative impacts on individuals (Birnie-Gauvin et al. 2016).

In the Northeast region, the impacts of development are almost ubiquitous. The region contains some of the most densely populated areas in the United States, which have been heavily modified by human land use change since European colonization. Very little of the region remains unimpacted by the effects of development and agriculture, and these impacts are likely to increase over the next few decades (Theobald 2010; Venter et al. 2016). Urban centers are not the only concern. Areas where low-density housing is developed near or intermixed with natural habitats, commonly referred to as the wildland-urban interface, are also widespread in the Northeast (Radeloff et al. 2005). These interfaces alter the risk of fire, vehicle collisions and mortality, invasion of non-native and human-subsidized species, and disease transmission (Bar-Massada et al. 2014; Kreling et al. 2019). In the conterminous United States, ten states have at least 33% of their area within the wildland-urban interface; eight of these states are within the Northeast region (Radeloff et al. 2005). This high level of intermixing has implications for conservation for the region. An analysis of Conservation Opportunity Areas identified in the 2015 SWAP revisions showed that a majority of these sites are vulnerable to future projected development or are constrained by current development (Carter et al. 2019). Management of this threat will require careful planning to balance the needs of the growing human population in the region and conservation priorities.

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*This chapter reviewed threats facing Maryland's wildlife species and their habitats (**Element #3**). It provided an overview of the threat classification system and discussed priority threat areas identified by both Maryland and the wider Northeast region. Please see Appendices 6a and 6b for a complete list of Maryland's threats and their associated actions. Chapter 6 will discuss the many conservation actions and strategies to address the threats in this chapter.*

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Chapter 6

Conservation Actions

MARYLAND

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NATURAL RESOURCES

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Introduction

The State Wildlife Action Plan (SWAP or Plan) represents an opportunity to reverse declining trends for numerous Species of Conservation Need (SGCN) and their associated key wildlife habitats (KWHs) through the proposal and implementation of conservation actions. This chapter discusses these conservation actions (**Element #4**), which are the measures taken to conserve, protect, and manage Maryland's identified SGCN and KWHs. They are intended to eliminate, minimize, and/or mitigate the threats addressed in Chapter 5 (**Element #3**). These actions range in scale; some address only a single species, while others are state-wide actions that would benefit all of Maryland's flora, fauna, and habitats. They range in scope as well; some call for specific regulations and research activities, while others propose general educational campaigns and coordination efforts.

The Maryland Department of Natural Resources (MD DNR) and its partners co-developed the 2025 SWAP revision's threats and actions on a one-to-one basis, meaning that every listed threat has an associated action. Over 700 conservation actions have been developed for Maryland's 2025 SWAP revision for the identified SGCN and KWHs. Given the number of threat–action pairs, the full lists of threats and actions have been relegated to Appendices 6a and 6b. Instead, this chapter provides a broad overview of major action categories, priorities, and origins, mirroring the organization of Chapter 5. It begins with a brief explanation as to how these conservation actions were created. Then, the prioritization scheme for individual actions is explained. This chapter then provides an overview of two sets of Maryland-specific conservation actions. The first set provides examples of conservation actions that address the priority areas articulated in the middle section of Chapter 5; the second set comprises a comprehensive list of all state-wide conservation actions listed in Appendix 6b. Finally, the chapter ends with a regional perspective of these actions, pulling from *The Northeast Regional Conservation Synthesis for 2025 State Wildlife Action Plans* (TCI & NEFWDTC 2023), in order to articulate the greater region's conservation priorities.

Conservation actions in Appendices 6a and 6b are outlined in sufficient detail to guide the development and execution of specific projects and programs to implement those actions. The process for identifying performance measures for priority actions is explained in Chapter 7. If available information is insufficient to describe needed conservation actions, the Plan lists the identified inventory, monitoring, and research needed so that specific conservation actions can be developed. The only exception to this is for species on the State Assessment Priority Species (SAPS) list, which is further explained in Chapter 3 and briefly mentioned below.

Actions in the 2025 SWAP Revision

As threats and actions were co-developed for Maryland's 2025 SWAP revision, the review and revision process for this chapter closely mirrors the process already articulated in Chapter 5. To summarize: MD DNR and its partners began by reviewing the threat–action pairs from the 2015 SWAP revision, made needed updates and removals, and then "filled in the gaps" through various meetings, workshops, and other forms of contact. Resources for this process included academic literature, non-governmental organization (NGO) and government reports, recent regulations and proposed regulations, existing best management practices (BMPs), lived experience, and much more. For a more detailed overview of this process, please see Chapter 5. For a comprehensive overview of partner participation in the SWAP in general, see Chapter 8.

For a full list of which organizations participated in Maryland's 2025 SWAP revision, see Appendix 8a.

Actions are listed at two different scales: the species scale and the habitat scale. This is because different threats are best addressed at different scales. For example, a taxonomic group-specific disease like Rabbit Hemorrhagic Disease Virus Type 2 (RHDV2) is a concern only for one SGCN, the Appalachian cottontail *(Sylvilagus obscurus),* and is therefore more appropriate to address at the population level, being tied to a species as opposed to a habitat or group of habitats. Other concerns, such as the overuse of pesticides, affect a variety of habitats and all or almost all of the species that rely on them. These sorts of threats are best addressed at the habitat or regional level rather than the population level. In this example, this means that, instead of listing overuse of pesticides as a threat for every insect SGCN and the species that rely on them (e.g., birds, bats, small mammals), the threat is listed under all working land and (sub)urban KWHs, where pesticide overuse is most common.

There are some key differences between the conservation actions in Maryland's 2015 and 2025 SWAP revisions; most notable is the number of actions. Maryland's previous SWAP had over 1,000 listed conservation actions; the new revision has closer to 700. This is not because 300 actions were either completed, determined to be inappropriate, or simply ignored over the past decade. Instead, it is due to the restructuring and consolidation of many of these actions. The 2015 SWAP had a tendency to cross-list threats and actions across species subgroups and habitats, meaning that many of those 1,000 actions were in fact duplicates. The 2025 SWAP has made an effort to consolidate these duplicates, as outlined in the previous paragraph. This means that many actions previously listed under multiple species groups—assessing the impacts of emerging contaminants, for example—now take the form of a single action with the applicable habitats "tagged." When reviewing the full list of threats and actions in Appendices 6a and 6b, it may therefore be helpful to have Appendix 3a open as well, which includes the full SGCN list and associated KWHs. Duplicate actions are occasionally permitted when a threat has an outsized impact on a particular species group. For example, even though the threat of wind turbines impacts all species in the High Elevation Ridge Forest, Cliff and Rock Outcrop, and Atlantic Ocean KWHs to some degree, they have an outsized impact on certain bat and bird populations. For this reason, these taxonomic groups are permitted to have their own, species group-specific actions.

Habitat-level threats and actions have also been organized differently in the 2025 SWAP revision. Instead of splitting up threats and actions by applicable habitat group, as in the 2015 revision, these larger scale threats and actions are now sorted by threat category (see Chapter 5 for an explanation of these categories) with appropriate regions and habitat groups "tagged." This was done, in part, because of the way in which these threats and actions were reviewed/created; much of this content came from four day-long regional meetings in eastern, southern, central, and western Maryland. See Chapter 8 for a more detailed explanation of these meetings; a brief overview is also included below in the "Prioritizing Habitat-Level Actions" subsection of this chapter. This tagging system allows the 2025 SWAP to both achieve a higher level of precision and consolidate actions that apply to multiple habitat groups. In other words, tagging applicable regions of Maryland and applicable habitat groups together permits more specific area-focused actions without duplicating them across groups. To use the same example as above, large-scale industrial wind development is a threat mainly to the western and eastern regions of Maryland. In western Maryland, the threat is to high-elevation ridge habitats, which can take the form of either forests or cliffs/rock outcrops; in eastern Maryland, the threat is primarily to offshore aquatic habitats. Therefore, this threat–action pair is tagged for Maryland's eastern and western regions, and these habitat groups: forest; glade, barren, and cliff; and bay and ocean. For the sake of further precision, the 2025 SWAP also includes a "Priority KWHs" column that lists any KWHs in the tagged regions and habitat groups that are especially impacted by the threat. This example lists the High Elevation Ridge Forest, Cliff and Rock Outcrop, and Atlantic Ocean KWHs. These larger scale threats and actions are included in Appendix 6b. See Chapter 4 for an explanation of habitat groups and KWHs; see Chapter 2 for an explanation of Maryland's regions.

Another major change is that the invertebrate threats and actions have been completely redone. This is partially due to the overhaul of the invertebrate SGCN determination process and resulting SGCN list, as outlined in Chapter 3. As a part of this process, MD DNR's State Entomologist worked with partners to determine species-specific threats and actions for every invertebrate SGCN. This resulted in a much more comprehensive list of threats and actions for all invertebrate SGCN, particularly the insects. This includes threats and actions for species groups that were not articulated in the previous SWAP revision, including fireflies, snails, and cave and groundwater invertebrates.

Finally, the addition of the SAPS list means that some research needs that were included in the 2015 SWAP may not be present in the 2025 SWAP revision. This is because the SAPS list contains data deficient species that may have been SGCN in the previous version of the SWAP—but for the purposes of the 2025 revision, only SGCN have been associated with specific threats and actions. All species on the SAPS list can be assumed to have general surveying, research, or identification needs, even if they are not expressly articulated.

Prioritizing Conservation Actions

The U.S. Fish and Wildlife Service (USFWS) requires that all SWAPs identify the relative priorities of their conservation actions. Maryland's 2025 SWAP revision does so with three categories: low, medium, and high priority. It is important to note that these priorities are all relative; all actions included in the SWAP are important for at least one species or habitat, but prioritization helps identify the most urgent needs in a sea of important actions. Nothing is truly "low" priority, but certain actions are labeled as such to indicate that they are not as pressing as others. For example, all or almost all actions related to the Small Coastal Plain Island KWH are marked as high priority because these islands are disappearing rapidly, and work must be done as soon as possible to ensure their continued existence. On the other hand, actions related to hydraulic fracturing (i.e., fracking) are marked as low priority, as the practice is currently banned in Maryland, though the potential of such a threat means it is included in the SWAP regardless.

Prioritizing Species-Level Actions

As the species-scale and habitat-scale threats and actions were developed differently (see Chapter 8 and parts of Chapter 5 for details), methods of calculating their priorities differed. Species-level actions were prioritized according to a set of metrics suggested by the 2022

Northeast Lexicon (Crisfield & NEFWDTC 2022). These seven metrics are explained below in Table 6.1.

Table 6.1 Prioritization metrics for Maryland's conservation actions

Metric	Definition	Available Levels	Additional Information
Threat Spatial Extent	I.e., scope. Within the next 10 years or so, what portion of the population is expected to be negatively impacted by this threat?	Small (≤10% of pop.) Restricted (11-30% of pop.) Large (31-70% of pop.) Pervasive (≥71% of pop.) Unknown percentage of pop.	
Threat Severity	Within the next 10 years, how much is this threat expected to reduce the overall population? Percentages correspond to expected population loss.	Slight (pop. reduction of 1-10%) Moderate (pop. reduction of 11-30%) Serious (pop. reduction of 31-70%) Extreme (pop. reduction of 71-100%) Unknown pop. reduction	
***Threat Impact**	A value based on a matrix of Threat Spatial Extent and Threat Severity; estimates the **overall impact of a threat.**	Low impact Medium impact High impact Very high impact	This metric is automatically populated based on the inputs of two other metrics. See below for details.
Threat Immediacy	What is the time scale over which impacts of the threat will be observable?	Long-term (10 years or longer) Mid-term (about 5-10 years) Near-term (less than 5 years) Immediate (current or existing)	This metric also estimates the immediacy of any associated actions.
Likelihood of Action Success	To what degree will the action address the threat or improve species' populations or habitats? Alternatively, if difficult to estimate, what is the likelihood that this conservation action will be undertaken?	Very likely (91-100%): has already been demonstrated by other projects; Likely (31-90%): best management practices or sufficient info available; Unlikely/unknown (≤30%): not tested or implemented anywhere yet	
***Action Urgency**	A value based on a matrix of Threat Immediacy and Likelihood of Action Success; estimates **urgency of taking action.**	Low urgency Medium urgency High urgency	This metric is automatically populated based on the inputs of two other metrics. See below for details.
Action Duration	How long will action take to complete (or need to persist)?	Less than 2 years 2-10 years 10+ years (i.e., regular maintenance required)	This metric is not actually used in calculations for action priority; separate metric.

* = Metrics marked with an asterisk were estimated based on other metrics. See 'Additional Information' column.

The Threat Impact metric was calculated using an adaptation of the Threat Impact Calculation Matrix used in the NatureServe Element Rank Estimator, as recommended by the 2022 Northeast Lexicon (Crisfield & NEFWDTC 2022). This matrix calculates a threat's overall impact on a species group or population based on its estimated spatial extent and severity. It is included below in Table 6.2. Further building off this recommendation, MD DNR also adapted this matrix to calculate the urgency of that threat's associated action (i.e., Action Urgency) by considering the Threat Immediacy and estimated Likelihood of Action Success. This matrix can be found in Table 6.3.

Table 6.2 Threat Impact matrix

Threat Spatial Extent (i.e., Scope)		Pervasive (≥71%)	Large (31-70%)	Restricted (11-30%)	Small (≤10%)	Unknown
Threat Severity	Extreme (Pop. red. 71-100%)	Very High	High	Medium	Low	Medium
	Serious (Pop. red. 31-70%)	High	High	Medium	Low	Medium
	Moderate (Pop. red. 11-30%)	Medium	Medium	Low	Low	Low
	Slight (Pop. red. 1-10%)	Low	Low	Low	Low	Low
	Unknown	Medium	Medium	Low	Low	N/A

Table 6.3 Action Urgency matrix

Threat Immediacy		Immediate	Near-term (<5 years)	Mid-term (5-10 years)	Long-term (>10 years)
Likelihood of Action Success	Certain/Very Likely (91-100%)	High	High	Medium	Low
	Likely (31-90%)	High	High	Medium	Low
	Unlikely/Unknown (≤30%)	Medium	Medium	Low	Low

Using these calculated metrics, it was then possible to estimate an action's relative priority by considering its Threat Impact and Action Urgency via a similar matrix (Table 6.4). Given that these two metrics are already calculated using Threat Severity, Threat Spatial Extent, Threat Immediacy, and Likelihood of Action Success, this means that the resulting prioritization matrix takes all four metrics into account, even though there are only two inputs. The Action Duration metric was not used to calculate an action's priority, as it was determined that an action should not be given a lower or higher priority based on its estimated completion time, though duration is nevertheless an important consideration.

Table 6.4 Action prioritization matrix

Threat Impact		Very High	High	Medium	Low
Action Urgency	High	High	High	High	Low
	Medium	High	High	Medium	Low
	Low	Medium	Medium	Low	Low

The 2025 SWAP revision uses this quantitative prioritization scheme to better standardize priorities across taxonomic groups. This was possible because each taxonomic group had a dedicated group of partners and staff that was able to accurately estimate these metrics based on their own expertise. Additionally, there were less than two dozen taxonomic groups to consider, and many could be consolidated based on shared expertise (i.e., it was possible to hold a single meeting and rely on the same group of staff for all herpetofauna). KWHs, on the other hand, number nearly 60. They also lack the structure of taxonomic group expertise. In other words, while it can be relatively straightforward to identify and contact lepidopterists in and around Maryland, it is much more difficult to do so for Vernal Pool or Cliff and Rock Outcrop specialists. This necessitated more of a self-selection process from partners and resulted in the less quantitative—though somewhat more holistic—process of prioritizing habitat-level actions, as outlined below.

Prioritizing Habitat-Level Actions

Actions at the state, regional, or habitat scale retain the original low, medium, and high priority labels, though the determination process was quite different. This is due, in part, to the manner in which they were created. These larger scale threats and actions were developed during a series of day-long regional meetings attended by MD DNR staff and partners. One meeting was held for each region of Maryland: eastern, southern, central, and western. For further explanation of these regions, please see Chapter 2; Figure 2.2 contains a map of the four regions of Maryland. Each meeting cycled through a set of habitats or topics known to be relevant to that region, with four groups running simultaneously in two sets (i.e., a morning set and an afternoon set). For example, during the eastern regional meeting, habitat groups included larger scale aquatic habitats (i.e., the bays, ocean, and larger rivers); wetlands and floodplains; beaches, dunes, and islands; and forests. Topic groups included aquatic resource concerns (e.g., pollution, overfishing); agricultural landscapes and management; climate change; and other human-introduced issues (e.g., development, invasive species). Habitat-level threats and actions from Maryland's 2015 SWAP were divided into these categories for attendees to review. Over the course of these meetings, attendees edited, removed, and added to the threats and actions, as needed. See Chapter 8 for a more detailed account of these meetings.

Once the threats and actions were reviewed, attendees were asked to prioritize the actions using different colors of sticky notes. Pink corresponded to high priority, yellow to medium, and no sticker denoted a low priority action. Attendees were also given an explanation of what to weigh (i.e., the same metrics as listed in Table 6.1) when considering priorities. After the prioritization activity took place, the results were then compiled and used to help determine the final priorities for every threat–action pair.

Between the four regional meetings, this resulted in 500 prioritized threats and actions. However, many of these actions were either very similar to each other or already addressed in the species-level actions. After careful consolidation, the final list of actions at the state, regional, and habitat levels numbered closer to 200. Throughout the consolidation process, each combined action kept all its associated prioritization stickers. For example, if three actions that addressed white-tailed deer management, each with a high priority sticker, were combined into a single action, the resulting action had three high priority stickers. These final sticker counts were then used to determine each action's relative priority.

Some actions' final priorities were simpler to assign than others. In the example above, high priority was the clear choice. For an action that came from a single meeting and had no priority stickers, low priority was the clear choice. For other actions—for example, one that resulted from a combination of four, all from different regional meetings and all with different priority stickers—it was necessary to consider other aspects. Additional considerations included:

- Habitats affected: Are the habitats affected at imminent risk? To use an earlier example, actions associated with the Small Coastal Plain Island KWH were usually given higher priority, as they are already rapidly disappearing.
- Urgency: In addition to habitat considerations, do any other factors affect the urgency of the action? For example, current state- and county-level stormwater management regulations are already being overwhelmed due to climate change and must be updated as soon as possible. These sorts of time-sensitive actions were more likely to receive high priority.
- Feasibility: Is the action likely to be implemented? For example, an action with a lower likelihood of success, such as one that would rely upon changes to well-established regulations, was more likely to be given a lower priority.
- Frequency/pervasiveness: How often was the topic raised across all regional meetings? If an action was proposed in all four meetings, for example, it was more likely to be given a higher priority.

Standardization was also an important consideration. For example, if two different actions received the same number and combination of priority stickers, they received the same final priority level. This was especially helpful in determining the cutoffs between levels (i.e., low–medium and medium–high).

All these actions and their relative priorities are included in Appendices 6a and 6b. It is important to note that the section at the end of this chapter, "Addressing Priority Threats for Maryland," is not necessarily based upon individual actions' priorities. Instead, this section includes examples of specific conservation actions that address the threat categories articulated at the end of Chapter 5.

