

*A society grows great when old men
plant trees whose shade they shall never sit in.*

Greek proverb





THE ECOLOGICAL ENVIRONMENT

During the first one hundred years of settlement (1700-1800), intensive land development and the consumption of other natural resources in the Monocacy watershed had altered the region's ecological character. Prior to European arrival, the Monocacy River Valley supported a rich and diverse variety of forest vegetation, wetlands and wildlife.

The limestone regions had substantial forests that included Yellow Poplar, Beech, Red Oak and Basswood. Silver Maple, Cottonwood, Sycamore, Ash, Elm and Box Elder were abundant in flood plain forests. In the mountainous, western region of the river basin, pine-oak hickory forests were common, while the mountain hollows supported hemlock and mixed hardwoods (8). The American chestnut, once common in the Monocacy River Valley, was later eliminated by blight, which further contributed to change in forest cover. These woodlands, open grasslands, and wetlands supported a diversity of wildlife, including large herbivores such as elk and bison.

By the late 18th century, the Monocacy watershed's natural environment was indelibly altered. Thousands of acres of forests had been cleared for agriculture and prime hardwoods were harvested and processed into charcoal. These centuries of human-caused impact on forest, wetland and other types of habitat have forced the decline or disappearance of many plant and animal species in the Monocacy Valley as well as the rest of the state.

Biodiversity in the Monocacy River Watershed

Over 1,200 native plants and animals in Maryland are identified by the Maryland Department of Natural Resources (DNR) as endangered, threatened, rare, or 'watch-list' species. Habitat loss, habitat degradation and fragmentation, and invasive species are widely considered to be among the greatest threats to the survival of Maryland's rare flora and fauna. However, some species are also vulnerable to and threatened by various human activities, especially illegal collection, over-exploitation, excessive harassment, excessive disturbance of their fragile habitats, and purposeful destruction.

In general, conservation of rare species is most effective when their habitats are protected. To facilitate habitat conservation, the locations of rare species were analyzed and processed using standardized methods by DNR into habitat conservation boundaries called Ecologically Significant Areas (ESAs). The ESAs are primarily the buffered habitat of rare, threatened, and endangered species, as well as significant or rare habitats and ecological systems. The ESAs are more generalized than exact focus points, which are only provided to data requestors under certain circumstances, such as landowners, scientists, researchers, and conservation partners, or to State permitting agencies during the review of development projects when habitat and locations may be impacted by the development.



Dickcissel

The Maryland DNR has identified 61 ESAs in the Monocacy River Watershed as shown on the accompanying map. A large portion of the Watershed's ESAs are located within the River Corridor, attesting to the unique landscape and sensitive environmental resources present along the River. The appendix includes information about each of the Monocacy River Watershed's ESAs, the resources found within the Monocacy ESAs, plus descriptions of global and state conservation rankings for the resources, and species status (threatened, endangered, etc).



Red Headed Woodpecker

The Wildlife and Heritage Service of the Maryland Department of Natural Resources (DNR-WHP) produces maps and other products that integrate its vast data and prioritizes Maryland's vanishing natural landscape to highlight those areas that are important to conserve the full complement of species and natural communities currently found within the State.

The Biodiversity Conservation Network (BioNet) is a digital map that prioritizes areas for terrestrial and freshwater biodiversity conservation. It was developed by DNR to use for proactive land conservation activities, such as targeting for acquisitions and easements, location appropriate areas for project mitigation or habitat restoration, and planning for areas that require management to sustain dwindling species and habitats. In addition to focusing on vanishing species and habitats, and on high quality common habitats, the criteria used in BioNet also were designed to incorporate the large landscape required for migratory animals, population dispersal, and habitat shifts results from climate change.