Maryland Actions

This section pulls a selection of threat–action pairs from Maryland's 2025 SWAP revision. The first subsection addresses the nine priority areas listed in the "Priority Threats for Maryland" section of Chapter 5. The second subsection lists the threats and actions that were determined to apply to all of Maryland's regions and habitat groups (i.e., the statewide or "catch-all" actions). Only a small portion of the approximately 700 threat–action pairs are included here. For a comprehensive list of all threats and actions identified for the 2025 SWAP revision, please refer to Appendices 6a and 6b.

Addressing Priority Threats for Maryland

The nine priority areas, split into fourteen topics, were identified during Maryland's 2025 SWAP revision process. The fourteen topics comprise eight threat categories and six resource need (or "scarcity") categories. Although the individual actions that address these topics may not have all received a high priority level, these general areas of concern have been highlighted as topics to pay special attention to in the post-SWAP submission period. In other words, to build on the momentum that the 2025 SWAP revision process has helped create, MD DNR and its partners intend to further efforts in these areas through continued conversation, outreach, and associated coordination efforts to strengthen capacity to address these concerns. See the "Priority Threats for Maryland" section of Chapter 5 for more details on these threat categories, including how they were identified.

The following threats and resource needs were identified as areas of particular concern:

- Threats to urban and suburban habitats
- Threats to coastal habitats
- Threats to working lands
- Managed species
- Invasive (plant) species
- Pollution
- Climate change
- Habitat loss and fragmentation
- Resource needs:
    - Funding
    - Coordination
    - Policy and regulations
    - Education and outreach
    - Research
    - Monitoring

The tables below (Tables 6.5–6.12) pull three actions from across species groups and habitats to provide examples of strategies that address these threats/needs. The six resource-need categories have been compiled into a shared 12-action table instead, as most resource needs span multiple categories (Table 6.13). Unless otherwise marked, most of the example actions are also considered high priority at the individual level. Additionally, a case study is included for climate change in order to emphasize the importance of mapping and modeling in predicting and addressing a changing environment.

Table 6.5 Examples of actions that address threats to urban and suburban habitats

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Bird SGCN	Residential & Commercial Development	Use of materials that cause collision hazards	Encourage practices that minimize bird window strikes, including alternative lighting and use of glass in buildings.
Working lands and (sub)urban KWHs	Natural System Modifications	7.3 Other Ecosystem Modifications: Over-mowing and over-raking (residential areas)	Utilize existing (e.g., Wild Acres) and new educational materials/programs to emphasize the negative impacts of over-mowing and over-raking on the biodiversity of residential landscapes, including the benefits of traditional yard alternatives. Education will need to be done at both the municipal and landowner level in order to address legal barriers (i.e., grass height ordinances) and public perception.
(Sub)urban KWHs	Pollution	9.6.1 Light pollution	Create state-level mandates, set of regulations, or educational campaign (similar to Lights Out Baltimore) regarding light pollution, especially during peak bat and bird migration months. Implement these policies and programs at the local community level.

[1] = The “Applicable Species/Habitats” column also refers to an action’s source table in Appendix 6a or 6b.

Table 6.6 Examples of actions that address threats to coastal habitats

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Coastal KWHs, especially Small Coastal Plain Islands	Transportation & Service Corridors	4.3.2 Dredging of shipping lanes	Improve coordination between relevant agencies (Army Corps of Engineers [ACOE], MD DNR, etc.) to ensure that dredging occurs during appropriate times of year, dredged material is given beneficial use (i.e., habitat restoration), and dredge placement projects are properly maintained.
Aquatic and semi-aquatic KWHs	Pollution		Better assess and manage instances of point source pollution such as landfills, combined sewer overflows, leaking sewers/septic, residual pharmaceuticals, etc.
Tiger beetle and firefly SGCN	Climate Change	11.5.2 Storm surges: Beach erosion from sea-level rise and storm surges	Assess risks of sea-level rise and develop management plan for Assateague.

[1] = The “Applicable Species/Habitats” column also refers to an action’s source table in Appendix 6a or 6b.

Table 6.7 Examples of actions that address threats to working lands

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Bird SGCN	N/A	Habitat loss (from various causes)	Start a Maryland grasslands bird initiative (similar to Virginia's), which could include efforts such as paying farmers to delay haying a few weeks and asking mowers to raise their blade heights.
Working lands and forested KWHs	Energy Production & Mining	3.3.4 Solar farms	Encourage (or require) solar development in areas that are already developed, rooftops, brownfields, etc. in order to minimize forest and grassland loss.
Terrestrial mammal SGCN	Pollution	9.3.3 Herbicides & pesticides	Identify the types of pesticide/herbicide use (e.g., mosquito control, spongy moth control, various forms of agricultural pest control) that are known to or could potentially impact mammalian insectivore populations and take measures to avoid or minimize those impacts.

[1] = The "Applicable Species/Habitats" column also refers to an action's source table in Appendix 6a or 6b.

Table 6.8 Examples of actions that address managed species

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Wetland KWHs	Invasive & Other Problematic Species, etc.	8.2.2 Increased grazing by vertebrates: Resident (Canada) geese	Increase efforts to control resident geese, which are negatively impacting marsh vegetation (e.g., along the Patuxent River).
Wetland, stream, and working land KWHs	Other Options	12.2 Resource Needs: Need for fish, wildlife and/or habitat planning	Review beaver management and survey techniques currently employed by state and federal agencies to determine relevance and potential action items for inclusion into Maryland guidance.[2]
Bird SGCN	Other Options	12.3 Education & Outreach: Need for improved knowledge of fish and wildlife and their habitats	Better educate private landowners on the impacts of invasive plants on native bird populations, especially in the understory. Emphasize the importance of allowing deer hunting on their lands to help address this issue.

[1] = The "Applicable Species/Habitats" column also refers to an action's source table in Appendix 6a or 6b

[2] = The beaver-related action is medium priority, not high.

Table 6.9 Examples of actions that address invasive plant species

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
All	Invasive & Other Problematic Species, etc.	8.1 Invasive Non-Native / Alien Plants & Animals	Better coordinate invasive species monitoring and management efforts through evidence-based, localized plans. Utilize existing partnerships (e.g., National Capital PRISM) and create new ones in order to share resources, prioritize areas/actions, have a stable volunteer base, and create lasting partnerships.[2]
All	Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants	Support the refining and implementation of state-level invasive species legislation.
Tiger beetle SGCN	Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants: Invasive species along streams	Remove invasive plant species (e.g., Japanese knot weed and stiltgrass) along streams where this species (Appalachian tiger beetle *[Cicindela ancocisconensis]*) is known to occur.

[1] = The "Applicable Species/Habitats" column also refers to an action's source table in Appendix 6a or 6b.
[2] = The coordination-focused action is medium priority, not high.

Table 6.10 Examples of actions that address pollution

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Freshwater mussel SGCN	Agriculture & Aquaculture	2.1.1 Annual cropping systems (field crops): Nutrient and sediment laden run-off, and other impacts to stream hydrology, habitat quality, etc. from field crop agriculture	Restore ecological integrity of streams through BMP implementation, revegetation, and cooperative landowner agreements to reduce effects from agricultural practices (e.g., fertilizers, pesticides, and herbicides).
Aquatic and semi-aquatic KWHs	Pollution	9.1.1 Domestic wastewater	Better engage with utility companies and owners of septic systems (especially in riparian zones) in order to identify solutions to failed/failing wastewater infrastructure. To ensure future failures do not occur, work with government entities and NGOs in order to brainstorm, create, and enforce higher standards for maintenance and inspection.
Aquatic and semi-aquatic KWHs	Pollution	9.1.2 Runoff	Develop more incentives for green infrastructure projects, especially those related to stormwater management. Prioritize pervious surfaces and reduce impervious surfaces when possible.

[1] = The "Applicable Species/Habitats" column also refers to an action's source table in Appendix 6a or 6b.

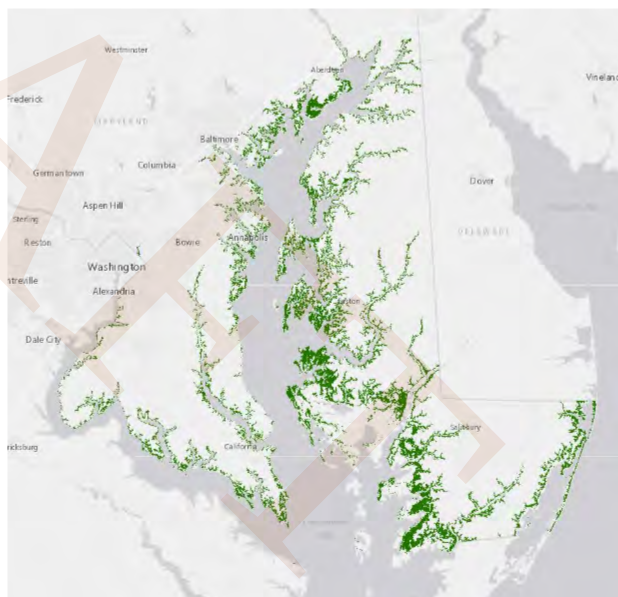
Table 6.11 Examples of actions that address climate change

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Small Coastal Plain Island KWH	Climate Change	11.1 Habitat Shifting & Alteration: Sea-level rise	Prioritize the conservation and restoration of rapidly disappearing islands, which are a vital habitat type for colonial waterbirds, tiger beetles, diamond-backed terrapins, and more.
Bird SGCN	Climate Change	11.1.2 Phenological mismatch: Changes in timing of ecological processes causing issues for long-distance migrants	Continue researching the effects of phenological mismatches and the impact to the survival of species, as well as potential habitat management practices that may mitigate these effects.[2]
All	Climate Change	11.4 Changes in Precipitation & Hydrological Regimes	Update both state- and county-level stormwater management regulations, as climate change has been overwhelming current regulations.

[1] = The "Applicable Species/Habitats" column also refers to an action's source table in Appendix 6a or 6b.
[2] = The bird-related action is medium priority, not high.

Case Study: Sea-Level Affecting Marsh Model (SLAMM), Wetland Adaptation Areas (WAAs) and the Maryland Habitat Connectivity Network (HCN)

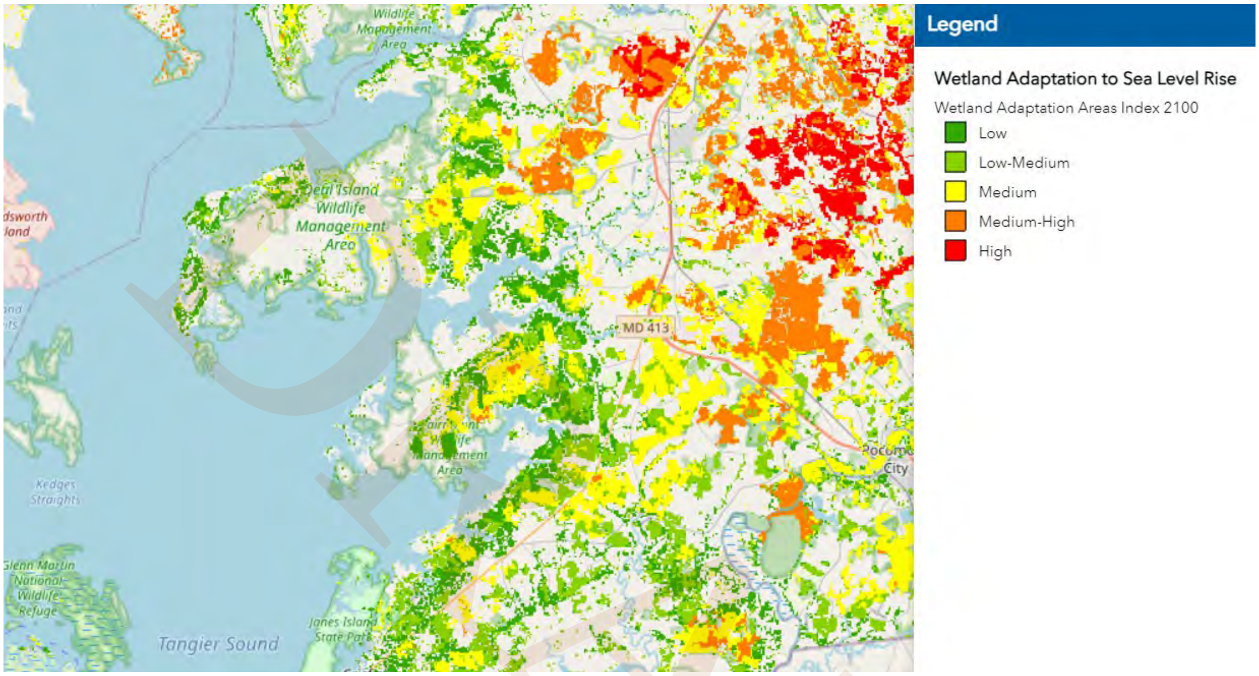
One of the most important aspects of addressing climate change is first understanding *where* and *how* it is expected to affect Maryland's species and habitats. Maps and models are two of the main tools that MD DNR and its partners rely on to reach this understanding.



Uplands to Wetlands in 2100 (MD DNR)

In order to visualize wetland movement under certain sea-level rise scenarios, the Sea-Level Affecting Marsh Model (SLAMM) was run for all 16 coastal counties and Baltimore City. Using elevation, sea-level, erosion rates, and other input data, SLAMM attempts to predict where certain habitat types may be present in the future. Three model years were selected for the sea-level rise (or SLR) scenario: 2050 (1.37 feet of rise), 2070 (2.32 feet), and 2100 (4.03 feet). The areas where wetlands are predicted to be present are considered the "wetland adaptation areas" (WAAs). These WAAs include both wetlands that persist as sea levels rise and wetlands that convert from upland land types. In order to differentiate between them, a data layer was produced for 2100 to show only areas where upland land types are projected to convert to wetlands (see *Uplands to Wetlands in 2100*).

In addition, a conservation model (the Wetland Adaptation Areas Index, or WAA) was developed to prioritize the most important areas for wetland adaptation for the year 2100. Conservation criteria used include areas that may support future wetland migration, wildlife habitat and corridors, high priority living resources, vulnerable wetland habitat, and suitable soils for wetland establishment. A "high" designation in this data layer represents areas with the greatest potential for providing high quality wetland habitat.



Wetland Adaptation Areas Index data layer (2100), Somerset County (MD DNR)

By modeling where future wetlands may be lost, migrate, or persist, staff and partners can proactively plan for conservation action across Maryland's coastal zone. SLAMM is able to portray nine unique wetland types, from forested wetland to inland fresh marsh to transitional salt marsh. While these future habitat types and locations are only projections, it can be helpful to visualize and to use as a starting point for planning purposes. Land acquisition, adaptation strategies, wildlife migration, and marsh restoration are just a few examples of how SLAMM and WAA data can be used.

These data layers, including the Wetland Adaptation Areas (2050, 2070, and 2100) and SLAMM (2050, 2070, and 2100), are located on Maryland's Coastal Atlas and hosted on iMap. The SLAMM project was funded by the National Oceanic and Atmospheric Administration (NOAA) and was run in collaboration with George Mason University and The Nature Conservancy.

In addition to understanding the location and quality of wetland habitats, it is also important to understand the connectivity of habitats, wetland or otherwise, across the Maryland landscape. Habitat connectivity is particularly important with regards to climate change because it allows species to adapt to the changing environment around them, facilitating necessary movements such as migration and range shifts. To capture this connectivity, the Maryland Habitat Connectivity Network (HCN) data (previously known as Green Infrastructure) was created. This data layer maps upland forest, wetland, and aquatic hubs; upland forest and aquatic corridors;

and potentially restorable gaps in habitat connectivity. Hubs are defined as contiguous habitat blocks of at least 50 acres that include a minimum of 10 acres of forest interior habitat, habitat for rare or sensitive species, biologically important rivers and streams, and/or existing conservation lands managed for natural values. Corridors are defined as 1,100-foot-wide linear areas that follow the most natural or best ecological routes between hubs, which allow animals, plant seeds, and water to move between hub areas. This mapping allows MD DNR and its partners to identify and prioritize areas for conservation, restoration, and protection.

The resulting map is located on MERLIN Online and hosted on iMap. HCN features were mapped in partnership with the Chesapeake Conservancy, using their 2017/2018 1-meter resolution Land Use Land Cover (LULC) dataset.

Table 6.12 Examples of actions that address habitat loss and fragmentation

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
All	N/A	Habitat loss (from various causes)	Encourage implementation of BMPs that minimize and reduce habitat fragmentation in land use plans, especially for large, contiguous forest blocks and old growth conditions that are connected by effective movement/dispersal corridors.
Terrestrial mammal SGCN	Residential & Commercial Development	1.3.4 Recreational trails	Site recreational trails in a way that minimizes fragmentation of habitat.
Stream, river, and floodplain KWHs	Transportation & Service Corridors	4.1 Roads & Railroads	Improve habitat connectivity in streams via blockage removal, culvert retrofit, and transportation BMPs.

[1] = The "Applicable Species/Habitats" column also refers to an action's source table in Appendix 6a or 6b.

Table 6.13 Examples of actions that address resource needs

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Freshwater mussel SGCN	Energy Production & Mining	3.2.1 Underground mines: Coal mine permitted to operate underneath and discharge mine water into the Casselman River circa 2010	Conduct population monitoring in the Casselman River to assess potential impacts from permitted coal deep mine.
Working lands and forested KWHs	Energy Production & Mining	3.3.4 Solar farms	Site and design solar projects in a way that minimizes impacts on (and potentially benefits) SGCN and their habitats. Distribute guidelines and enforce regulations at the state level.

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Cave and Karst KWH	Human Intrusions & Disturbance	6.3.3 Vandalism	Decrease cave vandalism/breaking and entering through tactics such as emergency gating, cameras, increased signage, and improved response time. Explore options for funding these interventions.
All	Invasive & Other Problematic Species, etc.	8.4 Pathogens: Unknown/unstudied diseases	Continue to support research to monitor wildlife health and identify emerging zoonotic diseases.
All	Other Options	12.2 Resource Needs: Lack of funding	Explore options for a permanent and significant source of funding for conservation work. Options to pursue include a portion of an existing state tax, a new state tax, a biodiversity license plate, charging for environmental review, or federal sources (i.e., Recovering America's Wildlife Act [RAWA]).
Terrestrial mammal SGCN	Other Options	12.2 Resource Needs: Need to develop new technique	Develop more effective survey and monitoring techniques, including live capture methods for insectivores.
Amphibian SGCN	Other Options	12.2 Resource Needs: Lack of initial baseline inventory	Conduct eDNA surveys in subwatersheds to determine presence/absence of certain species.
Bird SGCN	Other Options	12.3 Education & Outreach: Need for improved knowledge of fish and wildlife and their habitats	Increase public outreach and education regarding what habitats and management practices are beneficial for birds.
All	Other Options	12.3 Education & Outreach: Outreach needs	Provide more outreach and education on available technical assistance programs, easements, etc. There are already a variety of available programs (state government, county government, University of Maryland Extension, etc.), but many landowners do not know they exist.
Bat SGCN	Other Options	12.4 Administrative Needs: Need for coordination for effective program/project management	Coordinate inventory, monitoring, and research across Maryland and surrounding states.

Applicable Species/ Habitats[1]	Threat Category	Threat Description	Action Description
Forested KWHs	Other Options	12.4 Administrative Needs: Need for coordination for effective program/project management	Increase collaboration between foresters, wildlife conservationists, landowners, and others when creating forest stewardship plans. Potentially do this through a standing group that can establish considerations for wildlife, management techniques, educational materials, etc.
Groundwater wetland KWHs	Other Options	12.5 State Specific Issues: Need for increased legal protection	Strengthen protections for vernal pools, springs, and other isolated wetlands. May want to establish a vernal pool (and related habitat) conservation workgroup across multiple fields of expertise in order to better identify, map, and create management actions for these habitats.

[1] = The “Applicable Species/Habitats” column also refers to an action’s source table in Appendix 6a or 6b.

Statewide Actions

During the refining of the habitat-level threats and actions list, a number of actions were identified as being applicable to all or nearly all regions, habitat groups, and KWHs in Maryland. These do not necessarily reflect the highest priority actions. Instead, this group includes actions that are less tied to specific places and habitats; most are more general BMPs or resource needs. Table 6.14 below lists all these statewide or “catch-all” actions. It may be helpful to refer to the “Threat Classification System” section in Chapter 5 for the listed threat categories and codes.

Table 6.14 Statewide conservation actions for Maryland

Threat Category	Threat Description	Action Description	Action Priority[1]
Residential & Commercial Development	1.3 Tourism & Recreation Areas	Increase funding for additional staffing, public education efforts, and environmentally sensitive design with regards to recreational areas in or near important SGCN habitat.	Low
Residential & Commercial Development	1.3 Tourism & Recreation Areas	Streamline process (i.e., waivers and permits) for public lands to implement "keep out zones" as needed to protect sensitive SGCN habitat.	Low
Residential & Commercial Development	1.3.1 Parks and sports fields	Work with municipal and county planning and zoning offices to ensure a balance of natural areas versus traditional recreational areas (e.g., sports fields).	Low
Residential & Commercial Development	1.3.1 Parks and sports fields	Discourage the use of artificial turf and promote/incentivize native turf grass alternatives.	High
Energy Production & Mining	Fossil fuels	Continue and increase efforts to establish in-state mitigation funds to offset damages caused by fossil fuel extraction and related operations.	High

Threat Category	Threat Description	Action Description	Action Priority[1]
Energy Production & Mining	Fossil fuels	Explore the feasibility of increased nuclear power generation through means such as small modular reactors, expanded capacity at existing sites, etc. Work with entities such as the Power Plant Research Program (PPRP) and Public Service Commission (PSC) to do so.	Low
Energy Production & Mining	Fossil fuels: methane gas	Increase efforts to monitor, map, and mitigate methane gas leaks from various sources.	High
Transportation & Service Corridors	4.1 Roads & Railroads	In order to minimize habitat fragmentation by transportation infrastructure, work with the Maryland Department of Transportation (MDOT) to improve transportation planning for new roads and encourage/facilitate additional opportunities for public transportation.	Mid
Human Intrusions & Disturbance	6.1 Recreational Activities	Build a culture of stewardship among natural area user groups through tactics such as roundtable meetings, inclusion in field work days, educational signage and talks, encouraging use in less sensitive areas, etc.	Mid
Invasive & Other Problematic Species, etc.	8.1 Invasive Non-Native / Alien Plants & Animals	Increase MD DNR's capacity for invasive species monitoring and management by funding data analysis efforts (animals), deepening involvement with preexisting removal efforts (plants), and encouraging staff to get certified in herbicide application (plants).	High
Invasive & Other Problematic Species, etc.	8.1 Invasive Non-Native / Alien Plants & Animals	Better coordinate invasive species monitoring and management efforts through evidence-based, localized plans. Utilize existing partnerships (e.g., National Capital PRISM) and create new ones in order to share resources, prioritize areas/actions, have a stable volunteer base, and create lasting partnerships.	Mid
Invasive & Other Problematic Species, etc.	8.1.1 Terrestrial animals: Predation from domestic cats	Continue to educate the public on effects of free-ranging cats on wildlife. Research population management options other than trap-neuter-release programs.	Mid
Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants	Support the refining and implementation of state-level invasive species legislation.	High
Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants	Continue and increase targeted efforts regarding invasive species removal, especially on state lands.	High

Threat Category	Threat Description	Action Description	Action Priority[1]
Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants	Prioritize the planting of and education about native plants, especially on state-owned properties.	High
Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants	Explore the feasibility of banning the sale of invasive plant species.	High
Invasive & Other Problematic Species, etc.	8.1.2 Terrestrial plants / 8.1.4 Aquatic plants	Create visitation management plans for public lands in order to reduce the spread of invasive plants (e.g., brush/shoe wash stations).	Low
Invasive & Other Problematic Species, etc.	8.1 Invasive Non-Native / Alien Plants & Animals / 8.2 Problematic Native Plants & Animals	Continue to manage all invasive non-native and problematic native plants and animals impacting key wildlife habitats.	Low
Invasive & Other Problematic Species, etc.	8.4 Pathogens: Unknown/unstudied diseases	Continue to support research to monitor wildlife health and identify emerging zoonotic diseases.	High
Pollution	PFAS	Work with the Maryland Department of the Environment (MDE) to further reduce the use of PFAS and other endocrine-disrupting chemicals.	Low
Pollution	9.3.3 Herbicides & pesticides	Develop strict protocols for restricting the use of pesticides, such as for mosquito control, in SGCN habitats.	Low
Pollution	9.3.3 Herbicides & pesticides	Regulate pest companies to only allow Bacillus thuringiensis (BT) treatments rather than broad spectrum pesticides.	High
Pollution	9.3.3 Herbicides & pesticides: Commercial/ residential use	Initiate new marketing and public service campaigns to educate the public on the harmful effects of inappropriate or off-label use of herbicides and pesticides, particularly those which are commercially available. Promote Integrated Pest Management (IPM) as an alternative.	High
Pollution	9.4.1 Garbage	Improve public education on litter management, particularly on state lands. Utilize plastic pollution reduction campaigns such as 'pack it out' stations with provided bags.	High
Pollution	9.4.1 Garbage	Build on existing work (e.g., MDE's Historic Landfill Initiative) to locate and remove legacy waste disposal sites.	Low

Threat Category	Threat Description	Action Description	Action Priority[1]
Climate Change		Better coordinate efforts in monitoring how/which species are affected by climate change (both plants and animals) in order to track populations, monitor overall impact, and adapt land management practices appropriately.	Mid
Climate Change		Prepare for new invasive species and pathogens that are likely to establish themselves in Maryland due to changing climatic conditions. Create new guidance and rely on existing documentation, including MD DNR's Climate-Ready Fisheries Planning Menu (2024).	Mid
Climate Change		Work with local and county governments to develop more localized models and plans for climate resiliency. Include aspects of flood response, stormwater management, storm damage, and major heat events.	Low
Climate Change		Encourage the use of electric vehicles and lawn care equipment. Emphasize the multiple negative impacts of fossil fuel-powered equipment, including climate change and noise pollution, and continue to discourage overall usage through "leave the leaves" campaigns and similar initiatives.	Mid
Climate Change	11.4 Changes in Precipitation & Hydrological Regimes	Update both state- and county-level stormwater management regulations, as climate change has been overwhelming current regulations.	High
Other Options	12.2 Resource Needs: Lack of funding	Explore options for a permanent and significant source of funding for conservation work. Options to pursue include a portion of an existing state tax, a new state tax, a biodiversity license plate, charging for environmental review, or federal sources (i.e., Recovering America's Wildlife Act [RAWA]).	High
Other Options	12.2 Resource Needs: Need for fish, wildlife and/or habitat planning	Include habitat protection and connectivity needs in local and county land zoning plans (e.g., comprehensive plans) through increased communication, outreach, and/or incentives to counties planning departments.	Mid
Other Options	12.2 Resource Needs: Need for fish, wildlife and/or habitat planning	Periodically re-evaluate state conservation status (i.e., S-ranks) for SGCN.	High

Threat Category	Threat Description	Action Description	Action Priority[1]
Other Options	12.3 Education & Outreach: K-12 education needs	Encourage more schools to adopt Maryland's (relatively) new environmental literacy standards.	Mid
Other Options	12.3 Education & Outreach: Lack of understanding and appreciation of rare, threatened, and endangered species	Continue existing and create new efforts for education/outreach regarding the importance of conserving the state's rare, threatened, and endangered species. Utilize specific stories and species in order to have a greater, more personal/emotional impact.	Low
Other Options	12.3 Education & Outreach: Lack of understanding regarding how wildlife conservation is funded	Increase education/outreach to the public regarding how wildlife conservation is funded, emphasizing that no general state tax dollars go towards this work.	Mid
Other Options	12.3 Education & Outreach: Outreach needs	Provide more outreach and education on available technical assistance programs, easements, etc. There are already a variety of available programs (state government, county government, University of Maryland Extension, etc.), but many landowners do not know they exist.	High
Other Options	12.3 Education & Outreach: Outreach needs	Work with less "traditional" conservation partners such as scout groups, church groups, and civic centers to better distribute conservation-related messages and information.	Mid
Other Options	12.3 Education & Outreach: Outreach needs	Build public interest in natural area stewardship through additional community workdays, opportunities for student volunteer hours, and creatively funded positions (e.g., AmeriCorps). Invasive species removal projects and surveying efforts are good ways to reach the most people.	High
Other Options	12.3 Education & Outreach: Outreach needs	Reach more people with conservation messaging through less traditional online means (YouTube shorts, Reddit, podcasts, etc.).	Low
Other Options	12.3 Education & Outreach: Outreach needs	Improve the marketing of conservation plans to the general public in order to increase awareness and interest.	Low
Other Options	12.3 Education & Outreach: Outreach needs	Increase efforts to influence legislators making infrastructure decisions that affect important habitat, especially in the realm of energy infrastructure.	Mid

Threat Category	Threat Description	Action Description	Action Priority[1]
Other Options	12.3 Education & Outreach: Disproportionately low outreach to non-English speakers	Increase existing efforts (i.e., funding, materials, staff capacity) for non-English language outreach and education. Until capacity is larger, focus on the translation of existing materials and providing a presence at public cultural events.	Low
Other Options	12.3 Education & Outreach: Lack of focus on underrepresented communities	Make a concerted effort to include a more diverse group of participants in outreach efforts, volunteer opportunities, and other events by diversifying timing, availability, and length of engagement opportunities.	Mid
Other Options	12.3 Education & Outreach: Lack of oversight for HOAs, corporate bodies, and other quasi-community groups	Increase outreach to homeowner associations (HOAs) and similar organizations in order to promote environmentally friendly land management practices for groups with large holdings. Consider setting up advisory committee(s) of HOA members, government representatives, and NGO staff.	Low
Other Options	12.3 Education & Outreach: Lack of public trust in state management and expertise	Improve data sharing and transparency in targeted areas. Hold more meetings and roundtables with stakeholders as well as the general public in order to increase trust, transparency, and input in the decision-making process.	Mid
Other Options	12.3 Education & Outreach: Lack of social science expertise	Better incorporate social sciences into outreach and education techniques in order to reach diverse sets of people and encourage behavior change.	Mid
Other Options	12.4 Administrative Needs: Need for coordination for effective program/project management	Pursue opportunities for larger scale coordination and collaboration. Specific needs include species/habitat inventory, research (existing and future), invasive species management, and more.	High
Other Options	12.4 Administrative Needs: Need for coordination for effective program/project management	Facilitate better coordination between state agencies, conservation organizations, and other nonprofit groups to reduce competition for funding sources and volunteers, and increase effectiveness.	Mid
Other Options	12.5 State Specific Issues: Lack of smaller scale land easements	Explore ways to incentivize less wealthy landowners (i.e., lower- and middle-income landowners who typically do not benefit from easement tax incentives) to conserve land. Tactics could include the selling of tax credits, financial assistance to cover legal and surveying costs, etc.	Low

Threat Category	Threat Description	Action Description	Action Priority[1]
Other Options	12.5 State Specific Issues: Need for updates to existing laws/regulations and enacting new laws/regulations	Provide a tax break for people who donate land easements across all Maryland counties, not just some of them.	Low

[1] = Since these are statewide actions, the "Applicable Species/Habitats" column was replaced with "Action Priority."

Regional Actions

Chapter 4 of *The Northeast Regional Conservation Synthesis for 2025 State Wildlife Action Plans* (TCI & NEFWDTC 2023) summarizes how regional priority conservation actions identified by the 2017 SWAP Synthesis (TCI & NEFWDTC 2017) are being implemented by the Northeast Regional Conservation Needs (RCN) Program, USFWS Science Applications (SA), and Competitive State Wildlife Grant (CSWG) partner projects throughout the region. Chapter 4 of this document lists seven priority regional conservation actions grounded in the common themes and priorities of the 2015 Northeast SWAPs (TCI & NEFWDTC 2017) and further prioritized by the Northeast Fish and Wildlife Diversity Technical Committee (NEFWDTC) and its SWAP Coordinators, Threat Working Groups (TWG), and taxonomic teams.

Critical to the implementation of these priority actions is the existence of the RCN program, which is the main conduit for funding projects of regional interest in the Northeast. The RCN Program formalizes a cooperative approach to address SGCN needs across multiple states. The purposes of the RCN program are to develop, coordinate, and implement conservation actions that are regional/sub-regional in scope, and to build upon the many regional initiatives that already exist. The RCN program continues to provide information and support conservation actions and management that help to protect SGCN and their habitats. The RCN program utilizes a funding mechanism that is equitable to all Northeast states and the District of Columbia, creating a base of funding for regional projects. A full list of projects awarded through this program can be found at NEAFWA's website.

According to the 2023 synthesis, the seven priority action areas for the Northeast region are:

- Develop science-based information and tools to conserve regional SGCN (RSGCN) and key habitats in the Northeast.
- Conserve Northeast RSGCN and their habitats from habitat loss and degradation by addressing development, natural systems modification, and biological resource use.
- Protect native species and habitats from the introduction and spread of disease and invasive species in the Northeast.
- Conserve aquatic habitats by addressing pollution and aquatic connectivity in Northeast waters.
- Address climate change impacts to Northeast RSGCN and their habitats.
- Coordinate inclusively across state boundaries to maximize efficiency and effectiveness of fish and wildlife diversity conservation in the Northeast.

- Develop and implement effective regional scale monitoring to inform adaptive management of regional priorities and conservation in the Northeast.

As in Chapter 5, certain portions of the 2023 synthesis have been included below regarding these seven priority actions. Their complete descriptions can be found in the full document. Many of these priorities closely align with those identified during the course of Maryland's 2025 SWAP revision, as articulated in the final section of this chapter, though the actions are broader and more focused on increasing the region's capacity and consistency in addressing certain threats.

Regional Action: Develop Information and Tools

The 2005 and 2015 Northeast SWAPs identified data deficiency as a limiting factor in the effective conservation of SGCN and their habitats in their states. They identified species and habitats of greatest conservation need, but differences in available data, capacity, and approaches to prioritization posed a further challenge to collaborative, regional conservation. Many of the SWAP SGCN and SGCN/Watchlist species lack the current, consistent status, habitat, threat, and other information needed to inform effective conservation in the Northeast.

Priority actions to address this need are as follows:

- Identify and develop regionally consistent information and priorities for species, key habitat, and threats, including climate vulnerability.
- Develop and apply targeted and inclusive communication of NEFWDTC priorities and products (from SWAPs, RCN, and key partners) to inform and guide regional conservation planning and incorporate into partner plans at all levels.
- Strategically focus "on-the-ground" conservation actions for regional habitat and species priorities by providing incentives, science-based best practices, techniques, tools, and information on land and water conservation to conserve RSGCN and their habitats.

Regional Action: Protect from Habitat Loss and Degradation

The 2005 and 2015 SWAPs, the 2017 SWAP Synthesis, and the 2023 RSGCN process consistently identified that habitat loss and degradation from development, natural systems modification, and biological resource use as top threats facing Northeast RSGCN and their habitats. The Northeast region is among the most developed and modified areas in the United States, impacting RSGCN species and their associated habitats. A coordinated, regional approach and set of tools and guidelines to address land and resource use on Northeast landscapes and waters are needed, especially in the face of increasing impacts from climate change.

Priority actions to address this threat are as follows:

- Provide and encourage incorporation of SWAP and regional priorities into land, water and natural resource use plans, decisions, and management programs across the Northeast.
- Provide information and guidance with best practices and consistent protocols for RSGCN and their key habitats.
- Work with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement holistic, effective, consistent policies and approaches that

incorporate climate projections into risk assessments across Northeast lands and waters to conserve and restore RSGCN and their habitats.

Regional Action: Protect from Disease and Invasive Species

The 14 Northeast 2005 and 2015 SWAPS, the 2017 SWAP Synthesis, and the 2023 RSGCN process identified Invasives and Disease as top regional threats to fish and wildlife diversity in the Northeast. Imperiled species and habitats can be severely impacted or lost due to invasive species or disease, even if all other conservation objectives are met. Invasive species may be less negatively impacted by climate change than native species; or may even benefit from these changes. To effectively prevent or address these impacts, an effective, collaborative regional scale effort is required.

Priority actions to address this threat are as follows:

- Develop regionally coordinated and targeted early detection and rapid response strategies for the control and management of invasive, non-native species that pose threats to native wildlife or communities.
- Work with and through Northeast partners and networks for effective, inclusive, regional conservation.
- Use climate projections to estimate timelines and locations most vulnerable to invasive species spread and establishment.
- Coordinate with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement effective, consistent policies, incentives, and approaches to address invasives and disease across Northeast lands and waters.

Regional Action: Address Pollution and Aquatic Connectivity

The 2015 SWAPS, 2017 SWAP Synthesis, and NEFWDTC identified pollution and the loss of aquatic connectivity as top threats facing aquatic RSGCN and their habitats across the Northeast. Many RSGCNs are associated with aquatic habitats in the Northeast, but these habitats continue to be affected by pollution, water quantity and quality management challenges, and aquatic connectivity issues that can benefit from watershed-focused regional approaches. Climate change will exacerbate water quality issues, requiring environmental assessments and restoration actions to evaluate past management in light of these additional challenges to effectively address present and future conservation goals.

Priority actions to address this threat are as follows:

- Provide regional SWAP priorities for incorporation into local, state, and regional water management and watershed planning efforts, highlighting RSGCN and key habitats.
- Work with partners to improve aquatic connectivity, water management, and water quality for RSGCN and their habitats.
- Work with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement effective, consistent policies and approaches across Northeast lands and waters.

Regional Action: Address Climate Change Impacts

The 2015 SWAPS, 2017 SWAP Synthesis, and NEFWDTC identified climate change as one of the top five threats facing Northeast RSGCN and their habitats. One of the largest current challenges related to climate change is uncertainty. As information related to climate change and its effects becomes more available, it is increasingly important to incorporate climate-change scenarios into conservation decisions for priority regional species and habitats and to develop climate-smart actions.

Priority actions to address this threat are as follows:

- Collaborate with key climate change partners to provide the best available scientific data for RSGCN and climate-related conservation issues to inform existing and new actions developed to address climate change as both a threat and threat amplifier.
- Incorporate climate projections and information to assess future scenarios of risk and use this information to develop climate-smart actions.
- Use existing climate vulnerability data when possible and conduct Climate Change Vulnerability Assessments to assess risk.
- Develop a regional Climate Adaptation Strategy guided by the 2021 national plan, NE CASC, and other key partners' expertise and resources.