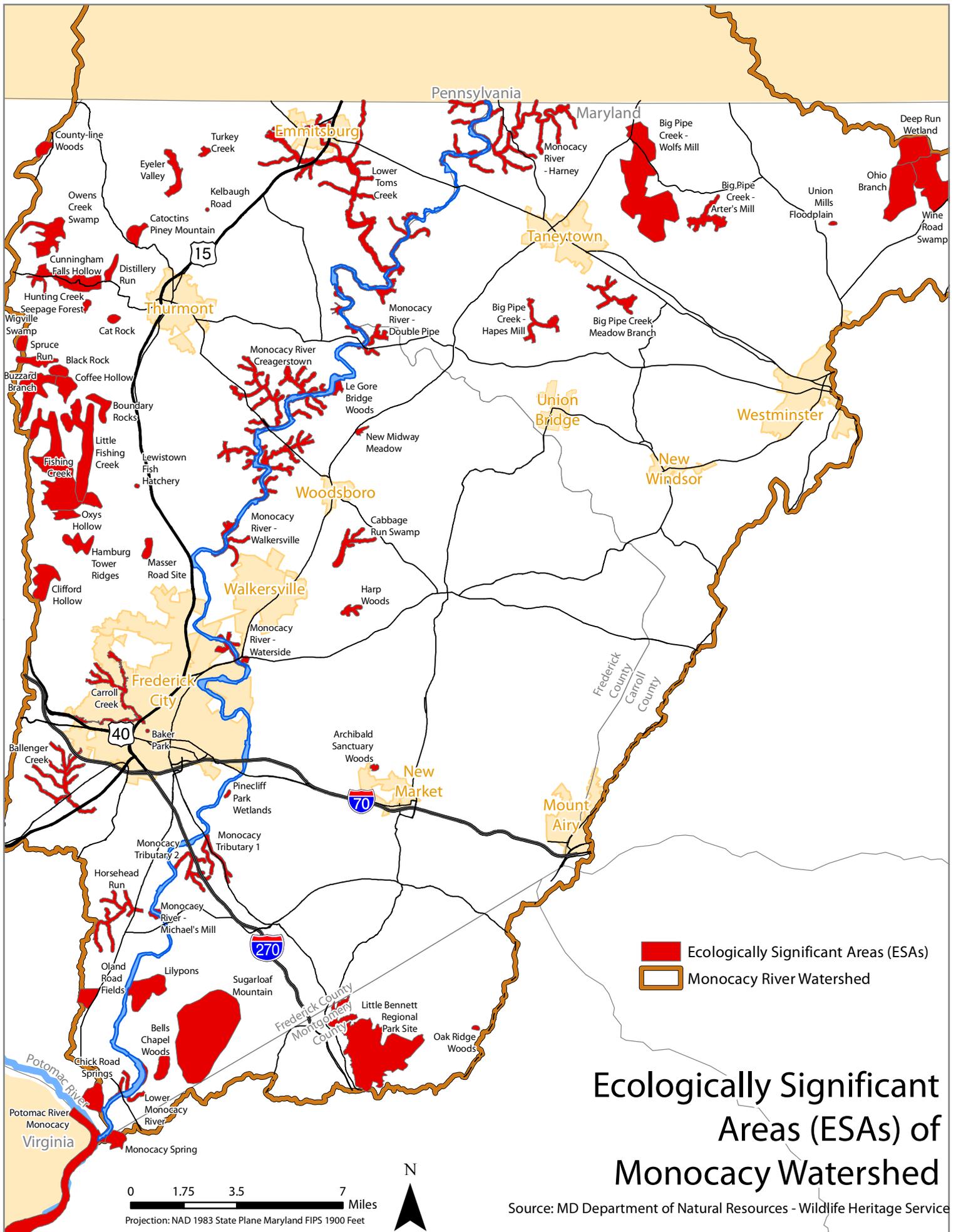
Grasshopper Sparrow

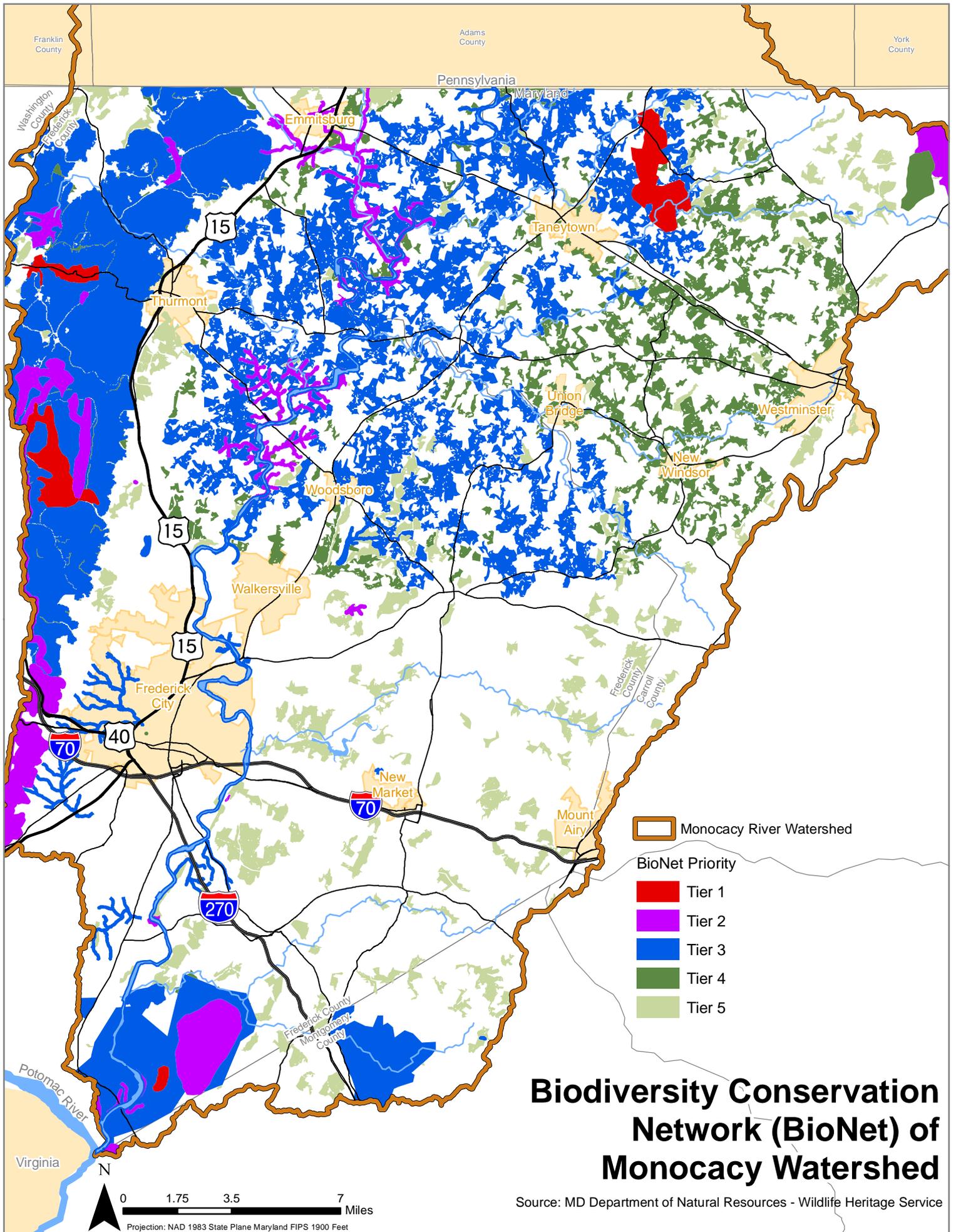
In summary, BioNet includes and prioritizes:

- Only known occurrences of species and habitats
- Globally rare species and habitats
- Animals of Greatest Conservation Need
- Watch List plants and indicators of high quality habitats
- Animal assemblages (e.g., forest interior species)
- Hotspots for rare species and habitats
- Intact watersheds
- Wildlife corridors and concentration areas

These areas are prioritized into a five-tiered system, as shown on BioNet map of the Monocacy River Watershed:

- Tier 1: Critically Significant for Biodiversity Conservation
- Tier 2: Extremely Significant for Biodiversity Conservation
- Tier 3: Highly Significant for Biodiversity Conservation
- Tier 4: Moderately Significant for Biodiversity Conservation
- Tier 5: Significant for Biodiversity Conservation





According to the DNR-WHP, this five-tiered system was designed to capture and support the full array of biological diversity within Maryland; not just those places that are one of a kind, but also the places that are needed to maintain viable populations of more common species, and to maintain the larger fabric of our natural landscape.

The Monocacy River corridor is biologically rich and diverse, as indicated by the substantial presence of Ecologically Significant Areas—biological ‘hot spots’ that contain rare, threatened, or endangered species of plants and animals and their associated habitats. These lands are critical and vital to our region’s biodiversity.

Monocacy Grasslands Important Bird Area (IBA)

IBAs are sites that support significant populations of birds considered vulnerable to decline and extinction. Sites are identified based on rigorous scientific criteria that focus on three categories of vulnerable birds.

- 1) At-risk species of conservation priority.
- 2) Species assemblages that specialize in a particular habitat type.
- 3) Birds that occur in exceptional concentrations.