Regional Action: Improve Coordination Across State Boundaries

Conservation efforts for RSGCN must continue to include collaborative, cooperative landscape and watershed scale approaches, as species distributions and movements are not restricted by state boundaries. At the same time, constraints posed by limitations of funding and capacity make such collaborative efforts challenging. NEAFWA's technical committees are charged with developing and implementing regional projects that identify and address the top conservation targets and threats in the Northeast. Many of the needed actions are not under the authority or purview of state fish and wildlife agencies, so coordination and effective communication between the agencies impacting or regulating those impacts is essential. Clear, consistent, inclusive messaging and communication are needed to inform and engage broader participation across the region.

Priority actions to address this need are as follows:

- Continue to collaborate and coordinate across state boundaries for effective landscape and watershed scale conservation of these regional priority species and habitats.
- Build state capacity and funding to more fully conserve, restore, and protect the SGCN, RSGCN, and their key habitats as identified in the 14 Northeast SWAPs.
- Develop improved, inclusive communication approaches for outreach, education, and technical assistance to target audiences including policy and land use decision makers, land managers, stakeholders, and the broader public to inform and engage them in addressing the top threat impacts to SGCN and key habitats.
- Coordinate with agencies and entities that regulate key impacts to fish and wildlife to develop and implement effective, consistent policies and approaches across Northeast lands and waters.

Regional Action: Develop and Implement Regional Monitoring

The 14 Northeast 2005 and 2015 SWAPS, the 2017 SWAP Synthesis, and the 2023 RSGCN process identified monitoring as a key need for effective fish and wildlife diversity conservation in the Northeast. Substantial efforts and investments have been made to conserve RSGCNs and key habitats across the Northeast region. A coordinated monitoring approach and consistent methodologies are also necessary to determine the effectiveness of these conservation efforts and inform adaptive management at the regional scale.

Priority actions to address this need are as follows:

- Review and evaluate priorities, data, and tools, and their implementation.
- Review regional targets, indicators, incentives, laws, programs, and policies to ensure current relevance and conservation effectiveness.
- Develop and improve regional monitoring efforts to evaluate effectiveness and inform adaptive management at multiple scales.
- Work with agencies and entities that regulate impacts to fish and wildlife habitats to develop and implement effective, consistent monitoring policies and approaches across Northeast lands and waters.

This chapter provides information pertinent to **Element #4** regarding conservation actions determined to be necessary to conserve the identified species and habitats, as well as the priorities for implementing such actions. It focuses on actions that address priority threat categories, which are applicable statewide, or are considered regional priorities. All conservation actions are listed in Appendices 6a and 6b. Chapter 7 will provide information pertinent to **Element #5** regarding approaches and strategies for monitoring Maryland's Species of Greatest Conservation Need (SGCN), their habitats, and the effectiveness of implemented conservation actions.

Citations and Sources

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Chapter 7

Monitoring and Effectiveness Measures

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Introduction

This chapter provides an overview of approaches and strategies for monitoring Maryland's Species of Greatest Conservation Need (SGCN), their habitats, and the effectiveness of implemented conservation actions. These specific conservation actions are outlined in Chapter 6 and in Chapter 6 appendices. An inventory of existing monitoring programs for Maryland's wildlife and habitats is included in this Chapter's appendices (Appendices 7a and 7b), as well as descriptions of some of the national and Northeast states regional monitoring programs. This chapter describes the use of monitoring data in an adaptive management framework to assess and improve the effectiveness of conservation actions. At the end of the chapter, a proposed approach to Maryland's framework for monitoring and measuring effectiveness measures is described with an example, which will assist in the successful implementation of the State Wildlife Action Plan (SWAP or Plan).

Monitoring continues to be recognized as priority need for biodiversity conservation. This is because monitoring is essential in all aspects of conservation, from tracking which species are present and where they are present (their distribution), to evaluating priorities for future land protection and restoration. The information provided through monitoring Maryland's SGCN, their habitats, and the effectiveness of conservation actions will allow the Maryland Department of Natural Resources (MD DNR) and partners to reduce threats facing the state's fish and wildlife resources. As new threats and unfavorable conditions, such as changes in land use and climate patterns, new information and data are needed to understand how to manage natural resources appropriately and sustainably.

The long-term successful implementation of Maryland's SWAP will, at a minimum, prevent more SGCN from becoming increasingly rare and endangered, prevent Key Wildlife Habitats (KWHs) from being degraded and irreparably lost, and minimize or mitigate threats to both. A critical measure of success will also include the reversal of population trends, such that rare species will become more abundant and the restoration of degraded KWHs within a natural landscape will increase. These are long-term outcomes of the success of the SWAP, recognizing the many external factors that might limit implementation. Another important measure of the effectiveness and adaptability of this SWAP is the frequency and degree of integration of SWAP targets into the operations of MD DNR's many programs, as well as those of its partners and stakeholders. Maryland's monitoring framework and adaptive management strategy focuses on evaluating long-term progress towards these broad objectives.

Inventory, Monitoring, and Research

The activity referred to in this chapter as "monitoring" can be defined as the collection of data over a period of time, usually at certain defined and repeated intervals. Inventory and research are other activities that are frequently related to monitoring. Inventory includes the collection of baseline data such as whether a particular species is present and where it can be found. Repeating an inventory survey, especially at regular intervals, is one type of monitoring. Scientific research can be defined as a systematic investigation used to solve a problem or answer a question. Using the scientific method, investigators move through a cycle of observing, asking questions, formulating ideas to explain what they see (hypotheses), making predictions from the hypotheses, collecting data to test the predictions (which may involve an experiment), evaluating the results, and altering the hypotheses as needed. The cycle can then begin again as predictions from the revised hypotheses are tested. Monitoring can be thought of as part of the scientific research process when data needed to test predictions are collected over a period of time. In other words, the results of an experiment or management activity are “monitored” to see if they are consistent with the predictions.

Inventory, monitoring, and research activities as defined above are all important conservation actions for SGCN and their habitats. Inventory provides basic information on the location, number, and condition of species and habitats. Scientific research on species and habitats is critical to understand needs, interactions, and responses to threats so that land managers and others have the basic information needed to develop effective conservation strategies for individual species and habitats. Monitoring that is not connected to particular questions or hypotheses is often referred to as status assessment or surveillance monitoring (Nichols & Williams 2006; Lambert et al. 2009). Status assessment or surveillance monitoring can provide updated information such as the current population size, distribution, reproductive output, and threats for a particular species or habitat, and, if repeated through time, can demonstrate changes in these parameters (i.e., trend monitoring). Effects monitoring goes a step further, linking changes in populations or habitat condition to changes in the environment. Although status assessment or surveillance monitoring is needed to establish current conditions or to demonstrate trends, it may not provide enough information to meet conservation goals. For example, status monitoring alone does not address reversing the decline of a population or analyzing the impacts of threats in order to reduce them.

Monitoring, whether to collect current inventory data or data to address predictions from a research hypothesis, should not be viewed as a stand-alone activity, but rather as a component of a larger process of conservation-oriented science or management (Nichols & Williams 2006). The collection of monitoring data should be targeted to answer specific, well-defined questions and the link between monitoring data and improved conservation outcomes should be determined in advance. For example, for monitoring to contribute to species recovery, it must be considered in light of a complex set of factors that guide the design and impact of monitoring (Figure 7-1; Lindemeyer et al. 2021).

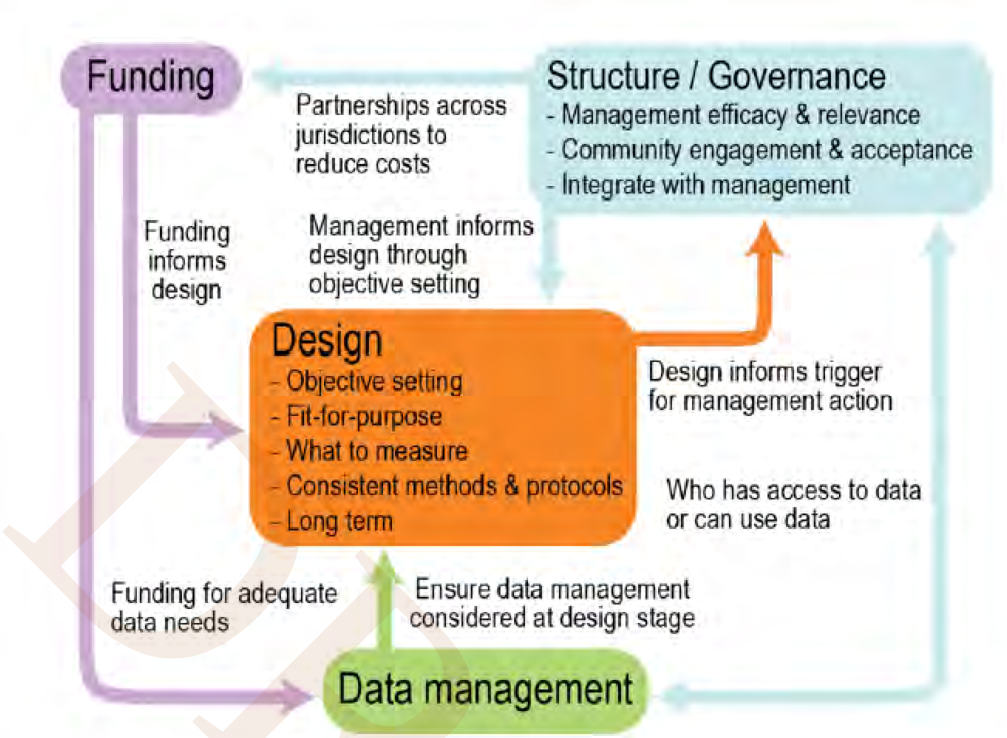

Figure 7.1 Conceptual diagram highlighting the relationships between factors that influence monitoring and recovery of threatened species. Source: Lindenmeyer et al. 2020.

Monitoring to Improve Conservation Outcomes

Monitoring is fundamental in the process of evaluating how conservation actions affect targeted species and habitats. By providing conservation planners the ability to adjust actions and better understand how ecological systems function, monitoring the outcomes of conservation and management activities fits under the bigger picture approach of adaptive management. Adaptive management is a sequential, iterative process that uses monitoring data to improve management actions (Figure 7.2). It can be defined as: “the incorporation of deliberate learning into professional practice to reduce uncertainty in decision making. Specifically, it is the integration of design, management, and monitoring to enable practitioners to systematically and efficiently test key assumptions, evaluate the results, adjust management decisions, and generate learning” (Conservation Management Partnership 2020). Adaptive management includes the process of hypothesizing how ecosystems work, analyzing results from monitoring, and comparing results with action expectations (Williams & Brown 2012). The conservation actions can then be modified to better manage decisions to achieve conservation objectives through the improved understanding of ecological processes (Lancia et al. 1996). This is particularly important for complex natural systems because responses to conservation actions can be difficult to predict, especially when there is uncertainty about current conditions (e.g., unknown threats, unavailable or incomplete population data, unknown species response to habitat alteration).

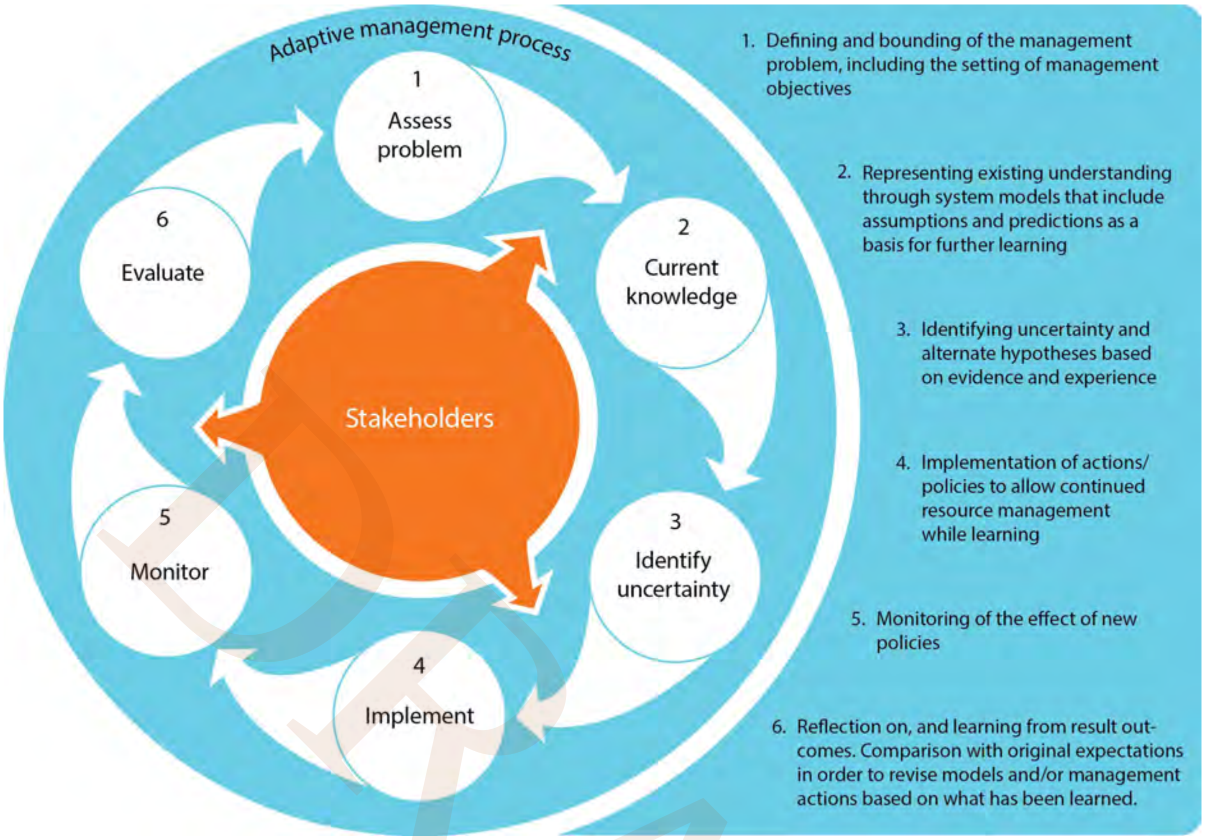

Figure 7.2 The adaptive management process, including the role of monitoring. Source: Rist et al. 2013.

Monitoring clearly plays a critical role in the process of tracking and improving wildlife conservation. An example of how to set up monitoring programs to meet the needs of adaptive management was developed by the Northeast Coordinated Bird Monitoring Partnership to improve conservation for birds (Lambert et al. 2009). These ten steps are suggested to optimize the value of monitoring and to carry out effective conservation:

1) Establish a clear purpose;
2) Determine whether an existing program or protocol meets your needs;
3) Assemble a team of collaborators with complementary interests and skills;
4) Summarize the relationship of target populations to other ecosystem elements, processes, and stressors;
5) Develop a statistically robust approach to sampling and data analysis;
6) Design and pilot standardized field protocols that minimize error and bias;
7) Identify or develop a data management system;
8) Implement the monitoring program;
9) Present results in a format that supports sound management and conservation decisions; and,
10) Evaluate and adjust management and monitoring to make better conservation decisions.

Although this example was developed initially for monitoring birds, these 10 steps provide general guidance for the development of effective and efficient monitoring activities that can directly feed into the adaptive management process and are useful for the conservation of all SGCN and KWHs.

Monitoring of SGCN and their habitats should be targeted to guide future conservation efforts and conducted in a way to make data relevant to scientists and useful to land managers in an adaptive management framework. Continued coordination with the regional development of monitoring programs, protocols, and data management is also critical to maximize the effectiveness and efficiency of monitoring activities for conservation. The use of permanent, centralized regional and national databases for species that range across broad geographic areas, such as Biotics for rare species or the Avian Knowledge Network database for birds, is particularly needed for the exchange and integration of relevant biological data. An evaluation of monitoring for the revised Plan can also benefit from assessing monitoring data management capacity and needs, identifying bottlenecks to integrating monitoring data at a larger scale, and evaluating how well Maryland is meeting best management practices and standards for data management as outlined by Martin and Ballard (2010).

Monitoring Species of Greatest Conservation Need and Key Wildlife Habitats

Monitoring is identified as a priority need for a number of SGCN and their KWHs (see Chapters 5 and 6). This includes filling knowledge gaps for species that are a priority for assessment (SAPS), as listed in Appendix 3b. Maryland is fortunate to have an extensive monitoring system (**Element #5**) already in place for many species, habitats, and environmental parameters, including hundreds of state, federal, local, and grassroots monitoring projects and programs. Appendices 7a and 7b list many of the existing plans and programs that have been developed by local, state, regional, national, or international partners that include monitoring SGCN or their habitat components in Maryland. Many of the conservation actions identified in Chapter 6 and its appendices related to monitoring were developed with these existing monitoring actions/plans in mind, as they provide the majority of the SWAP monitoring framework. Implementation of the SWAP will rely heavily on the existing monitoring projects and programs conducted by MD DNR's partners. Wherever possible, the SWAP recommends and supports the full implementation of partners' plans (e.g., U.S. Fish and Wildlife Service, Atlantic States Marine Fisheries Commission, Partners in Flight Bird Conservation Regions, The Nature Conservancy, and Bat Conservation International), especially those that have recommended or identified standardized monitoring actions and protocols for regional and/or national consistency. These existing monitoring efforts will be utilized as mechanisms to address SWAP conservation actions and implementation partnerships wherever applicable at the local, state, regional, and national levels.

Guidance from past monitoring efforts is invaluable to determine what type of monitoring is needed, appropriate indicators, and the use of standardized methods. Given the many knowledge gaps for SGCN, SAPS, and the inherent difficulty to monitor biodiversity, guidance such as that found in Dudley et al. (2025) and IUCN SSC Species Monitoring Specialist Group (2025) can help to focus monitoring efforts and direct practitioners to standardized protocols and procedures for collecting and analyzing data. Standardized monitoring protocols, such as those of the Breeding Bird Survey and the International Shorebird Survey, will be used wherever appropriate so that Maryland's data will be compatible with regional and national conservation efforts. Regional resources and coordinated data management, described below, provide additional guidance and best practices for monitoring.

Monitoring programs are scale dependent. For example, within each KWH, the most appropriate level of monitoring, whether it is at the species, species group, taxonomic group, habitat, or community level, needs to be identified to best monitor that biotic system at the relevant ecological scale. Implementation of this SWAP also involves monitoring at a variety of geographic scales, including local, state, regional, national, and international, according to the suitability and recommendation of relevant partners' plans and programs. Monitoring programs also need to consider temporal scales to inform management decisions under a changing climate (AFWA 2022). Taxonomic scales (e.g., species, guilds, or natural communities), temporal scales (e.g., how often to measure indicators, how long to monitor to detect changes), and geographic scales (e.g., statewide, regional/multi-state, international) need to be explored to best identify climate change impacts and consequences for SGCN. Promising approaches include working with other states and partners to systematically monitor species and habitats across their entire range using standardized indicators so that data may be more easily integrated and analyzed to recognize trends and impacts to species and ecosystems. Monitoring changes in climatic variables (e.g., microclimate, water levels, hydroperiods, snowmelt, ice-off dates, rainfall) in places where species and habitat data are also being collected can help to determine correlations or causal relationships between climate and ecological changes relevant to SGCN and their habitats. Climate variables that are most likely to be relevant to SGCN and their habitats should be prioritized for monitoring, such as those presented in Staudinger et al. (2024).

Regional Monitoring Coordination

The 2017 SWAP Synthesis drew from the 14 individual Northeast SWAPs to identify the monitoring needs for priority threats, species, and habitats (TCI & NEFWDTC 2017). State specific actions and monitoring needs can all be found in searchable format in the Northeast SWAP Database. Monitoring needs presented in the SWAP Synthesis included: developing regionally coordinated and cost-effective monitoring protocols that meet multiple objectives across states; monitoring changes to the Northeast's land and water resources and how those changes impact wildlife and people; and measuring and reporting the effectiveness of actions to improve and enhance future conservation efforts. Priority needs flagged for further investigation and monitoring in relation to Northeastern Regional Species of Greatest Conservation Need (RSGCN) and Watchlist species and their habitats include: invertebrate biomass decline; impact of insecticide spraying on forest-dwelling vertebrate RSGCN; disease, particularly for reptiles and amphibians, freshwater mussels, crayfish, and mammals; loss of genetic diversity; vulnerabilities of wintering RSGCN; impacts of take and collection; changes in hydrologic regimes; and coastal habitats.

Some of the monitoring needs identified for RSGCN and their habitats have been addressed through Regional Conservation Needs (RCN) Grants. This allows for the consistent and widespread use of common monitoring methodologies and survey protocols to support regional assessments of the status and trends of SGCN and their habitats. Coordinated projects developed and tested protocols for rare wetland butterflies, timber rattlesnakes, wood turtles, and pollinators in certain habitats. Links to monitoring plans and tools developed through the RCN Grant

Program are available on the RCN Final Products website. Current projects include developing protocols for surveys of diamond-backed terrapins and additional pollinator and insect surveys. Maryland is the lead state for both of these projects. More than 120 species or groups of species that occur in the NEAFWA region have standardized monitoring protocols available, listed in Supplemental Information 5 of the Northeast Regional Conservation Synthesis (TCI & NEFWDTC 2023). The updated Northeast RSGCN Database includes information on the availability of standardized monitoring protocols for RSGCN and Watchlist species.

Coordinated Data Management

Maryland DNR and its partner organizations collect and compile a wide variety of biological data that, when integrated with similar data collected by other states, regions, or countries, can greatly enhance the ability to evaluate trends in species population sizes and distribution, habitat losses and gains, and other common parameters across broad geographic areas. Increasingly, partners are working to coordinate survey and monitoring efforts that follow standardized data collection methods and protocols. These data can be used most effectively if centralized databases are developed and maintained where data gathered by multiple agencies can be entered, stored, and accessed by contributing partners through a series of security levels established and controlled by the data owners. Biotics, an integrated, web-enabled platform for tabular and spatial data management, is the most extensive example of a centralized database related to SGCN and KWHs. Used and populated by members of the NatureServe network (especially state Natural Heritage Programs, often part of a state government agency), the system provides built-in support for shared methodology and data standards with a focus on rare species, natural communities, and site conservation planning. Maryland contributes data tracking the status of over 1,250 rare native plants and animals to this database, which is updated daily with the results of inventory, monitoring, and research activities by MD DNR and its partners. This international compilation of over 40 years of monitoring data is publicly available through the NatureServe Explorer website.

Large-scale Monitoring Programs

A number of monitoring programs are coordinated and supported at the national level, with programs for habitat, species, and species groups that overlap with Maryland's SGCN and KWHs (TCI & NEFWDTC 2023). These include the monitoring of environmental conditions by the U.S. Environmental Protection Agency; species and habitats by the U.S. Fish and Wildlife Service; and species, habitats, environmental factors, and diseases by the U.S. Geological Survey. The U.S. Forest Service supports programs for forest condition and the U.S. Department of Agriculture supports monitoring programs for animal and plant pests and diseases as well as the outcomes of management actions. Multiple programs of the National Oceanic and Atmospheric Administration (NOAA) monitor the marine ecosystem, including marine habitats and their species. A comprehensive list of specific agency programs is included in the monitoring chapter of the "Northeast Regional Conservation Synthesis" (TCI & NEFWDTC 2023). Several of the most relevant programs for Maryland are included in Appendices 7a and 7b where monitoring programs for species and habitats are listed.

Monitoring the impacts of broadscale patterns, like climate change, presents a unique challenge. Monitoring to evaluate objectives in climate change is complex as species are simultaneously responding to multiple cues (AFWA 2022). States need to work towards implementing monitoring programs that can inform decisions under a changing climate, with an eye to working together to monitor species and habitats across their entire range. Monitoring suites of abiotic drivers at similar spatio-temporal scales at which species occur is critical to understand when, where, and why changes are occurring and to design management strategies that can respond accordingly (Staudinger et al. 2013). At the habitat level, there may be multiple reasons to protect and manage an area, requiring the assessment of multiple drivers. For example, an area may have complex terrain that provides microclimates or different canopy cover and groundwater inputs that minimize temperature extremes over fine spatial scales (Morelli et al. 2016). Each of these distinct characteristics would need different monitoring objectives to assess the effectiveness of the refugia as climate continues to change (Morelli et al. 2016). In addition, Staudinger et al. (2015) identified various examples of how monitoring can address climate change, as well as other anthropogenic stressors, through specific adaptation strategies and actions. Additional and updated SWAP climate science data and climate resources for SWAPs are available in Staudinger et al. (2024).

Two examples of broad-scale monitoring projects that address climate change impacts are being carried out by members of the general public ("community scientists"), a growing way to monitor and track changes in species responses to climate change, and to supplement existing scientific monitoring networks (Newman et al. 2012). The National Phenology Network (NPN) provides national standardized protocols for collecting phenology observations, advice, and education materials for the collection and organization of new phenology data, and supports the development of tools and approaches for natural resource decision-making. NPN developed *Nature's Notebook* as a community science tool that the general public can use to collect and submit phenology observations on plants and animals nationally. Numerous institutions across the Northeast and Midwest are using NPN's Nature's Notebook tool and contributing to a larger network of monitoring programs to inform an overall understanding of phenological responses to climate change. Budburst, a project of the Chicago Botanic Garden, provides an opportunity to help understand how plants are responding to this year's seasons and longer-term changes in climate by entering data through use of a phone application. Public engagement through community science projects like these increases awareness of conservation and climate issues and can help extend limited resources for activities like monitoring.

Regional, State, and Local Monitoring Programs in Maryland

Existing monitoring programs that track SGCN (Appendix 7a) and KWHs (Appendix 7b) provide critical data to set priorities and formulate protection strategies. Species monitoring programs may focus on individual species or species groups or guilds. Habitat monitoring programs in Maryland include data collection on air and water quality, the habitats of specific SGCN, habitat health, and threats that affect habitats. This network of monitoring programs, which includes aquatic and terrestrial species and habitat monitoring initiatives, provides data for use in conservation planning; federal, state, and local government decision-making; and private sector species and habitat projects. Examples of monitoring tools, programs, and partners are presented below.

The Chesapeake Bay may be one of the most monitored ecosystems in the country, with a wide range of state, federal, local, regional, academic, and non-governmental organizations (NGOs) actively facilitating research and monitoring programs. Recent water quality and habitat quality monitoring data for Chesapeake Bay, the Coastal Bays, and estuarine tributaries (periodic and continuous data) are available online through the state's Eyes on the Bay Monitoring Program. The Chesapeake Bay Monitoring Program, which brings together Maryland, Pennsylvania, Virginia, the District of Columbia, multiple federal agencies, and over 30 scientists, tests for nineteen chemical, physical, and ecological components 20 times each year. The Chesapeake Bay Program maintains a clearinghouse of monitoring data on the Chesapeake Bay's physical, chemical, and living resources. The Chesapeake Monitoring Cooperative team, made up of five partner organizations, is working with new and existing water quality and benthic macroinvertebrate monitoring programs across the Bay watershed to integrate community science data into the Chesapeake Data Explorer. The Chesapeake Bay Program Datahub is the primary tool for searching and downloading environmental data for the Chesapeake Bay watershed.

The 2025 Comprehensive Conservation and Management Plan for Maryland's Coastal Bays formulated a detailed monitoring strategy for the Coastal Bays that builds on existing partnerships between the Maryland Coastal Bays Program, MD DNR, and other state and national programs to present monitoring based conservation actions for the Coastal Bays. In addition to stand-alone research projects that are part of the Coastal Bays Management Plan, monitoring actions drive other conservation actions within categories of education and outreach and policy issues.

Since the 2015-2025 SWAP, a number of additional resources have established or increased an online presence to include the locations and results of monitoring programs, such as The Maryland Water Monitoring Site Mapper, the Maryland Watershed Resources Registry, and the Regional Council on the Ocean (MARCO), which maintains the Mid-Atlantic Ocean Data Portal as an online toolkit and resource center to collate data in a shared information management system for multiple uses. The interactive Stream Health Index Map allows exploration of the results of work by the Stream Waders volunteer program as well as MD DNR Maryland Biological Stream Survey sampling, including the Combined Index of Biotic integrity, Fish and Benthic Biotic Integrity scores, and additional details about land use, physical habitat, water quality, and the biota encountered at each sample site. EcoSHEDS, is housed by the U.S. Geological Survey as a collection of Spatial Hydro-Ecological Data Systems (SHEDS) designed to improve our understanding of stream ecosystems. The website provides access to a series of user-friendly tools that support transparent research, management, and decision-making by linking together one or more hydro-ecological databases, models, and data visualization tools. These and other existing sources of data from monitoring programs for Maryland's coastal and aquatic resources are integral to the SWAP's monitoring framework for key aquatic and wetland habitats and SGCN.

Although extensive monitoring programs for Maryland's aquatic and wetland habitats already exist, fewer monitoring programs support Maryland's terrestrial habitats. MD DNR leads many of these programs and is involved with most terrestrial monitoring programs in the state via the important geographic information system (GIS) tools in which MD DNR specializes. The MD DNR Natural Heritage Program (NHP) tracks hundreds of plant and animal species and natural communities, maintaining a detailed database on their abundance and distribution. Monitoring programs for certain species and taxa groups, such as Puritan and northeastern beach tiger beetles, bog turtles, upland game birds, rare plants, waterfowl, and colonial waterbirds, are ongoing, as are other monitoring programs within the MD DNR Wildlife and Heritage Service. Status and trend data for additional species can be tracked by adapting the existing NHP database or by developing additional data systems, as needed, to include data on the status of all SGCN, research and survey results, and ongoing inventory and monitoring projects. MD DNR habitat and species monitoring are also carried out by Maryland Forest Service, Watershed and Climate Services, Fishing and Boating Services, Maryland Environmental Trust, and Resource Assessment Service.

Additional monitoring programs for SGCN and KWHs are carried out by many partners across the state (Appendices 7a and 7b), including engaging the public in monitoring activities to the benefit of both monitoring objectives and public knowledge of Maryland's wildlife. Federal monitoring partners include the U.S. Geological Service Eastern Ecological Science Center, National Park Service, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, and National Oceanic and Atmospheric Administration. Pest organisms and the outcomes of practices on agricultural lands are monitored by the U.S. Department of Agriculture. The U.S. Army monitors fish, wildlife, and submerged aquatic vegetation (SAV) habitats at its Aberdeen Proving Ground. Local governments, including county environmental programs, and NGOs provide as well as public engagement through activities like bioblitzes. These one-day programs engage participants in community science around the state, as participants canvas specified state parks, county parks, wildlife refuges, and other natural areas to identify plants and wildlife. With 120 monitoring programs for species/species groups and just over 100 programs for habitats, coordination between all partners is critical to better implement the SWAP's monitoring framework.

Addressing Monitoring Gaps

It is impractical and inefficient to have individual and separate monitoring actions for each of the many SGCN and KWHs. It is more practical to develop an effective monitoring framework or strategy that monitors the status and condition of select species and habitats, conservation action effectiveness, and, finally, the incorporation of new information into the SWAP. Developing programs and strategies to monitor species, species groups, and KWHs must be done in the context of measuring the effectiveness of conservation actions. As SWAP implementation proceeds, monitoring needs related to priority conservation actions (Chapter 6 and Appendices) will be reviewed, and alternatives for implementing monitoring and conservation actions will be developed to benefit the overall KWH, community, and/or assemblage, including many of the other SGCN, in order to maximize limited resources and maintain practicality and efficiency.

To begin the process of review, priority conservation actions for monitoring can be matched with existing monitoring programs in Tables 7.1 and 7.2, as well as regional programs, to see if these programs are already meeting needs or can be modified to better meet SWAP priorities. Despite the many local and regional monitoring programs in Maryland, monitoring data may still be lacking because 1) programs do not exist, or 2) monitoring programs exist, but they are not part of a defined adaptive monitoring framework that addresses particular conservation priorities. In cases where not enough information exists to monitor a SGCN or KWH, or monitoring protocols have not yet been developed, this need has been documented and followed by a research action or other conservation action to address that information need (Chapter 6). This is true for some taxa groups, such as small mammals and especially invertebrate groups, for which standardized protocols need to be developed and for taxa where baseline data do not exist to form the basis of a monitoring protocol. In these cases, high priority taxa research or data needs/gaps have been identified by taxa experts, planners, and stakeholders (see Chapters 3, 6, and appendices). If monitoring programs do not currently exist for a SGCN or taxa group, viable options may exist to monitor closely-related species occupying the same habitats; monitor appropriate indicator species or other ecological indicators (Dale & Beyeler 2001; Carignan & Villard 2002); monitor threat reduction (Salafsky & Margoluis 1999); or use a multiple species-natural community approach (Barrows et al. 2005).

Since the 2015-2025 SWAP, technological advances have greatly increased the availability of practical, affordable tools for monitoring species and habitats (reviewed in Rout et al. 2022). For example, the widespread use of passive acoustic monitors such as Automated Recording Units (ARUs), coupled with increasingly efficient and robust identification of recorded sounds (Sarab et al. 2023), has increased our ability to monitor species in remote areas and over long periods of time. These methods have been employed in Maryland for secretive marshbird SGCN as well as several bat SGCN. The use of machine-learning and artificial intelligence algorithms has greatly reduced the time needed to analyze the large data sets generated by ARUs and also the many images generated from camera surveillance footage. The availability of Unmanned Aerial Vehicles (drones) is also changing the face of monitoring, with applications for monitoring habitat change as well as species inventory, including in inaccessible areas (Hodgson et al. 2016). The miniaturization of tracking devices and installation of more and more towers to detect passing migrating bats, birds, and even monarch butterflies has made the monitoring of large-scale movements as well as small-scale habitat use possible, largely through the Motus project (Taylor et al. 2017). Most promising is to use a combination of nature technologies including remote sensing, geographical information system, satellite data, eDNA and other molecular approaches, camera traps, passive acoustic sensors, artificial intelligence, and GPS monitors to augment traditional biodiversity measurements (Rout et al. 2022). An interesting approach for areas that are challenging to access is being developed by Dr. Matt Fitzpatrick at the University of Maryland Center for Environmental Science, Appalachian Lab, to create an automated system that uses machine learning, massive biological surveys, and remote sensing to map, monitor, and predict biodiversity changes in real time to contribute to monitoring for the Central Appalachians. The use of these technologies and integration of information to address species, habitat, and effectiveness will be considered to address monitoring needs identified in Chapter 6 and appendices.

An additional aspect of monitoring that has developed since the 2015-2025 SWAP is the opportunity to involve community members as data collectors. For example, the monitoring of breeding birds during the 2020-2024 Breeding Bird Atlas project, which provided data to assess the status of a number of SGCN birds, was carried out by volunteers using the eBird electronic data collection app on cellular phones. To date, more than 1.3 million records for over 22,000 species in Maryland have been contributed to the Maryland Biodiversity Project, many of which have been collected by the general public. The increasing use of volunteer community scientists in recent years has been evaluated and refined, and a number of resources are now available for widespread data collection as well as how to best coordinate and support the participation of diverse contributors (e.g., Danielson et al. 2021, Atsumi et al. 2024, Sigouin et al. 2025).

Monitoring Outcomes and Effectiveness Measures

Measuring the success of the Maryland SWAP is a challenging endeavor that requires assessing the results of individual conservation actions, as well as the overall impact of implementing the Plan. This is a challenging but critical part of effective conservation. Planning projects as part of a portfolio of actions to address conservation needs for SGCN and their habitats is a promising approach, especially given the large number of SGCN and conservation actions identified in this plan. One approach to link common goals with common indicators to measure aggregated conservation impact has been proposed by Stephenson (2019). This approach includes consideration of the following five steps:

1) Planning: developing a shared vision and measurable goals and objectives that are linked to higher-level program goals and objectives;
2) Using common indicators: identifying indicators that can be used to aggregate results;
3) Monitoring: collecting data to measure indicators, ideally in a way that makes data sharing and aggregation easier;
4) Interpretation: presenting data in a format that is useful to program managers, decision-makers, and on-the-ground resource managers (e.g., maps and dashboards); and,
5) Action: using data to evaluate progress and make adaptive management decisions.

The use of this approach can help organizations design projects with goals, objectives and indicators that are shared across a portfolio of sites, habitats, and/or species in order to measure overall effectiveness. Given the breadth and number of monitoring actions being carried out in Maryland, the shared vision and objectives included in the SWAP provide an excellent starting point for coordinating monitoring and the measurement of conservation outcomes through collective effort.

Maryland's assessment strategy (**Element #5**) involves a long-term commitment to the success of the SWAP. Populations that have been declining for decades may take decades to reverse and, therefore, many decades pass before the results of conservation actions can be fully realized. Thus, an effective assessment strategy incorporates the concept that many conservation actions involve different temporal scales; both short-term conservation actions as well as long-term strategies are necessary to bring about the conservation of SGCN and KWHs. Furthermore, differing geographic scales need to be taken into account. To provide measures of effectiveness at these different scales for use in adaptive management, the Association of Fish and Wildlife Agencies (2012) recommends developing a "theory of change" linking actions to their ultimate desired impacts. This can be achieved through a five-step process:

1) Define the conservation action;
2) Describe, via a results chain, the theory of change as to how the action will lead to desired impacts;
3) Identify a limited set of effectiveness measures to assess progress at key points throughout the life of the project;
4) Develop and test effectiveness measures to ensure they provide meaningful information within existing human, legal, and financial constraints; and,

5) Collect, analyze, and share data about the effectiveness measures to show whether or not the conservation action achieved the desired impact, why it succeeded or failed, and how implementation of the action can be improved over time under different conditions.

Using this system, if the activity provides the expected results, effectiveness measures help to communicate success so that others may follow suit. Besides having more effective and efficient conservation actions, tracking the success of actions helps to ensure the most efficient use of limited staffing and funds.

To measure large-scale results and overall effectiveness measures, metrics developed for the region, including the regional approaches outlined below, will be used. Some examples of measurable outcomes related to long-term goals are listed in Table 7.1 by conservation action category (see Chapter 6 and appendices for more information about conservation actions in SWAP). In a broad sense, performance measures generally relate to success in conserving land, amassing scientific knowledge, funding conservation priority projects, increasing involvement of the public and partners, and reducing threats to SGCN and their habitats.

Table 7.1 Examples of performance measures developed to assess effectiveness of conservation activities.