The IBA program began in the 1980s and seeks to achieve conservative goals through partnerships with conservation planners, landowners and managers of public lands. IBAs are identified by an IBA Technical Review Committee, which reviews all nominated sites against scientific criteria based on analysis of bird populations and their habitats.

The Monocacy Grasslands was identified as an IBA in 2009 based on surveys of large populations of three at-risk bird species: Red-headed Woodpecker, Grasshopper Sparrow, and Dickcissel; as well as habitat supporting a highly diverse assemblage of grassland birds. This extensive IBA includes grasslands between U.S. Route 15 in Frederick County and MD Route 97 in Carroll County. More specific information on IBAs may be found at <http://mddc.audubon.org/birds-science-education/important-bird-areas>.

Riparian Forests

The Monocacy River’s riparian environment includes forested floodplains and wetlands, vernal pools, forested slopes, non-floodplain forestlands, as well as cleared and cultivated agricultural fields. All have value, but a forested riparian landscape provides far superior environmental benefits or ecosystem services than a non-forested riparian landscape.

- Dense rows of trees growing in portions of the Monocacy’s floodplain and riparian areas—sycamores, alder, red maple, oaks, etc—provide nesting sites for bald eagles, blue heron rookeries, and many other birds, animals and waterfowl. The Monocacy’s floodplain and riparian areas that lack woody vegetation reduce wildlife habitat, water quality benefits, and overall River corridor resiliency.
- Forested riparian areas and wetland areas are valuable for keeping soil intact during flooding events. Tree roots tightly hold and bind soil and control scour erosion, compared to plowed fields that lack woody structure. Rain falling on trees is intercepted and slowed by leaves, limbs, and branches, is utilized by tree roots and infiltrated into the ground.

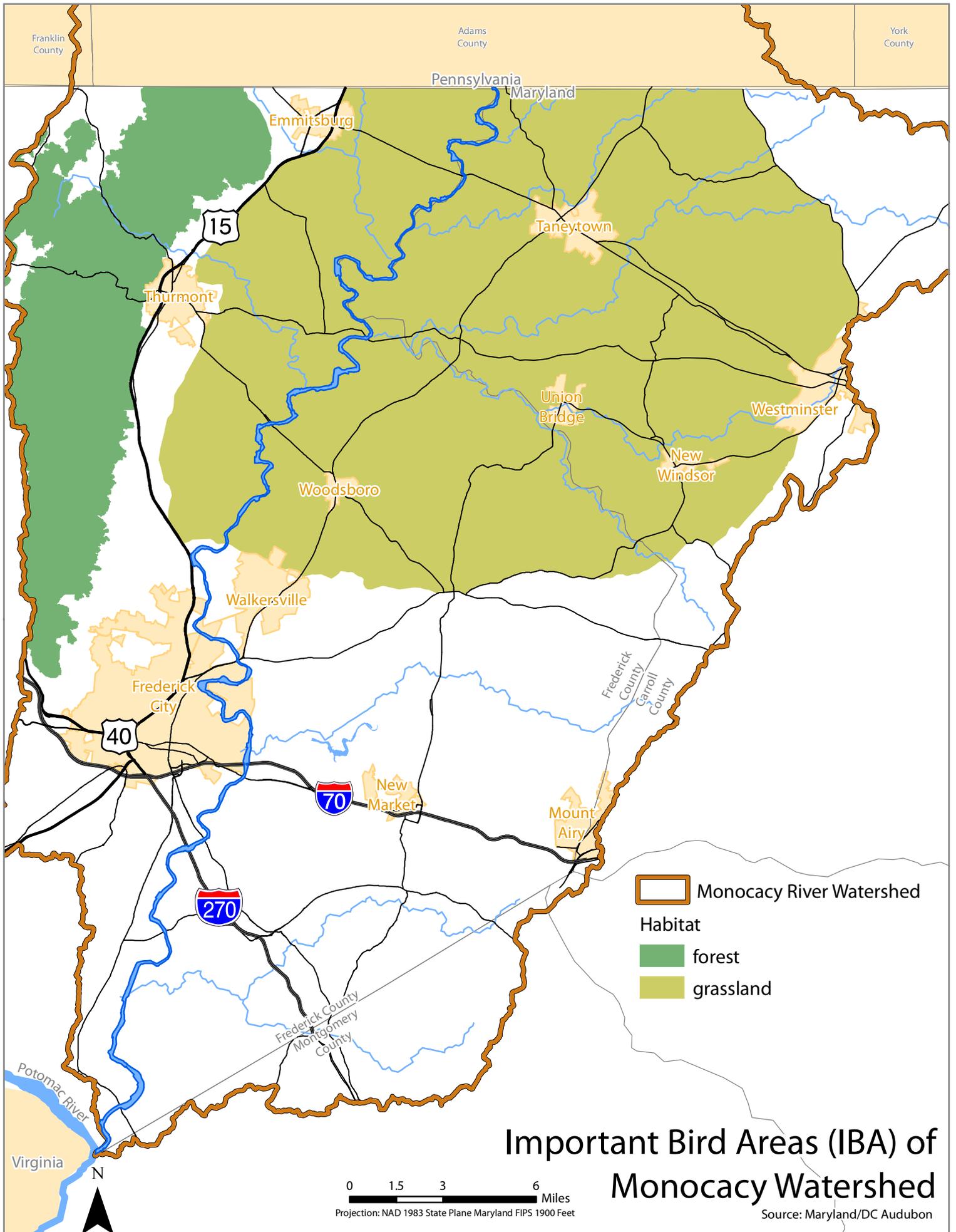
THE ECOLOGICAL ENVIRONMENT

- The duff layer—fallen and decomposing leaves, twigs, bark, seeds, nuts, logs--- in a forested riparian landscape sequesters sediment from overland flow and during flood events, preventing the sediment from entering or reentering the river.
- Tree canopies provide shade which cools the surrounding area and is critical in moderating water temperatures, particularly in small streams.
- A riparian forest or floodplain forest is superior in its retention, detention, and interception of water from storm events and flooding, compared to agricultural fields or pasture that lack forest cover along waterways. Riparian and floodplain forests absorb energy from flood waters and help prevent otherwise higher downstream water levels during storm events and flooding, acting as natural flood protection for structures and people. Forests purify the very air we breathe.
- Riparian forests help to buffer and protect waterways by enabling bacterial transformation of the nutrient nitrogen (which in high amounts can pollute waterways) to harmless gas before it enters surface waters through overland flow (runoff), subsurface flow, or shallow groundwater flow. Cultivated fields or pasture lands adjacent to streams and rivers without vegetative buffers or stream fencing can also contribute soil-bound phosphorus directly to waterways through overland flow—runoff.



In the past 25 years, increased deer populations and invasive species have intensified and have profound impacts on the Monocacy River Corridor and the entire watershed. Increased deer densities result in more grazing and consumption of most young tree seedlings—saplings—which severely reduces natural forest regrowth, regeneration, and succession.

Today, such woody invasive plants, such as *Ailanthus* ('Tree of Heaven'), Bradford Pear, Norway Maple, Autumn and Russian olive, Bush Honeysuckle, Japanese Barberry, Multiflora Rose, Japanese Bittersweet, Garlic Mustard, and Oriental Stiltgrass have seen significant spread through the Corridor and entire watershed. These invasives can quickly overtake an area, significantly affect the food web, and displace native vegetation. Non-native invasive plants and trees prevent natural forest regeneration and ecological succession. In many cases, they negatively alter soil chemistry and nutrient cycling, as well as reduce wildlife habitat since they do not provide the high quality food and cover that native vegetation provides. Once invasive communities become established, they tend to remain in place unless control measures are initiated.



Important Bird Areas (IBA) of Monocacy Watershed

Source: Maryland/DC Audubon



Local Efforts

Since the late 1980's renewed efforts have been made in the Monocacy River Watershed, through federal and state Chesapeake Bay Watershed programs, to enhance water quality and stream health by planting trees and shrubs adjacent to waterways, creating permanent forest conservation easements, implementing enhanced Best Management Practices (BMPs) on agricultural lands, creating networks of like-minded conservation groups, and educating the public on the benefits of forestlands on clean water and a healthy Chesapeake Bay.

Through these programs, Monocacy River Watershed Foresters from the Maryland Department of Natural Resources also targeted the 1,800-acre Monocacy Natural Resource Management Area (MNRMA) for restoration, tree planting, and research. The MNRMA is a publicly-owned natural area adjacent to the Monocacy River and Sugarloaf Mountain in southern Frederick County and contains vast forestlands, fields, and agricultural uses, providing abundant wildlife habitat and ecosystem preservation.

Nearly 300 acres of forest plantings and warm-season grass meadows have been established at MNRMA by the State of Maryland. A comprehensive stewardship plan has been developed for the property that addresses development of old growth forests, some rotational timber harvesting, invasive plant control, and Agroforestry initiatives (the intentional blending of trees and shrubs into crop and livestock systems). Other research and demonstration activities developed at MNRMA include:

- Buffer demonstration areas
- Cattle fencing plots
- Tree growth field investigations
- Mice and vole control studies
- Tree shelter, deer fencing experiments

Forest Legacy

The US Congress created the Forest Legacy Program in 1978, which allows public acquisition of forest lands and compensation to landowners for "protecting, managing, and enhancing the productivity of timber, fish and wildlife habitat, water quality, wetlands, recreational resources, and aesthetic values of forest lands..and investing in practices to maintain, protect, and enhance forest resources..." (16 US Code § S2103a). The Maryland Forest Service within the Department of Natural Resources (MD-DNR) is the agency designated to implement the Forest Legacy Program in Maryland (11).

The MD-DNR conducted a Forest Legacy Assessment of Need in 1995, with an update completed in 2007 that focused on the incorporation of socioeconomic factors such as recreational forest values, location of productive timber stands, and indicators for forest area vulnerability. The 2007 Assessment defined strategic forests as key blocks of forest providing the optimal mix of ecological and socioeconomic values necessary to support natural resource-based

Monocacy Natural Resource
Management Area

industries and to maximize ecological benefits (11). These efforts by the State utilized Maryland's 2000 Green Infrastructure Assessment, a comprehensive inventory of ecologically significant lands in the State.

Although only a portion of the Monocacy River Watershed was included in the State's Forest Legacy Assessment, it is important to note that the 2007 Assessment includes those portions of the Monocacy River Watershed containing all the River's headwater streams that originate on the eastern slopes of the Catoctin Mountain range, north of the City of Frederick. These forested headwater streams within the Catoctin Mountains support native brook trout, which require cool water temperatures that forests provide.

Since that time, Frederick County has created its own Green Infrastructure analysis to identify a local network of significant environmental landscapes, which includes the forestlands present along the Monocacy River corridor. Given the critical importance of the Monocacy Scenic River's forestlands for water quality protection, wildlife habitat, watershed protection, and place-making, additional focus on the forest resources in the River corridor is needed.



A Ribbon of Green

The Monocacy River and its riparian forests can be viewed as a unified, cohesive, inseparable whole, a "functional unit" as used to describe an ecosystem. The Monocacy River Corridor is part of our 'Green Infrastructure.' The concept of Green Infrastructure (GI), as defined by the Conservation Fund, is "an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife." Green Infrastructure is an ecological framework for social, environmental and economic health—our natural life support system—that many people take for granted. (12)

Green Infrastructure is a network of 'hubs' (large, unfragmented forested areas) and corridors (linking the hubs) that allows animals, seeds, and pollen to move and migrate from one area to another. They also protect the health of river and streams by maintaining adjacent vegetation.

Large portions of the Monocacy River's forestlands are included as GI hubs in the County, where significant forestlands and wetlands areas are adjacent to the River as shown on the accompanying maps. The River and its forests can be viewed as a linear natural resource throughout the County, providing longitudinal connectivity of habitats, species, and natural communities between up-River and down-River areas.

Both Frederick County and the State of Maryland have performed Green Infrastructure analyses to identify key forest hubs, their resources and functions, as well as the corridors for connecting hubs. The hubs and corridors identified by the State were expanded using Frederick County-specific forest data, wetland studies, geo-spatial analysis, and other established County priorities and goals. Gaps in the local Green Infrastructure network were evaluated through a landscape-ecology restoration opportunity matrix,

DNR Foresters at work in the MNRMA.

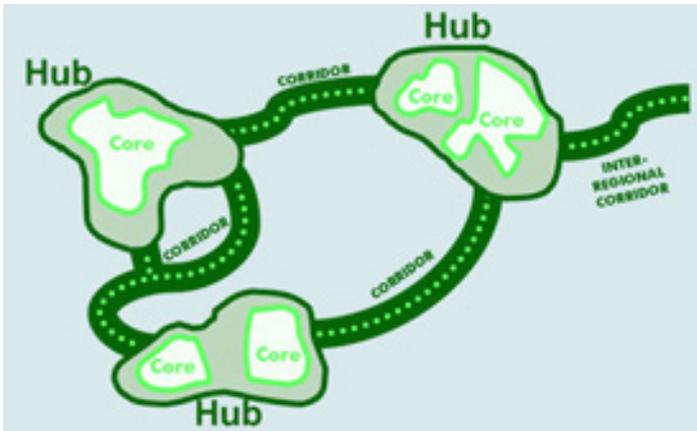


which examined, for example, portions of the Monocacy River Corridor with hydric soils or floodplain that lack forest cover, and agricultural fields surrounded by forest.