Conservation Action Category	Examples of Performance Measures
Land and Water Acquisition and Protection	• Percentage of protected lands where management plans are being implemented • Percentage of land acquisitions that minimize habitat fragmentation • Number of acres of prioritized land purchased, leased, or put into easement that are BioNet priority tiers • Number of acres protected that are SGCN habitat • Number of agreements with private landowners
Law and Policy	• Number of enforcement actions related to laws and regulations that reduce illegal harvest of SGCN or destruction of habitat • Number of laws and policies enacted to address threats identified in the Plan • Measures of positive responses of SGCN and KWHs to improved law and policy changes, including reduction of key threats and impacts
Direct Management of Natural Resources	• Number of acres or river miles restored/converted to target habitat • Number of dams removed • Acres or stream miles of invasive species removal • Number of active volunteers trained in invasive species survey and removal • Number of management actions implemented as planned • Indication that the direct management action is reducing key threats • Number of acres burned; indication that target species (post-burn) has benefitted from action • Species response (e.g., population size, nest success) of SGCN to direct management actions

	• Key habitat targets/processes (e.g., size, condition) response to direct management actions • Number of bat boxes built and installed; number of bats using structures
Planning and Administration	• Number of acres protected for SGCN conservation • Number of KWH management plans developed/implemented • Number of SGCN conservation plans developed/implemented • Number of grants administered/completed • Number of conservation plans using/implementing BioNet • Number of local government and municipal plans incorporating SGCN and habitat conservation
Data Collection and Analysis – Inventory, Monitoring, and Research	• Number of surveys/inventories focused on SGCN • Number of surveys/inventories focused on KWHs • Number of research projects focused on SGCN • Number of research projects focused on KWHs • Indication that researcher provides clear answers to research questions • Confirmation that data are used to develop and inform conservation action recommendations
Education, Outreach, and Technical Assistance	• Number of education, outreach, and technical assistance actions implemented • Indication that education, outreach, and technical assistance changes are achieving increased awareness, behavior change, participation, and other anticipated outcomes • Number of landowners signing up, or continuing their training for landowner assistance programs • Number of acres managed for SGCN in Wildlife Management Areas • Number of Master Naturalist participants
Actions to Address Climate Change	• Incorporation of adaptation strategies into local government and state land management plans • Acres protected for marsh migration corridors • Acres of island created • Acres of marsh protected from sea level rise • Number of conservation plans including actions to address climate change • Number of species with highest vulnerability scores addressed by MD DNR or partner conservation plans

For conservation actions related to more specific conservation targets, such as priority conservation actions for groups of SGCN and KWHs, the five-step process described above, including ‘results chains’, provides the framework that MD DNR can use to develop performance measures. Results chains (Foundations of Success 2007; Margoluis et al. 2013; Salafsky & Margoluis 2021) are graphical diagrams that link actions to the desired impacts through a series of short-, medium-, and long-term results in an “if-then” fashion. Building a results chain starts with a specific conservation action, then links are added to related threats, species, and habitats. Indicators and effectiveness measures are selected for key steps in the results chain, providing both intermediate, shorter-term and ultimately, longer-term measures of success.

Using Regional Approaches to Monitor Effectiveness in Maryland

The Monitoring and Performance Reporting Framework

NEAFWA (Northeast Association of Fish and Wildlife Agencies) developed a Monitoring and Performance Reporting Framework (NEAFWA 2008), intended to help each Northeast state meet the expectations set by Congress and the USFWS for State Wildlife Action Plans. The goal of this framework is to assess the status and trends of SGCN and their habitats across the Northeast states, and to evaluate the effectiveness of activities intended to conserve species and habitats across the Northeast. The monitoring framework identified eight conservation targets (defined as species, landscape features, or vegetation communities important to fish and wildlife): forests, freshwater streams and river systems, freshwater wetlands, highly migratory species, lakes and ponds, managed grasslands and shrub lands, regionally significant SGCN, and unique habitats in the Northeast. For each target, key threats were identified, along with conservation actions that could help alleviate or eliminate the effects of that particular stressor. Indicators were proposed for tracking status and trends of each of the targets, and data sources were identified for each of the indicators (NEAFWA 2008). Table 7.2 from NEAFWA (2008) lists the indicators, including stressors, which were selected by workshop participants for each of the eight conservation targets (TCI & NEFWDTC 2023). Data sources for indicators appropriate to Maryland that can be used to monitor effectiveness of the SWAP were identified as part of a SWG project. In Table 7.2, indicators with existing and relatively complete Maryland-specific data are indicated in bold text. The Nature Conservancy assessed these eight conservation targets as part of the Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape: Implementation of the Northeast Monitoring Framework (Anderson & Sheldon 2011). The Nature Conservancy updated this condition assessment in 2023 with new information and analysis tools (Anderson et al. 2023). By utilizing standardized techniques and datasets, the Northeast Monitoring and Performance Reporting Framework provides a consistent and regional assessment of priority species and their habitats for landscape level collaboration and the regional context in SWAPs.

Table 7.2 Conservation targets and proposed indicators for the Northeast. Bold text indicates that relatively complete data specific to Maryland are available. Source: NEAFWA 2008.

Targets	Proposed Indicators
Forests	**1a. Forest area - by forest type** **1b. Forest area - by reserve status** 2. Forest composition and structure - by seral stage **3. Forest fragmentation index** **4. Forest bird population trends** 5. Acid deposition index
Freshwater streams and river systems	**1. % impervious surface** **2. Distribution and population status of native Eastern brook trout** **3. Stream connectivity (length of open river) and number of blockages** **4. Index of biotic integrity** 5. Distribution and population status of non-indigenous aquatic species

Freshwater wetlands	**1. Size/area of freshwater wetlands** **2. % impervious surface flow** 3. Buffer area and condition (buffer index) 4a. Hydrology - upstream surface water retention **4b. Hydrology - high and low stream** **5. Wetland bird population trends** **6. Road density**
Highly migratory species	1. Migratory raptor population index 2. Shorebird abundance **3. Bat population trends** 4. Abundance of diadromous fish 5. Presence of monarch butterfly
Lakes and ponds	**1. % impervious surface/landscape integrity** 2. % shoreline developed (shoreline integrity)
Managed grasslands and shrub lands	To be developed
Regionally Significant Species of Greatest Conservation Need	1. Population trends and reproductive productivity of federally listed species **2. State-listing status and conservation status ranks of highly imperiled wildlife** 3. Population trends of endemic species
Unique habitats	**1. Proximity to human activity/roads** 2. Wildlife presence/absence 3. Wildlife population trends **4. Land use/land cover changes**

State Wildlife Grants Effectiveness Measures Project

Building on the success of the Northeastern Regional Monitoring and Performance Measures Framework (NEAFWA 2008), the Association of Fish and Wildlife Agencies (AFWA) led an effort to develop an approach for measuring the effectiveness of wildlife conservation activities funded under the USFWS's SWG program. In September 2009, AFWA's Teaming with Wildlife Committee formed the Effectiveness Measures Working Group. This working group included representatives from state fish and wildlife agencies as well as private, academic, and non-governmental conservation partners with expertise in wildlife conservation and performance management.

In April 2011, the working group released a final report that outlines a comprehensive approach to measure the effectiveness of the activities funded under the SWG program, which was outlined above as a proposed approach to monitor effectiveness of the Maryland SWAP at different scales. The report builds on the monitoring framework that was originally developed in the Northeast states and recommends a set of common indicators for measuring status, trends, and/or effectiveness of thirteen general types of conservation actions that are commonly supported by SWG. These actions include direct management of natural resources, species restoration, creation of new habitat, acquisition/easement/lease, conservation area designation, environmental review, management planning, land use planning, training and technical assistance, data collection and analysis, education, conservation incentives, and stakeholder involvement. The report includes sample templates and forms that could be used for reporting the results of conservation activities funded through SWG, as well as a discussion of the specific methods by which these reporting methods could be incorporated into the USFWS's grants management database (TCI & NEFWDTC 2023). Whenever possible, conservation outcomes will be entered into state or regional tracking databases that are developed before the next SWAP revision.

Wildlife TRACS

The State Wildlife Grants Effectiveness Measures Project informed the development of Tracking and Reporting Actions for the Conservation of Species system (TRACS), a database designed by the USFWS to record information about conservation activities funded through the Wildlife and Sport Fish Restoration Program, including State Wildlife Grants. TRACS provides modules that track and report project outputs, effectiveness measures, and species and habitat outcomes. The Reports module provides users with the ability to view and export TRACS system data as itemized reports. Accomplishment reports include Featured Accomplishment Reports for curated data that address frequently requested program metrics, and Program Accomplishment Reports by Strategy that include all TRACS strategies, objectives, and activities. Reports are available at the national, regional, and state levels depending on each user's TRACS group(s) and permissions. Direct Habitat and Species Management Reports include the total number of acres managed for habitat or species for the creation, enhancement, restoration or maintenance of habitat or biological processes for the benefit of fish, wildlife, their habitats and /or recreational users, including game and non-game species management. The Research, Survey, Data Collection and Analysis Reports include the total number of research investigations for research, survey, collection, and analysis of data. TRACS can be used to track long-term outcomes for species and habitats in Maryland, above and beyond the types of short-term output measures commonly tracked by funding agencies (e.g., number of publications, number of workshops, number of people contacted). TRACS includes its own customized classifications of conservation actions and threats which are based, at least in part, on the classifications developed jointly by the International Union for the Conservation of Nature (IUCN) and the Conservation Measures Partnership.

Northeast Lexicon for Common Planning and State Wildlife Action Plan Database

Wildlife conservation planners in the Northeast states have long recognized a potential ambiguity in many of the terms that are used to describe fish and wildlife conservation activities. In response to the need for standardized terminology, a standard lexicon was developed that provides conservationists with a uniform terminology that accurately and adequately describes the work of state fish and wildlife agencies (Crisfield & NEFWDTC 2022). The lexicon includes a set of common terms that can be used by state wildlife agencies and their partners to describe wildlife conservation activities in the Northeast (TCI & NEFWDTC 2023). The use of this standardized terminology makes it possible to combine information across state lines to measure effectiveness of conservation actions that address wide-ranging species or large-scale threats. The lexicon was also used to create a comprehensive database that includes all species, habitats, actions, and threats from the individual Northeast State Wildlife Action Plans (Northeast SWAP Database) that can be used to plan species and habitat monitoring as well as how to measure the effectiveness of conservation actions at the regional scale.

Measuring Effectiveness by Linking Conservation Actions to Outcomes

Although measuring the effectiveness of a conservation action requires more than counting short-term outputs, it is not possible to rely solely on measures of the ultimate impacts – the status of the species and habitats of interest—to measure effectiveness. This is because as confidence in the measures increases, the cost of measurement and the time required to detect change also increases (Figure 7.3). To solve this problem, the best effectiveness measures require defining a *results chain* that links actions through outcomes to the ultimate impact. The basic components of a results chain are strategies connected to outcomes (objectives) connected to the goal or impact on the target (Conservation Measures Partnership 2020). Data are collected at key steps to assess outcomes from intermediate actions and to determine if elements in the chain need to be revised. The use of results chains contributes to adaptive management and effective conservation by making assumptions explicit, facilitating the development of targeted monitoring plans, and developing action plans that efficiently address conservation priorities (Margoluis et al. 2013). Given the knowledge and effort needed to build conceptual models and results chains, it is most efficient to group priority conservation actions by the threats, species groups, or habitats that they have in common and to create results chains for broader conservation targets and threats. This makes it possible for priority actions identified in Chapter 6 and its appendices to be addressed in a way that provides maximum benefit to multiple species and habitats, and to develop strategies that address multiple threats.

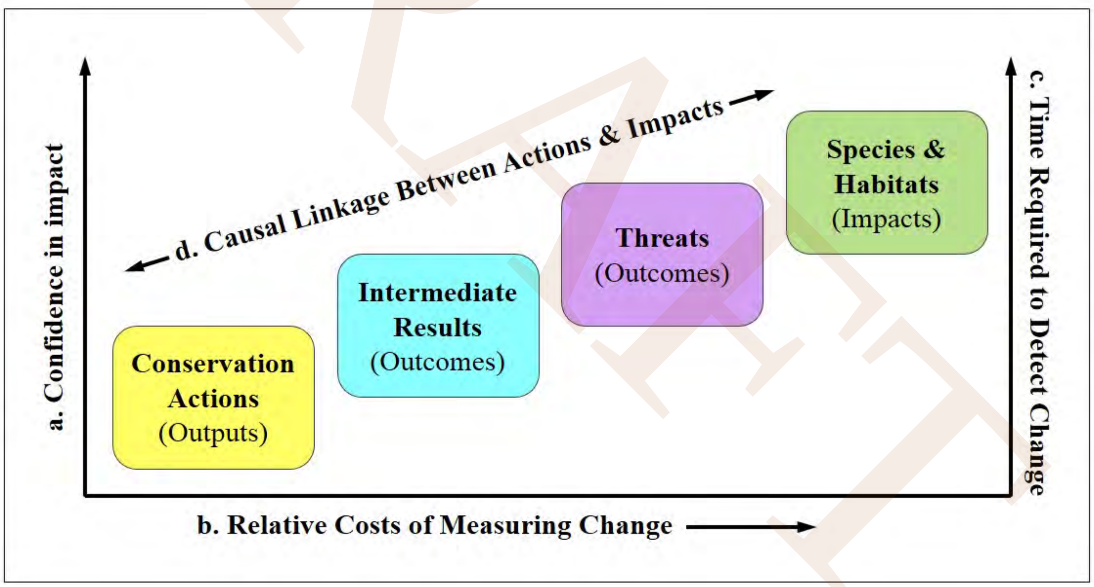

Figure 7.3 Constraints on measuring performance considering linkages between outputs, outcomes, and impacts. Source: Adapted from Association of Fish & Wildlife Agencies 2012.

Since the completion of the 2015-2025 SWAP, habitats have continued to be modified by human activities, including climate change. The emergence of new diseases and changes to threats to species due to illegal trade have further changed the context in which conservation outcomes will be measured. Decisions about how to measure the effectiveness of a conservation action and the best means to monitor results are increasingly being made in a complicated ecological and social context with limited resources. Developing a theory of change is another structured way to articulate goals and objectives to identify monitoring needs, although even informally sketching goals, objectives and other external forces (such as climate change impacts) can help clarify what to monitor (Helmstedt et al. 2025). In order to be effective and to measure the outcomes of monitoring, considering how monitoring and evaluation are connected to the desired conservation outcomes is critical (Figure 7.4). Viewing monitoring and outcomes in a broader, developed theory of change also reveals additional, often overlooked, reasons to monitor and goals for monitoring that can better structure a monitoring program. A full and comprehensive theory of change is likely to have many more arrows than pictured in Figure 7.4, including feedback loops.

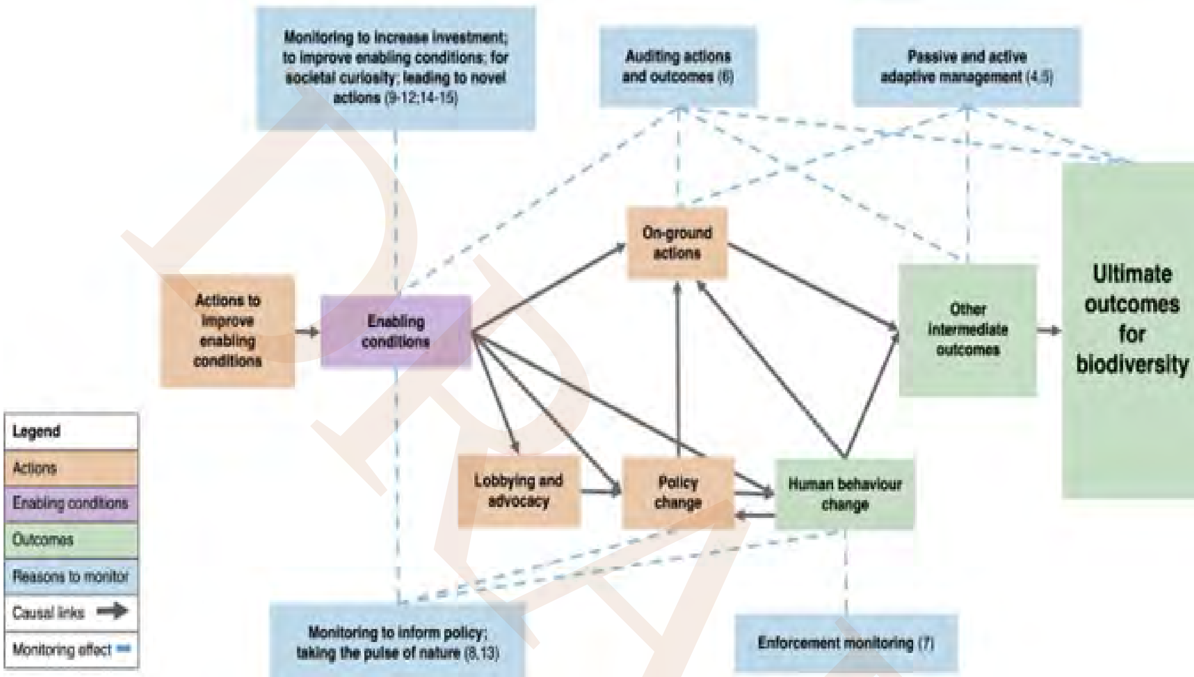

Figure 7.4 Theory of change linking actions to monitoring and biodiversity outcomes. Actions (orange) deliver outcomes (green) that rely on enabling conditions (purple). Monitoring actions (blue) are connected so that their contribution to ultimate outcomes is clear. Source: Helmstedt et al. 2025.

A full theory of change can be complicated and difficult to develop, especially when existing conditions or causal links are not well understood. An intermediate approach might be to reassess the threat impact calculation (see Chapter 3) to document reduced threats which would indicate actions with the desired effect. In this case, a strategic pathway could be defined that illustrates the expected connection between an action that reduces the impact of a threat and results in the desired outcomes (Salafsky et al. 1999; Salafsky & Margoluis 2021). This kind of framework is based on the definition of a theory of change linking the action with intermediate results, threat reduction, and the conservation target outcomes.

These diagrammatic approaches to effectiveness monitoring and to linking monitoring actions for species and habitats to conservation outcomes will be used as the SWAP is implemented, especially when the regional approaches discussed above do not fit the right geographical or temporal scale.

Visualizing Monitoring and Conservation Effectiveness

The effective communication of conservation outcomes can be challenging. Several organizations have developed regular reports, story maps, and report cards to help partners and the public visualize progress towards conservation goals. For example, the Chesapeake Bay Foundation releases a State of the Bay reports every two years. The most recent monitoring report, the State of the Bay 2025 Chesapeake Bay and Watershed Report Card, illustrates the status of 13 monitored indicators in three categories: pollution, habitat, and fisheries resources. Each indicator is given a score compared to pre-Colonial conditions, based on available monitoring data and field observations. The scores of the three indicator categories are averaged and translated into letter grades for communication purposes. The Chesapeake Bay Foundation also monitors progress of meeting the goals and objectives of the Chesapeake Bay Watershed Agreement and releases a Chesapeake Bay State of the Blueprint monitoring report to illustrate progress towards Agreement goals. The Maryland Department of the Environment Water Quality Assessment Report and Water Quality Assessment Map help the public and partners to be informed about current conditions and where practices are being effective. The University of Maryland Center for Environmental Science has developed a number of report cards that show the outcomes of monitoring and progress towards environmental goals. Story Maps, such as those developed for migratory shorebirds by the Western Hemisphere Shorebird Reserve Network, provide the means to demonstrate outcomes as well as monitoring data over large spatial scales for migratory species. The Susquehanna River Basin Commission Story Maps provide the opportunity to explore monitoring outcomes from multiple projects, from water quality to eDNA projects, for a particular geographic area. Interactive mapping tools like U.S. Geological Survey's Siren can help to target monitoring and also illustrate where conservation actions are taking place for invasive species. As the SWAP is implemented, MD DNR will explore how to best show progress on monitoring goals and conservation outcomes as a way to inform partners and engage the public.