Ecosystem Services

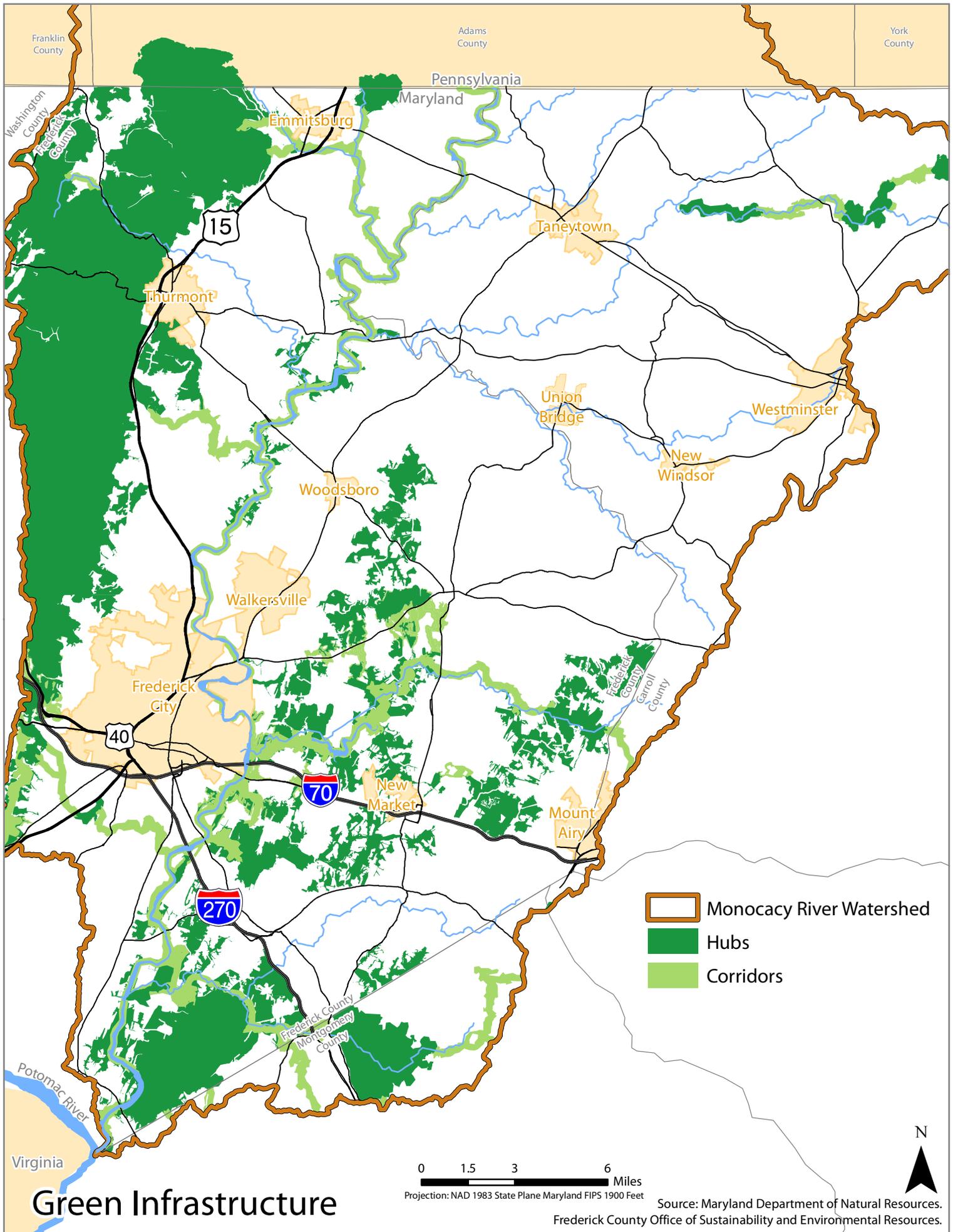
When land that contains forests and wetlands is developed into human-centered uses, there are costs incurred that are typically not accounted for in the marketplace; they are hidden costs to society. These services, such as cleansing the air and filtering water, are fundamental needs for humans and other species, but in the past, the lands providing them have been so plentiful and resilient, that they have been largely taken for granted. In the face of a tremendous rise in both population and rate of land conversion, many people now realize that these natural or ecosystem services must be afforded greater consideration. (13)

From Green Infrastructure by McMahon & Benedict, 2006



The Maryland Department of Natural Resources is currently creating an “Ecosystem Service Valuation Framework” that will establish metrics for communities to use when considering land use planning decisions and development projects. The Framework evaluates natural assets using valuation and economic analysis that put a monetary value on the activities, functions and opportunities that conserved lands offer, such as ground and surface water filtration, water supply and flood protection, and recreational opportunities. Like a return on investment, the Framework uses nature as a portfolio for what it provides---a “return on environment.” US Government agencies that manage land must now take into account ecosystem services when writing management plans or evaluating proposals for activities or development, according to Elliott Campbell of the Maryland Department of Natural Resources.

Consider the billions of dollars spent each year to construct or maintain Maryland’s built (‘grey’) infrastructure of roads, bridges, buildings, utilities that we depend on for modern life. By contrast, the amount of money we collectively spend as a society to preserve and protect our Green Infrastructure—our natural life support system---is an order of magnitude less.



Green Infrastructure

0 1.5 3 6 Miles
 Projection: NAD 1983 State Plane Maryland FIPS 1900 Feet

Source: Maryland Department of Natural Resources.
 Frederick County Office of Sustainability and Environmental Resources.



Fish and Wildlife

Stream valley corridors are important to fish and wildlife for several reasons. They provide vital sources of food, and habitat for breeding and serve as migratory routes for some animals. As development continues in the watershed, the Monocacy's corridor and its stream valleys will play an even more critical role in the survival of plants, animals, and maintenance of water quality.

Removal of forest cover in the watershed has disrupted the ecological balance between natural habitat and living resources. Agriculture and development have changed the natural patterns of plant succession. Farming practices with unfettered livestock access to waterways and streams that lack sufficient vegetated buffers result in elevated water temperatures (harmful to fish and aquatic organisms) and excessive sediment and nutrient inputs to stream systems, and eventually to the Monocacy River. Compared to pre-European settlement, wildlife habitats now restricted to farmland, isolated woodlots, stream corridors and certain protected public lands, limit the diversity and reproductive capacity of plant and animal species that remain in the areas.

Information gleaned from fish and wildlife surveys is partially indicative of the Monocacy's ecological health. A river that has poor to fair water quality may only support a marginal number of different species. Some species, such as catfish and carp, can better survive in polluted waters, further disrupting the ecological balance.

Forest Conservation

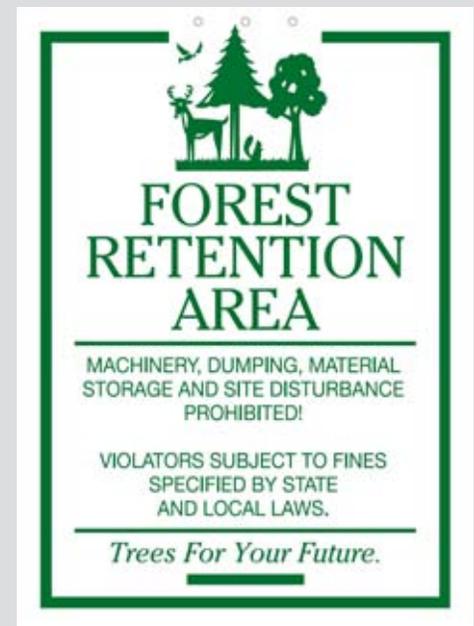
Recognizing the importance of trees and forests to Maryland's waters, landscape and residents, the Maryland Legislature enacted the Forest Conservation Act of 1991 (FCA) to help protect and enhance forest resources in Maryland. Acknowledging that land development and conversions have impacted Maryland's forestlands and wildlife habitat, the FCA applies to all counties in Maryland with less than 200,000 acres of forest; Garrett and Allegany Counties are exempt from the FCA.

Generally, land development projects that are equal to or greater than 40,000 square feet (0.92 acres) are subject to the FCA. In order to fairly distribute forest stewardship responsibilities, the FCA encompasses two 'quantitative goals.' The first is to replace a certain amount of forest that is removed as part of the development process, called Reforestation or Conservation. The other goal is Afforestation, which requires applicants to plant forest in accordance with the 'afforestation threshold,' which is 20% of the development site. This means that if the amount of forest on a site is less than 20%, the applicant is required to plant up to 20% of the development site in forest.

The FCA prioritizes the types of environments to be preserved and planted. Essentially, the highest priority sites are those that are hydrologically sensitive. These include: streams, rivers, wetlands, springs, etc. The reason that hydrologically sensitive areas are specified as priority sites is that forest cover in these areas help to absorb excess nutrients before they enter aquatic systems, and forest cover stabilizes soil in sensitive areas, thereby reducing erosion and sedimentation of our waterways. Other areas of priority for forest

retention or planting are: habitats of rare, threatened, or endangered species; areas which connect large blocks of forested tracts ('hubs') that facilitate wildlife movement; areas containing specimen tree species; forest areas that are parts of historic landscapes, or forests that buffer incompatible land uses.

As of July 2015, a total 6,892 acres of forestland has been permanently protected through the FCA in Frederick County (this figure includes land outside of the Monocacy River Watershed). In Carroll County, 1,199 acres of forestland has been protected through the FCA within the Monocacy River Watershed.



The Monocacy River has the potential to support a greater diversity of fish and wildlife populations as efforts continue to improve its water quality.

Fish Species

The Department of Natural Resources, Inland Fisheries Division documented a total of 39 fish species representing ten families in the Monocacy River between 2006 and 2013. The sunfish family (*Centrarchidae*) contained the most abundant recreational species that included Smallmouth Bass, Redbreast Sunfish, Rockbass, and Longear Sunfish. Although commonly caught throughout the Monocacy, Largemouth Bass are not considered to be abundant, except in the impounded habitat upstream of Starners Dam in the northern watershed. There was little difference in species richness between the upper and lower river segments (see Table 1, "Fish Species collected from Monocacy River" in Appendix).

The minnow family (*Cyprinidae*) contains the most abundant nongame fish species. Spotfin Shiner, Bluntnose Minnow, and Spottail Shiners are the most abundant minnows and provide food for the predatory game fish species. Common Shiner, Swallowtail Shiner, and Fallfish are also abundant throughout the Monocacy. The largest member of the minnow family, the Common Carp, is commonly found throughout inhabiting the slower, deeper pools.

The Northern Hog Sucker along with the Shorthead Redhorse, Golden Redhorse, and White Sucker are members of the sucker family (*Catostomidae*). The Northern Hog Sucker is generally associated with riffle habitat while the redhorse species prefer deeper pools and glides. The White Sucker is more prevalent in the upper Monocacy and the tributaries, but is found throughout the watershed.

The headwaters of several Monocacy tributaries in the western watershed support populations of native Brook Trout (*Salvelinus fontinalis*) and naturalized populations of exotic Brown Trout (*Salmo trutta*). Brook Trout can be found in the Owens Creek, Hunting Creek, Fishing Creek, and Tuscarora watersheds and a single stream in the eastern watershed, Bear Branch. Brown Trout are found in the western watersheds of Owens Creek, Hunting Creek, and Ballenger Creek, though loss of habitat and an increase in impervious surfaces due to urban development has largely extirpated Brown Trout from the Ballenger Creek watershed. Trout species are also believed to have been extirpated from Glade Run and Furnace Branch in the eastern watershed. Natural and stocked trout resources in the Monocacy watershed provide recreationally and economically important sport fisheries.