This chapter and its appendices provided an overview of approaches and strategies for monitoring Maryland's Species of Greatest Conservation Need (SGCN), their habitats, and the effectiveness of implemented conservation actions, addressing **Element #5.** It also described the use of monitoring data in an adaptive management framework to assess and improve the effectiveness of conservation actions. Chapter 8 will provide information relating to **Elements #7** and **#8** regarding coordination with and participation of partners and the public during the Plan's review and revision process.

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Chapter 8

Revision Process and Outreach

MARYLAND

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Introduction

Although the Maryland Department of Natural Resources (MD DNR) was the lead on the development of the State Wildlife Action Plan (SWAP or Plan), this Plan serves as a *statewide* guidance document for use by all agencies and organizations that work to conserve Maryland's species and habitats. Actions included in the Plan (Appendices 6a and 6b) are meant to be implemented by a wide range of partners, across Maryland and beyond. Furthermore, the 2025 revision of Maryland's SWAP would not have been possible without the hundreds of volunteer hours provided by partner organizations, academics, community scientists, and more.

This chapter begins with a brief overview of MD DNR's conservation partners, regardless of whether they directly contributed to the SWAP revision's content. Specifically, it describes coordination with federal, state, and local agencies and Native American tribes that manage significant land and water areas within the state and/or administer programs that affect the conservation of Species of Greatest Conservation Need (SGCN) and their key wildlife habitats (KWHs) (**Element #7)**. This chapter then provides a thorough description of the partner and public participation process in the review and revision phases of Maryland's SWAP (**Elements #7 and #8**). A full list of organizations that participated in the 2025 SWAP revision can be found in Appendix 8a. Details on how partners and the public will be involved in the Plan's implementation can be found in Chapter 9.

Maryland Department of Natural Resource's Partners in Conservation

The Maryland Department of Natural Resources collaborates with numerous partners in natural resource conservation efforts. Such partnerships are essential to support the research, communication, and action that drive wildlife conservation at local, state, national, and international levels. A summary of these partnerships and their functions are described in the following section, followed by a brief discussion of non-governmental conservation partners.

Nearly all SGCN and key wildlife habitats (KWHs) extend beyond Maryland's borders, making partnerships a necessity for successful natural resource conservation. At the national level, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) are the lead agencies for the conservation of federal trust species found in Maryland and elsewhere. The USFWS, National Park Service (NPS), National Oceanic and Atmospheric Administration (NOAA), and the Bureau of Land Management (BLM) are also among the federal landowners in Maryland, managing key habitats on the ground to protect fish and wildlife resources. MD DNR regularly collaborates with these and other federal agencies (e.g., Department of Defense installations, U.S. Army Corps of Engineers [ACOE]) to implement restoration projects and manage habitats on their lands (i.e., direct management of natural resources). The ACOE, for example, is instrumental in assisting the state to restore habitats like Small Coastal Plain Islands, as well as larger Artificial Impoundments and Wetlands such as Hart-Miller Island and Poplar Island in the Chesapeake Bay. The U.S. Environmental Protection Agency (EPA) and U.S. Geological Survey (USGS) are key partners with Maryland in improving the water quality and resources of the Chesapeake Bay, as are the five other states in the Chesapeake Bay watershed and local governments in these states. The USFWS, NOAA, U.S. Department of Agriculture (USDA), and Natural Resource Conservation Service (NRCS) provide technical and financial assistance to the state, its partners, and its citizens to manage, enhance, and restore fish and wildlife resources and habitats.

On a regional level, state conservation agencies in the Northeast have established a broad range of partnerships for fish, wildlife, and habitat conservation, including Partners in Flight for birds, Northeast Partners for Amphibian and Reptile Conservation, Northeast Bat Working Group, the Joint Ventures and Atlantic Coast Fish Habitat Partnership for migratory bird and fish conservation, and the U.S. Department of the Interior's Landscape Conservation Cooperatives. Regional coordinating bodies, such as the Northeast Association of Fish and Wildlife Agencies (NEAFWA) and its Fish and Wildlife Diversity Technical Committee (NEFWDTC), which operate on a separate and broader level than the individual partnerships, have been a driving force behind these and other wildlife conservation initiatives. Wildlife management agencies from the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia, as well as the District of Columbia participate in NEAFWA. NEAFWA, one of four regional affiliates of the Association of Fish and Wildlife Agencies (AFWA), is tasked with promoting and coordinating conservation activities across the Northeast U.S. The NEFWDTC has led wildlife diversity conservation projects for the NEAFWA and is composed of the Wildlife Diversity representative from each Northeast state and the District of Columbia. Maryland is also a member of the Northeast Section of the NatureServe Network, which has affiliates in most state agencies or other institutions (e.g., universities) throughout North America. Member organizations of this Network compile and analyze species and natural community data in a standardized data system, and develop status assessment information (e.g., global and state conservation status ranks) for imperiled resources.

Aside from the regional coordinating bodies, the Chesapeake Bay watershed also has several regional partnerships that focus on funding, developing, and implementing plans and projects in and around the Chesapeake Bay. These include the Chesapeake Bay Program (CBP), Chesapeake Bay Commission (CBC), Chesapeake Watershed Investments for Landscape Defense (WILD) Program, Chesapeake Conservation Partnership (CCP), Susquehanna River Basin Commission (SRBC), Chesapeake Conservancy, Chesapeake Bay Foundation (CBF), and various Waterkeeper groups. These groups provide much-needed coordination, funding, legislation, advocacy, and more for natural resources in the Chesapeake Bay watershed.

At the state level, MD DNR collaborates with the Maryland Department of the Environment (MDE) on water quality issues, wetland conservation, review of permits, and Bay restoration projects. The Maryland Department of Transportation (MDOT) and other state agencies work with MD DNR to protect fish and wildlife resources by avoiding, minimizing, and mitigating impacts during the construction of state-permitted projects. The Maryland Department of Agriculture (MDA) oversees the state's aquaculture programs, manages pest species and animal health, and collaborates with MD DNR and private landowners in nutrient management, land preservation, invasive species management, pest management, habitat restoration, and wildlife enhancement projects.

Although currently no Native American tribes indigenous to Maryland are federally recognized, the state officially recognized the Piscataway Indian Nation and the Piscataway-Conoy Tribe in 2012, the latter of which includes three subtribes. This was followed by recognition of the Accohannock Tribe in late 2017 (MSA 2026). The Maryland Commission on Indian Affairs (MCIA) serves all American Indian/Alaska Native people of the state. Its threefold mission is to

(1) serve the interests of the Native American communities in Maryland, partially through aiding in the process of obtaining legal recognition; (2) promote awareness and better understanding the contributions of Native Americans to Maryland, both historic and contemporary; and (3) assist state, local, and private agencies in providing the necessary resources to address the educational, social, and economic needs of Native American communities (GOCI 2026). As the representative entity for these indigenous stakeholders, MCIA was invited to participate in the SWAP process and review the draft material for the Plan.

At the local level, MD DNR collaborates with 23 county agencies and Baltimore City, plus over 150 local municipalities. Collaborative efforts include various planning and zoning requirements, such as the development of local Comprehensive Plans, as well as more detailed Land Preservation and Recreation Plans. MD DNR frequently provides technical guidance to assist with the conservation of the state's fish and wildlife resources and the key habitats they depend upon. For instance, the establishment of Habitat Protection Areas provides protection for and information about areas important for conservation within the Critical Area of the Chesapeake Bay and Atlantic Coastal Bays. Coordination at the local level includes communication with county staff in fields related to environmental protection and resource management. The Maryland-National Capital Park and Planning Commission is another partner agency that develops and operates public park systems and provides local land use planning for the great majority of both Montgomery and Prince George's counties. All other Maryland counties and Baltimore City manage open spaces that contribute to wildlife conservation, and over 30 nature centers operated by local governments provide important opportunities for environmental education.

The successful conservation of fish and wildlife resources in Maryland would not be possible without partnerships with non-governmental organizations (NGOs), universities, private industry, academia, and the public. To name a few, The Nature Conservancy, Maryland Coastal Bays Program, Audubon Mid-Atlantic, Maryland Ornithological Society, Maryland Bird Conservation Partnership, Ducks Unlimited, Quail Forever, Maryland Native Plant Society, Maryland Biodiversity Project, Natural History Society of Maryland, Sierra Club, Susquehannock Wildlife Society, Izaak Walton League, various land trusts, various river/waterkeepers, and other NGOs are not only stakeholders in the protection of the state's natural resources, but also valuable partners in planning, funding, and implementing conservation projects. All of these organizations were invited to participate in the 2025 SWAP revision process, and the vast majority were able to do so.

MD DNR maintains ongoing partnerships with universities, museums, zoos, botanical gardens, and experts statewide, as well as in surrounding states. For example, MD DNR works with University of Maryland Center for Environmental Science Appalachian Lab, Towson University, Frostburg State University, Maryland Zoo, Oglebay Good Zoo in West Virginia, Schiele Museum of Natural History & Planetarium in North Carolina, and Mt. Cuba Center botanical gardens in Delaware on various research projects involving SGCN and key wildlife habitats. Taxonomic experts from the Smithsonian Institution and private consultants have assisted with projects and conservation planning. Industry representatives from timber companies, the energy sector, and development interests assist the state in conserving fish and wildlife resources on private lands. Perhaps the most important of all partners, the citizens of Maryland provide the state with opportunities to protect natural resources on private property and benefit from grass-roots efforts to monitor threats, assess ecosystem health, enhance key wildlife habitats, and improve species populations.

Coordination with Partners and the Public in the SWAP Development Process

MD DNR's Natural Heritage Program (NHP) in its Wildlife and Heritage Service (WHS) coordinated Maryland's SWAP revision. Like the previous SWAP revision process, a project coordinator was hired to oversee the process and an informal development team. A number of MD DNR staff—most from NHP, though not all—were considered the lead points of contact for various taxonomic groups. This group of "taxa team leads," along with some supporting staff, became the informal development team over the course of the revision process. Table 8.1 contains the list of these lead MD DNR staff members, although many more MD DNR staff contributed to the SWAP than are included in this table.

Table 8.1 Lead MD DNR SWAP team members

Name	Position Title	MD DNR Unit/Program
Mimi Sanford	SWAP Coordinator	WHS NHP
Matt Ashton	Natural Resources Biologist	RAS MBSS*
Gwen Brewer	Science Program Manager	WHS NHP
Lynn Davidson	Conservation Technology Manager	WHS NHP
Brian Durkin	Natural Resources Biologist	WHS NHP
Max Ferlauto	State Entomologist	WHS NHP
Chris Frye	State Botanist	WHS NHP
Mark Hall	Central Region Ecologist	WHS NHP
Chloe Jacobson	Marine Mammal & Sea Turtle Stranding Response Biologist	FABS*
Jay Kilian	Natural Resources Biologist	RAS MBSS*
Dana Limpert	Eastern Region Ecologist	WHS NHP
Jonathan McKnight	Associate Director	WHS NHP
Jason McNees	Information Manager	WHS NHP
Beth Schlimm	State Herpetologist	WHS NHP
Kevin Stohlgren	State Zoologist	WHS NHP
Joshua Tabora	Furbearer Biologist	WHS Game Management
Amanda Weschler	Marine Mammal & Sea Turtle Stranding Coordinator	FABS*
Angel Willey	Coastal Fisheries Program Manager	FABS*
Megan Zagorski	Western Region Ecologist	WHS NHP

[*] = Resource Assessment Service (RAS), Maryland Biological Stream Survey (MBSS), Fishing and Boating Services (FABS)

Maryland's 2025 SWAP revision process began with internal MD DNR WHS kickoff meetings in the late fall of 2024. The effort to obtain input was then expanded to non-WHS staff, established MD DNR partners, new potential partners, academics, community scientists, and other partners through a series of emails, personal contacts, and meetings. For more information as to how the list of invitees was determined and how this outreach was conducted, please see the "Outreach and Coordination for the 2025 SWAP" section later in this chapter.

The three major SWAP sections most in need of stakeholder input during the revision process were the SGCN, threats, and conservation actions. The processes undertaken to determine the content of these sections are described below.

The Process for Identifying SGCN for the 2025 SWAP

Selection of SGCN in Maryland began with reviewing the previous 2015 SGCN list. Review of these species, using the guidance criteria explained in Chapter 3, provided an introductory understanding of species changes over the last ten years. Decisions about which species to include on the draft 2025 SGCN list relied heavily on a review of the species' current conservation status, based on both state and global conservation ranks. The best available quantitative and qualitative data regarding status, abundance, distribution, and population trends for many species in the state were considered to confirm conservation status and preliminary SGCN selection. Further justification for changes (i.e., additions and deletions) to the 2015 SGCN list, other than changes in conservation or legal status, included new discoveries and research findings since 2015; an increase (or decrease) of existing threats (e.g., illegal trade, habitat loss/fragmentation); and new, emerging threats (e.g., novel pathogens, energy sector changes, loss of host species due to non-native pests). In addition, species on the Northeast regional SGCN (RSGCN) list and priority species from taxa-specific groups, conservation partners, and regional conservation plans were evaluated for inclusion on Maryland's 2025 SGCN list.

New to the 2025 SWAP is the State Assessment Priority Species (SAPS) list. The inclusion of this list was recommended by the "2022 Northeast Lexicon" (Crisfield & NEFWDTC 2022). It is essentially a list for data deficient species for which more information is needed to fully understand their status, trends, and associated threats and actions. Therefore, part of the SGCN list review involved the selection of which data deficient species from the 2015 SWAP belonged on the SAPS list, as well as which new species should be added. For a more detailed explanation of the SAPS list and the criteria used to determine its contents, please refer to Chapter 3. For the full SGCN and SAPS lists, see Appendices 3a and 3b.

This initial review of the SGCN list was done through a series of "taxa team" meetings led by the MD DNR staff listed in Table 8.1. Most of these meetings were held in the winter of 2024–2025. In order to accommodate the needs of the different taxa teams, meetings ranged in length from day-long to one hour, in format from in-person to virtual, and in size from fewer than 10 attendees to more than 40. These meetings were split based on taxonomic groups and included, in chronological order:

- Freshwater mussels
- Mammals (small mammals and carnivores)
- Bats
- Crayfish
- Freshwater fish
- Marine/tidal fish

- Moths
- Aquatic insects (mayflies, stoneflies, and caddisflies)
- Butterflies
- Herpetofauna (amphibians, turtles, and snakes/lizards)
- Beetles
- Dragonflies and damselflies
- Cave and groundwater invertebrates
- Fireflies
- Birds
- Bees

Prospective meeting attendees were provided with the relevant taxonomic group's 2015 SGCN list (and, in most cases, the 2015 threat–action list as well; see below for more details) in advance, as well as a brief explanation regarding the criteria for the SGCN and SAPS lists. During the meetings, after an overview of the meeting's goals and the criteria for each list, team leads led attendees through species on the 2015 SGCN list one-by-one, reviewing changes to each species' various statuses/ranks, abundance, distribution, trends, and associated threats. Meetings also included the review of species for addition that had been suggested in advance by team leads and attendees. The process of determining the species lists for plants and some groups of invertebrates was slightly different; please see Chapter 3 for more details.

Species from the 2015 SGCN list that no longer met the criteria were either removed or moved to the SAPS list; species that were deemed to meet the guidelines for listing as SGCN in this revision were added; and data deficient species of concern were added to the SAPS list. All species that were removed, moved to the SAPS list, or are new additions to either list have the reasoning behind that decision included in Appendices 3a, 3b, or 3c. For species that were suggested later in the revision process (i.e., after the taxa team meetings), MD DNR staff reviewed each additional suggestion, including external stakeholders and experts in the discussion when needed. All participants had the opportunity to review the final SGCN and SAPS lists in early 2026, and edits were made to both lists based on feedback.

Partners in this process included other agency staff as well as external stakeholders and individuals who are recognized as experts in their fields. Many of these individuals are affiliated with major universities, institutions, government agencies, and conservation organizations active in conserving these species in Maryland and the Northeast region. The invite list was based on the list of contacts from the 2015 SWAP, heavily augmented with new suggestions from MD DNR staff and additional research. Out of the approximately 250 individuals that were contacted, nearly 150 people from more than 60 organizations and programs participated in the species review process. This is true for the species-level threat and action review process as well; see more details below. A full list of participating organizations can be found in Appendix 8a.

The Process for Developing Threats and Conservation Actions for the 2025 SWAP

For the 2025 SWAP revision, threats and corresponding actions were split into two levels: species and habitat. They were therefore reviewed, revised, and added to based on this distinction. The species-level threats and actions were generally reviewed either at the same time or shortly after the initial taxa team meetings described above. This review followed a similar format: invitees were provided with the applicable list(s) of 2015 threat–action pairs in advance, asked to review them before the meetings, and collaboratively updated the list during the meetings, including the assignment of each threat–action pair to specific SGCN. After this round of meetings, MD DNR staff continued to refine and make changes as needed and prioritized actions according to the process outlined in Chapter 6. All participants had the opportunity to review the final species-level threats and actions lists in early 2026, and edits were made according to feedback. The resulting detailed lists of threats and actions can be found in Appendix 6a.

As with the species lists, the threat and action revision process for some groups of invertebrates was also different; please see Chapter 3 for more details. The bird-focused meeting differed in scope as well. Given the size of the meeting group (>40), the number of bird species on the SGCN list (>140), and the wide range of threats and actions that affect this taxonomic group, it was decided that the meeting would focus mainly on threats and actions on a larger scale. This day-long, in-person workshop therefore asked attendees to discuss threats and actions regarding vulnerable groups of birds as opposed to individual species. This is reflected in the bird-specific threat–action pairs in Appendix 6a, which assign actions to groups of birds with similar characteristics rather than to individual species. Finally, given their intrinsic ties to their habitats, plants were not assigned species-specific threats and actions. Instead, their needs have been included within the habitat-level threats and actions.

Habitat-level threats and actions were reviewed and revised somewhat differently than for species. This is in large part because habitats lack the structure of taxonomic group expertise. In other words, while it can be relatively straightforward to identify and contact a group of herpetologists to review herpetofauna-specific content, stakeholders for marshes, forests, and other groups of habitats span a wide range of backgrounds and expertise, making it difficult to identify where individuals' and organizations' interests lie from an outside perspective. This necessitated more of a self-selection process from partners.

These habitat-level threats and actions were reviewed and revised during a series of day-long, in-person regional meetings attended by MD DNR staff and partners. One meeting was held for each region of Maryland: eastern, southern, central, and western. For further explanation of these regions, please see Chapter 2; Figure 2.2 contains a map of the four regions of Maryland. In order to address every habitat in the SWAP, habitat groups, specific KWHs, and topic areas were assigned to each meeting based on relevance to that region of Maryland. Subterranean habitats, for example, were discussed at the western Maryland meeting, and threats related to urban and suburban habitats were a topic of discussion at the meeting in central Maryland. This meant that all habitats and threat categories were addressed over the course of the four meetings. Additionally, some habitat groups and topics, such as forests and pollution, were discussed at every meeting due to their prevalence throughout the state.

Morning session of the central Maryland meeting
(Mimi Sanford, MD DNR)

Afternoon session of the southern Maryland meeting
(Mimi Sanford, MD DNR)

Each meeting cycled through selected sets of habitats and topics known to be relevant to that region. Attendees were allowed to self-assign to groups. In the morning session, attendees were asked to split into one of four habitat groups; in the afternoon session, they were asked to do the same for one of three or four topic groups. For example, during the morning session of the central Maryland meeting, attendees could choose between groups focused on forests, aquatic habitats, working lands, or urban and suburban habitats. In the afternoon, they could choose between groups concerned with land use conversion, waterway alteration and pollution, outreach and coordination, and a general "other" category for those whose interests did not align with the other three groups. Each session was 90 minutes long; attendees were allowed to switch groups halfway through each session if desired.

Morning sessions began with a review of habitat-level threats and actions from Maryland's 2015 SWAP, which had been sorted based on habitat group, written on pieces of paper, and posted on walls around the room. Attendees were asked to review these threats and actions and update them as needed. For example, if an action had already been completed or was no longer appropriate, it could be removed from the wall. If a threat was still present but its action needed to be changed, attendees could write their own action card and tape it over the old one. Participants were also provided with an assortment of paper and markers in order to "fill in the gaps," adding new threats and actions to their group's wall as needed.

During lunch, MD DNR staff took down the written threats and actions and re-sorted them based on the afternoon session topics. For example, to use the above example of central Maryland, a threat–action pair related to agricultural land loss from the working lands morning group would be placed in the land use conversion group in the afternoon. Afternoon groups were then asked to review the re-sorted content, continue to add and edit as needed, and then prioritize the actions using different colors of sticky notes. See the "Prioritizing Habitat-Level Actions" subsection of Chapter 6 for more information on this process.

After each meeting, threats and actions were typed up and sent back to attendees for confirmation and clarification. Between the four regional meetings, this resulted in 500 total threats and actions. However, many of these actions were either very similar to each other or already addressed in the species-level actions. After careful consolidation, the final list of actions best taken at the state, regional, and habitat levels numbered closer to 200. MD DNR staff then worked to refine these actions' KWH associations. All participants had the opportunity to review this consolidated and refined threat–action list in early 2026; again, edits were made according to feedback. The resulting list of threats and actions can be found in Appendix 6b. Refer to Chapter 6 for more information on how these actions are organized, how they were prioritized, and how they differ from the threats and actions in the 2015 SWAP revision.

Participants in this process included experts who had already contributed to the species content as well as additional partner organizations and individuals. The list of invitees was expanded to include stakeholders with a more general interest in conservation work (i.e., those not as focused on a particular taxonomic group) through additional research and suggestions from MD DNR staff. Invitees were also asked to forward invitations to their own contacts. Similar to the species-specific content, participants tended to be affiliated with major universities, institutions, government agencies, and conservation organizations. Out of the more than 300 individuals contacted, 100 people from across more than 50 organizations attended these regional meetings. A full list of participating organizations can be found in Appendix 8a.

Threats (purple) and actions (green) from the central Maryland meeting, prior to digitization and consolidation (Mimi Sanford, MD DNR)

Outreach and Coordination for the 2025 SWAP

As discussed earlier in this Chapter, MD DNR works with a diversity of stakeholders who passionately work to conserve species and habitats. The involvement of federal and state agencies, local organizations, academic institutions, citizens, and Native American tribes in both the 2005 and 2015 SWAPs made them successful in terms of having an impact on conservation efforts. Along with the desire to build on these past successes, MD DNR identified implementation of the SWAP's priorities as one of its major goals for the 2025 SWAP process. Since people are much more likely to implement a plan that they had a hand in creating, an effort was made to include an even greater number and range of stakeholders than in past SWAP revisions.

Outreach and coordination early in the SWAP process focused on informing and engaging stakeholders. Later in the process, efforts focused on involving as many individuals and organizations as possible in the revision of the SWAP's content, as well as keeping past participants up to date on the SWAP's process. Near the end, efforts turned to promote partner and public review of the Plan. An assortment of outreach techniques and tools were used to maximize coordinated input to partners and the public in the development of the 2025 SWAP. Examples of these tools include:

- Informational meetings and presentations
- Stakeholder input meetings/workshops (as described in previous sections)
- Personal contact and correspondence (e.g., emails, phone calls, one-on-one meetings)
- Wide distribution of public participation through email blasts, events, newsletters, press releases, and social media
- SWAP website with online comment form
- Public comment period

Informational meetings and presentations

MD DNR WHS sought out opportunities to present information about the SWAP to a number of audiences. The SWAP Coordinator and additional WHS staff used these opportunities to present information about the SWAP, provide information about ways to participate in Plan development and implementation, and seek feedback. Some of these presentations were organized by the SWAP revision team; others were at the request of partners and other interested groups. Presentations organized by the revision team included meetings with programs within or directly tied to MD DNR (e.g., the MD DNR Climate Team, Watershed & Climate Services, Critical Area Commission, Wildlife Advisory Commission) as well as affiliated groups like the USFWS, Maryland-Delaware Wildlife Society, and Society of American Foresters. Some groups also approached MD DNR to request similar presentations for their members. These groups included the Sierra Club Conservation Committee and Harford County Environmental Advisory Board.

Stakeholder input meetings/workshops

The various forms of stakeholder meeting used throughout the SWAP process are described above. These main goal of these meetings was to review, revise, and add to the "core content" (i.e., the species, threats, and actions) from the 2015 SWAP. Approximately 200 individuals from across 100 organizations contributed to this content; about 20% of that group contributed to both the species- and habitat-level content review.

In addition to these meetings, MD DNR also held some preliminary meetings regarding the 14 priority topic areas identified in Chapter 5. Virtual meetings were held for seven of these 14 areas in order to collect more detailed information on what work is already being done, what needs to be done in the future, and what would make such work easier to accomplish. More than 100 individuals from across 50 organizations attended this round of meetings. About half of these attendees had not participated in the SWAP process before this point, bringing the number of direct participants in Maryland's 2025 SWAP revision process to more than 250 people.

Personal contact and correspondence

Throughout the SWAP revision process, the SWAP Coordinator and other MD DNR staff engaged in personal contact and correspondence with conservation partners and other interested groups and community members. These communications included one-on-one meetings, phone calls, and emails regarding input to and implementation of the Plan. An effort was made to assist partners with tasks not directly related to the SWAP as well. For example, SWAP revision team members met with a group of interested citizens to discuss ways that groups can use MD DNR's online tools (e.g., MERLIN Online) to prioritize their own conservation efforts. In addition to building relationships and community, these sorts of efforts increase the likelihood that organizations and individuals will assist in implementing the SWAP's goals in the future.

Wide distribution of public participation opportunities

To inform and encourage broad public participation, MD DNR widely distributed news and information updates concerning the 2025 SWAP revision. Outreach staff displayed information encouraging public participation in the SWAP at numerous events, including the Maryland State Fair, with an estimated attendance of 4,500. At least 10 public speaking engagements also included a mention of the SWAP, further encouraging public participation. The final draft of the Plan revision was sent as mass email blasts to numerous outlets, including the list of conservation partners asked to help evaluate SGCN, workshop invitees, and the Master Naturalists listserv, which has nearly 3000 subscribers. MD DNR also posted about the SWAP revision to Facebook. Finally, MD DNR issued a press release to announce the final draft of 2025 SWAP revision and its public comment period.

SWAP website with online comment form

A dedicated State Wildlife Action Plan (SWAP) website was created in 2015 to more effectively disseminate information to a large and diverse audience and to receive and address public comments. The 2015 SWAP website was kept online for the public to use as a reference in the revision process until March 2026. The website contains background information about State Wildlife Action Plans, State Wildlife Grant funding, criteria for SGCN selection, and information about the revision process and public participation. In March 2026, an easy-to-use comment form for public input was placed on the site with the complete draft of the 2025 Plan. Written comments were received through the online comment form as well as by phone and email.

Public comment period

The draft of Maryland's State Wildlife Action Plan (SWAP) was posted on the MD DNR SWAP website during the development of the Plan. It was posted online in March 2026 and the official 30-day public comment period extended from then to April 2026. To announce the public comment period, press releases were sent to media outlets and emails were sent to all conservation partners involved in SWAP development, including workshop participants.

Throughout the process, the SWAP Coordinator reviewed all comments by both partners and the public, and those related to specific issues (e.g., individual SGCN) were reviewed by the most suitable SWAP Development Team member to ensure comments were evaluated and assessed fairly and accurately. This SWAP process was designed to include the continued input from all stakeholders and to keep the public informed about State Wildlife Grant projects and results through outlets such as social media posts, annual reports, and newsletter articles.

This chapter provided information pertinent to **Elements #7 and #8** regarding the coordination and participation with partners and the public on Maryland's SWAP review and revision. MD DNR's current partners were summarized and more detailed information on the 2025 SWAP development process was presented. Chapter 9 covers information on the review and revision of the next State Wildlife Action Plan in 2035 (**Element #6**) along with plans for implementation of the 2025 SWAP revision.

Citations and Sources

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Chapter 9

Review, Revision, and Implementation

Table of Contents

Introduction

Maryland represents an extraordinary ecological crossroads and is unique in its location in the North American landscape. The State Wildlife Action Plan (SWAP or Plan) will guide the next 10 years of state-level wildlife conservation to protect these diverse natural resources. Focused and well-planned efforts can lead to healthy animal populations and a healthier environment for Maryland's citizens. Strategic implementation, periodic plan review, and resulting adaptive management make this document a long-term tool for wildlife conservation in Maryland. For more details on adaptive management, please refer to Chapter 7.

This final chapter provides an overview of the future of Maryland's SWAP. First, it addresses how the Maryland Department of Natural Resources (MD DNR) intends to implement the Plan over the next 10 years with the help of partners, stakeholders, and the general public (addressing **Elements #7** and **#8**). It then describes how Maryland will review and revise its SWAP within the next 10 years (addressing **Element #6**), including minor reviews within the typical 10-year major revision cycle.

Implementation

Effective implementation of Maryland's SWAP will require many actions, but three basic objectives must be met: (1) participation from partner organizations, (2) increased visibility and usability, and (3) the availability of nongame funding sources over the next decade. Maryland's 2025 SWAP revision was purposely developed to facilitate the involvement of a broad spectrum of partners, stakeholders, and staff in both creation and implementation. This was partially done through the involvement of as many partners as possible, as people are much more likely to implement a plan that they had a hand in creating. For more details on the partner participation process, please refer to Chapter 8.

Not every partner could be involved in the SWAP revision process. Therefore, potential partners for implementation were identified for conservation actions by meeting participants, especially for the taxonomic group-specific actions. Some of these potential partners are not currently conducting or leading priority conservation efforts recommended in the MD SWAP. MD DNR intends to better connect with these groups in order to discuss possible project implementation, especially for the actions determined to be high priority. MD DNR will also continue to reach out to current and potential partners of all geographic scales to discuss next steps for implementation of priority actions and plan for future conservation projects. Although these potential implementation partners are not listed in the public-facing SWAP, MD DNR and partners have access to this information and will be reaching out to these potential partners as needed.

As MD DNR's Wildlife & Heritage Service (WHS), specifically WHS's Natural Heritage Program (NHP), is the entity responsible for coordinating Maryland's SWAP, NHP will be the lead on organizing implementation of the Plan. Along with reaching out to potential implementation partners for specific actions, as described above, this will entail leading increased conversation and coordination efforts regarding the 14 priority threat areas and resource needs described in Chapter 5. Some of this work has already begun; for example, in late 2025, MD DNR collected detailed information from partners regarding their work in these 14 areas. This included which of the 14 topic areas each partner works in, as well as the type of work (e.g., advocacy, land preservation, data collection, education). Virtual meetings were then held for seven of these 14 areas to collect more detailed information on what work is already being done, what needs to be done in the future, and what would make such work easier to accomplish. Though not all of these results are included in the 2025 SWAP revision, it is the intention of MD DNR to continue working in these areas. Specific ideas for next steps include:

- New standing meetings, workshops, or conferences that bring together partners with a wide range of expertise and backgrounds to address these priority threat areas in a multidisciplinary manner;
- One-time summits to address more urgent needs, such as the disappearance of Small Coastal Plain Islands and lack of funding;
- The creation of regional or statewide coordination bodies, such as a Maryland-specific Partnership for Regional Invasive Species Management (PRISM), that would allow partner organizations to better work together, share resources, and complete larger-scale projects; and,
- Improved communication with and utilization of existing partner networks, such as the Delmarva Restoration and Conservation Network (DRCN).

Networks like DRCN allow partners to strengthen conservation efforts on the landscape scale by coordinating efforts and pooling resources. Created in 2017, DRCN is a regional conservation collaborative that brings together partners from across a range of disciplines to address the most pressing conservation needs on the Delmarva Peninsula. It includes local, state, and federal government agencies and non-governmental organizations (NGOs) that work throughout the region, with its main goals being the identification, protection, and restoration of the most important places to protect. Partners also work to obtain support and funding for voluntary restoration and conservation on the Delmarva Peninsula. MD DNR intends to work more closely with existing networks like DRCN and identify gaps in coordination where new networks could help meet these regional needs.

MD DNR also intends to increase the SWAP's visibility and usability amongst partners and the general public. This will be done in a variety of ways. The principal effort will be a web-enabled version of Maryland's 2025 SWAP revision. This will allow MD DNR staff, partners, and members of the public to more easily view the contents of the SWAP. For example, a web-enabled SWAP will allow users to more easily search for a species' threats, actions, and habitat associations without requiring the cross-referencing of multiple chapters and appendices. The content of the SWAP will also be "repackaged" into various documents depending on partners' needs. For example, during the previous SWAP revision process, MD DNR worked with the Maryland Bird Conservation Partnership (MBCP) to create a short booklet titled "Conserving Maryland's Birds and their Habitats." It pulled all of the most crucial bird species, threats, and actions from the 2015 SWAP and summarized the information in a 12-page document for bird-focused partner organizations, ornithologists, and bird enthusiasts. Based on feedback from partners, preliminary ideas for repackaging of the 2025 SWAP include documents or webpages based the 14 priority threat areas, taxonomic groups, and counties, as much of Maryland's governance is conducted at the county level.

Finally, adequate funding sources for nongame species management over the next decade will be critical for successful SWAP implementation. Federal funding for nongame species conservation has decreased since the State Wildlife Grant (SWG) program was first established: $85 million were appropriated for Fiscal Year (FY) 2002 (USFWS 2002), whereas just over $55 million were appropriated for FY2025 (USFWS 2025). Additionally, plant conservation work is not eligible for SWG funding. This is exacerbated by the fact that MD DNR NHP—unlike many other state-run programs—does not receive any state general tax dollars. While MD DNR continues to seek out stakeholder support, it will be difficult for NHP to continue to lead conservation efforts statewide and to adequately implement the SWAP without sufficient funding. Partners have noted struggles with adequate funding as well, leading this lack of funding to be identified as one of the 14 priority need areas for the post-SWAP implementation period. It is MD DNR's intention to highlight this as a need over the next 10-year period through continued conversation with partners, stakeholders, and legislators in order to find a more permanent solution to this funding issue.

Review and Revision

Under U.S. Fish and Wildlife Service (USFWS) guidance, SWAPs undergo a maximum 10-year revision cycle. Most SWAPs across the country were first published in 2005, revised in 2015, revised again in 2025, and will be updated again in or before 2035. This cycle of revision allows the Maryland SWAP to be a living document that, through continuous information updates and periodic revisions, will guide Maryland's conservation planning for years to come. The creation of a web-enabled version of the SWAP will further support this effort to make the SWAP a living document.

As scientific knowledge and understanding of Maryland's species and their habitats continues to grow, information gathered during the implementation of the SWAP provides important updates to the body of scientific information maintained by MD DNR. In particular, the studies funded by SWG, other grants to MD DNR, and the activities of partners (e.g., universities, NGOs) form the basis of new scientific information to be incorporated into future revisions of the SWAP. MD DNR understands that conserving and protecting the state's wildlife requires a long-term commitment. During the plan's implementation, MD DNR will review, evaluate, and update progress on conservation actions, research, inventories, surveys, and monitoring on a periodic basis.

NHP will work to update the Plan as needed, especially in response to information that could affect management decisions. New information may be appended to the SWAP during the implementation phase in cases of major changes in the status or condition of Species of Greatest Conservation Need (SGCN) or key wildlife habitats (KWHs), or for new and rapidly emerging threats. For example, a new invasive species may become established in Maryland and the list of threats, actions, and SGCN may need to be revised to deal effectively with the new problem. However, most new information will be included during the next major SWAP revision in 2035.

MD DNR will work with its partners to continually assess the state of Maryland's SGCN and their habitats. This assessment will include factors such as changes in threats and landscape-scale or significant local issues that need to be addressed. MD DNR may also recommend modifications to the overarching conservation actions or any specific actions provided in

Appendices 6a and 6b based on any of these new and emerging significant threats. As part of this general review process and at other times when revision may be necessary, MD DNR will seek broader input and comment from other agencies, organizations, experts, and the public.

Despite best intentions, many of these interim review steps were not taken during the past SWAP implementation period (i.e., from the publishing of the 2015 SWAP revision until now). This is due in large part to the lack of a long-term staff member or team of staff at MD DNR dedicated to the implementation, review, and revision of the SWAP. It is MD DNR's intention that a staff member or team of staff will remain focused on the SWAP throughout this future SWAP implementation period, ensuring that the implementation of the SWAP's objectives, communication and coordination with partners, and interim review and revision will remain more consistent during the next 10-year period.

Maryland SWAP Review Schedule

MD DNR will coordinate and complete a comprehensive revision of this SWAP by October 2035 (**Element #6**). Between major revisions, MD DNR and USFWS frameworks will guide the implementation process, maximizing opportunities for both internal and external implementation. For example, the existing USFWS process requires annual reporting and review with five-year Application for Federal Assistance work plans and evaluations for some funding streams. Most MD DNR agency programs, including NHP, have annual reporting requirements from their federal grants or other funding sources. Annual or project-end results that indicate any changes or new information, including information from periodic review by technical experts, will be assessed for use in an adaptive management process and eventual plan revision.

In summary, the Maryland SWAP evaluation, review, and revision schedule will include the following benchmarks:

- Annual reporting for SWG funding and other Federal Aid grant requirements;
- Regular analysis and incorporation of tabular and spatial data into appropriate MD DNR and partner databases and GIS systems;
- Regular incorporation and updates of priority Maryland SWAP conservation actions into MD DNR and partner plans;
- Regular review of results of monitoring and performance measures;
- Regular status review of SGCN, including whether species on the State Assessment Priority Species (SAPS) list need to be moved to the SGCN list, which will likely align with the existing review of Maryland's Rare, Threatened, and Endangered Species list undergone every three to five years; and,
- The complete revision of the SWAP every 10 years, which will incorporate all interim updates and reviews.

This final chapter provided an overview of the future of the SWAP. It addressed how Maryland intends to implement the Plan over the next 10 years with the help of partners, stakeholders, and the general public (addressing **Elements #7** and **#8**). It also summarized how Maryland will review and revise the Plan within the next 10 years (addressing **Element #6**).

Citations and Sources

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U.S. Fish and Wildlife Service (USFWS). 2025. "Final Apportionment of State Wildlife Grants for Fiscal Year 2025." https://www.fws.gov/sites/default/files/documents/2025-05/fy-2025-swg-apportionment-tabel.pdf.