Smallmouth Bass

Smallmouth Bass (*Micropterus dolomieu*) and channel catfish (*Ictalurus punctatus*) are the most abundant and sought after sport fish in the Monocacy River. Prized for their tenacious fight and willingness to take lures, Smallmouth Bass generate economically important recreational fisheries. Smallmouth Bass are so well suited to the Potomac and Monocacy watersheds, many are surprised to learn that Smallmouth are not native to these waters. Albert M. Powell, a pioneer in the early Game and Inland Fish Commission, reported in his "Historical Information of Maryland's Commission of Fisheries with notes on Game" that Smallmouth were first introduced into the Potomac watershed in 1854 when a small lot of bass from the Ohio River near Wheeling, WV were transported in the tender of Baltimore and Ohio Railroad locomotive and released into the Chesapeake and Ohio Canal at Cumberland. By 1865 it was reported that more than 200 miles of the Potomac River and its tributaries had been populated with Smallmouth Bass from the original introduction. The first documented stocking of Smallmouth Bass in the Monocacy occurred in 1862. Additional introductions took place through the mid-1900s, but were not well documented. However, with

Intersex

Intersex is a condition in which an organism displays both male and female sexual characteristics. The Potomac watershed received national attention when researchers discovered intersex in the form of testicular oocytes (immature eggs) in male Smallmouth Bass. A joint investigation by the US Fish and Wildlife Service, the US Geological Service, and the Maryland Department of Natural Resources found a high prevalence of intersex (82 – 100%) in Monocacy River Smallmouth Bass (Iwanowicz, et al., 2009). Further, the sources of the endocrine-disrupting chemicals associated with intersex conditions appear to be effluent from wastewater-treatment plants as well as runoff from agricultural land, animal feeding operations, and urban/suburban land.

The most sensitive stage for induction of testicular oocytes in Smallmouth Bass may be during sexual differentiation or within the first 2 to 3 weeks after hatching. In the Monocacy River, this period is generally during May and June. Spawning male Smallmouth Bass create circular nests in protected areas. Fertilized eggs within the nests can be exposed to contaminants associated with bottom sediments. Exposure at these early life stages can lead to a greater sensitivity to estrogenic

exposure later in life. Atrazine is a widely used agricultural herbicide applied to emerging corn crops during the sensitive early life stages of Smallmouth Bass. A significant positive relationship between intersex in Smallmouth Bass and atrazine in the water column above bass nests has been documented. Moreover, a significant positive relation between intersex in Smallmouth Bass and total hormone/sterol in bed sediment at the nests has been observed (Kolpin, et al. 2013).

Additionally, exposure to estrogen reduces production of immune-related proteins in fish, suggesting that certain compounds, known as endocrine disruptors, may make fish more susceptible to disease (Iwanowicz and Ottinger, 2009). A recent study demonstrated that largemouth bass injected with estrogen produced lowered levels of hepcidin, an important iron-regulating hormone found in mammals, fish, and amphibians. The research suggests that estrogen-mimicking compounds may make fish more susceptible to disease by blocking production of hepcidin and other immune-related proteins that help protect fish against disease-causing bacteria (Robertson, et al. 2009).



Skin lesions and spring mortality events of Smallmouth Bass, sunfish, and sucker species were first noted in the South Branch of the Potomac River in 2002. Since then, disease and mortality have also been observed in the Shenandoah and Monocacy Rivers. Despite much research, no single pathogen, parasite, or chemical cause for the lesions and mortality has been identified. The findings suggest that sensitive species may be stressed by multiple factors and constantly close to the threshold between a healthy and unhealthy condition. Fish health is often used as an indicator of aquatic ecosystem health, and these findings raise concerns about environmental degradation within the Potomac River drainage (Blazer, et al. 2010), including the Monocacy River.

consistent natural reproduction and an abundant population, stocking was no longer necessary and was eventually discontinued. The Monocacy River has long been regarded as an excellent fishery for bass and catfish.

Environmental Concerns

A number of environmental stressors face the fish and other aquatic life in the Monocacy River. Primary stressors include sedimentation, excessive nutrients, and chemicals of emerging concern known as endocrine disruptors. Land use in the Monocacy watershed is approximately 64 percent agricultural, seven percent urban, and 26 percent forested. Stormwater runoff over unforested land carries sediment and associated nitrogen, phosphorus and contaminants



into the river. Sediment smothers gravel and cobble substrate reducing habitat quality for both fish and the invertebrates they feed on. High nutrient levels foster algal growth and increase habitat for snails, an intermediate host for many common fish parasites.

Chemicals in many detergents, pesticides, plastics, pharmaceuticals, and agricultural veterinary products are flushed into the Monocacy River by stormwater runoff. Once in the aquatic environment, this complex mixture of compounds can mimic hormones and elicit unnatural responses within the endocrine system of fish and other organisms. A high prevalence of skin lesions and spring mortality of mature Smallmouth Bass in the Potomac and James River watersheds indicates that they may be a sensitive indicator of environmental health in the Chesapeake Bay watershed (Blazer, et al. 2010).

Current Status and Monitoring of the Smallmouth Bass Fishery

The Department of Natural Resources, Inland Fisheries Division monitors the Monocacy River Smallmouth Bass by surveys of both the young and adult segments of the population. Populations in river environments are dynamic in nature and shaped by highly variable reproductive success and mortality. Annual haul seine surveys conducted during July have been used to measure the relative abundance of young Smallmouth Bass in the Monocacy since 1997. Relative yearclass strength is estimated by the average number of young bass captured per seine haul. High water levels and turbidity during the months of May and June are the primary factors that reduce spawning success and fry survival of Smallmouth Bass. No significant trends in yearclass strength were identified between 1997 and 2013; Smallmouth Bass reproduction has been sufficient to maintain an attractive recreational fishery (MD DNR, 2013).

The adult segment of the Smallmouth Bass population is monitored by conducting electrofishing surveys at least once every three years using boat or barge-mounted equipment. A substantial fish kill occurred in the upper Monocacy River during May, 2009 following a high water event. The kill primarily affected adult Smallmouth Bass and sucker species. To date, no single, specific biological or chemical "cause" for the mortality has been identified, despite much research by state, federal and other investigators. Population estimates determined during the fall of 2008 and 2009 using barge-mounted electrofishing equipment documented declines in adult Smallmouth Bass biomass and density near 60 percent (Maryland DNR, 2011). By 2013, surveys suggested that the Monocacy River Smallmouth Bass population had recovered from the 2009 fish kill. Further, the 2013 survey documented biomass and density values for legal length bass that were higher than pre-fish kill values recorded in 2008 (Maryland DNR, 2013). Smallmouth Bass biomass estimates from the Monocacy River compare favorably with other mid-Atlantic rivers.

Amphibians and Reptiles

The riparian environment and its associated flood plain and wetlands provide a vital, moist habitat for amphibians. Amphibian species diversity and composition may be affected by flood conditions. High water can disperse species to different regions, and during low-flow conditions, amphibians are often restricted to one area. (14)

Many different species of reptiles live in the Monocacy River Valley. Snakes and lizards may be found in stream valley bottoms as well as upland areas. Turtle habitats include streams, wetlands, forests, and other moist areas. (See Appendix, Amphibians and Reptiles.)

Waterfowl and Other Birds

Avian species found in the region include waterfowl, birds of prey, gamebirds, and songbirds. Waterfowl habitat includes vegetated areas along stream corridors. One of the greatest concentrations of waterfowl may be observed from Michael's Mill Dam through the Monocacy Natural Resources Management Area to the river's confluence with the Potomac. This region also has numerous pockets of wetlands and channels which provide an expanded habitat favorable for waterfowl. (14)

Mallards, Blue and Green Wing Teal, Mergansers, Black Duck and Pintail are bottomland ducks that have been sighted in the watershed. Mallards and Wood Ducks breed locally. More transient ducks include the American Widgeon, Ring Neck Duck and Ruddy Duck. Canada Geese are occasional year round residents.

A graceful wading bird that inhabits the lower Monocacy is the Great Blue Heron. Its smaller cousin, the Green Heron, may also be observed wading in shallow areas. The Solitary Sandpiper and Spotted Sandpiper are temporary visitors.

Fish, amphibians, reptiles and small mammals in the river corridor provide a varied food source for predatory birds. Permanent predatory birds include the Red Shouldered, Redtailed, Sharp Shinned, and Cooper's hawks, and the Osprey. The Broad Wing Hawk is also present in the River corridor. The Kestrel, a member of the Falcon family is common, as well as Bald Eagles. Owls such as the Screech, Barred, and Great Horned are seen in the watershed. Quail, pheasant and wild turkey are also present in the watershed.

Recommendations

- 5-1) *Frederick and Carroll Counties should consider identifying the Monocacy River, its floodplain and corridor as a "High Conservation Value" area and actively support the environmental enhancement of the River's floodplain and corridor by employing a wide range of economic incentives, financial aid, and technical assistance for landowners to protect, maintain, and restore the habitat and water quality functions of the forestlands and wetlands in the Monocacy River Corridor*
- 5-2) *Target resources from Frederick County's Tree Planting and Easement Program (within the Office of Sustainability and Environmental Resources) to reforest Ecologically Significant Areas (ESAs) in the Monocacy River Corridor and gaps in the River's riparian cover identified with Green Infrastructure spatial analysis*
- 5-3) *Consider establishing the Monocacy River Corridor as a priority area in Frederick County, Carroll County, and the City of Frederick, for Forest Resource Ordinance (FRO) easements. The Town of Walkersville Comprehensive Plan states that required FRO plantings will be directed to the Monocacy River, Glade Creek and Israel Creek stream valleys*
- 5-4) *Implement action item NR-A-05 from the Frederick County Comprehensive Plan which states, "Target areas along the Monocacy River as FRO priority areas (forest plantings and banking) in addition to streams in the agricultural zoning district"*
- 5-5) *Establish a mainstem Monocacy reforestation program by utilizing Frederick County's Fee-in-Lieu FRO funds to purchase easements (existing forest or new tree plantings) within the River's floodplain and corridor, with focus on ESAs in the River Corridor*



- 5-6) *Plan and conduct a public outreach and restoration project for the Waterside Community, where technical and financial assistance is provided for the reforestation of the 39-acre, unforested, floodplain Open Space that exists along the Monocacy River in the community. This River-front land is part of an area designated as a Tier III (highly significant for biodiversity conservation) Ecologically Significant Area (ESA) by the Maryland Department of Natural Resources. Also focus on the reduction in the HOA's land maintenance costs—mowing---after turf grass is replaced with natural forest cover*
- 5-7) *The City of Frederick should undertake an analysis of the River's riparian forest buffer on the Clustered Spires Golf Course with active management of the tree canopy and understory vegetation to enhance the ecology and morphology of the River's floodplain forest. As the Clustered Spires Golf Course is located within the River's floodplain, the City should critically examine the use of conventional fertilizers and pesticides and less toxic alternatives to lessen chemical inputs into the River*
- 5-8) *Frederick County and Frederick City should lead by example and employ Monocacy Scenic River Best Management Practices (MSR-BMP) to reforest, where feasible opportunities exist, their public land holdings along the Scenic Monocacy River*
- 5-9) *The River Board should request the Maryland Department of Natural Resources to evaluate the Monocacy River Corridor in its future update of the State Forest Legacy Assessment of Need, and Strategic Forestland Assessment for possible inclusion of the River Corridor in a revised Maryland Forest Legacy Area.*
- 5-10) *Continue to provide support and assistance to the efforts of the Maryland Department of Natural Resources' Forest Service in control of forest disease/pests, i.e., Gypsy Moth, Emerald Ash Borer, Hemlock Woolly Adelgid, etc.*
- 5-11) *Continue to provide support and assistance to the efforts of the Maryland Department of Natural Resources' Inland Fisheries Division in their study and analysis of the Monocacy River's fish species, as well as stocking for the recreationally and economically important sport fisheries in the Watershed*
- 5-12) *The Counties and the River Board should support the efforts of environmental organizations, civic groups, and other NGOs in tree planting projects, wetland enhancements, or environmental education/outreach initiatives*
- 5-13) *The River Board encourages Carroll and Frederick Counties to incorporate climate change related impacts and risks (to public safety, health, and welfare, and infrastructure, natural resources, structures, etc.) related to Monocacy River flooding in their respective Hazard Mitigation Plans*

- 5-14) *The River Board encourages both Counties to incorporate the following elements in their respective Hazard Mitigation Plans, in case of a spill of hazardous toxic materials into the Monocacy River:*
- *Identification of hazardous chemical sites (storage, usage, etc)*
 - *Spill event detection, including responsible party identification*
 - *Monitoring of contaminant properties, including health effects*
 - *Emergency response/clean-up operations*
 - *Follow-up tracking, including regulatory response*
- 5-15) *Encourage the Frederick and Carroll County Forestry Boards to expand their responsibilities (and offer additional county resources if needed) to include the review and field check of permit applications for timber harvesting within the Monocacy River corridor to ensure that sound forestry management practices and water quality protections are being employed (Frederick County currently requires forestry board involvement in timber harvesting only for properties zoned resource conservation)*
- 5-16) *The River Board should engage with the Maryland Wood Duck Initiative to implement a project to install nesting boxes in the River Corridor for waterfowl (e.g. Wood Ducks) and other birds, with possible assistance from the Parks Departments of Frederick County and the City of Frederick*
- 5-17) *The River Board, with assistance from both Counties, should explore the creation of a non-profit organization devoted to River protection and advocacy that will have the authority to seek and obtain grant funds from various governmental entities.*

