Browns Branch Wildlife Management Area

15 YEAR VISION PLAN

Location

Northeast of Church Hill, Maryland

In

Queen Anne's County
Maryland

On Approximately

1,172 acres

Prepared by:

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MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

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Box Turtle illustration by Wade Henry

Introduction

The Maryland Department of Natural Resources (DNR), Wildlife and Heritage Service (WHS) is responsible for the management of approximately 128,000 acres of State property. These areas designated as "Wildlife Management Areas" (WMA) encompass 64 separate tracts of land and are located in 22 of the 23 counties in the State. They range in size from just a few acres to well over 29,000 acres, and support most, if not all, of the major habitat types found throughout Maryland. These properties make up a significant portion of the Department's land holdings of approximately 494,000 acres.

In 2019, the State of Maryland acquired a property totaling 1,172 acres in north-central Queen Anne's County, which became Brown's Branch WMA. This property was acquired with Program Open Space funds. Brown's Branch WMA is currently the only WMA located in Queen Anne's County.

In 2020, a planning team of WHS staff was selected to establish long-term goals and visions for the management of this property, as well as develop a 15-year Vision Plan. To meet the goals outlined in this plan, WHS staff will develop a five-year work plan that coincides with our five-year work plan for the Federal Aid Grant time period.

Specific goals and objectives for Brown's Branch WMA are consistent with the Statewide Mission and Goals Statement for Wildlife Management Areas. The mission of the WMA system is "to conserve and enhance diverse wildlife populations and associated habitats while providing opportunities for public enjoyment of the state's wildlife resources through hunting and other wildlife-dependent recreation."

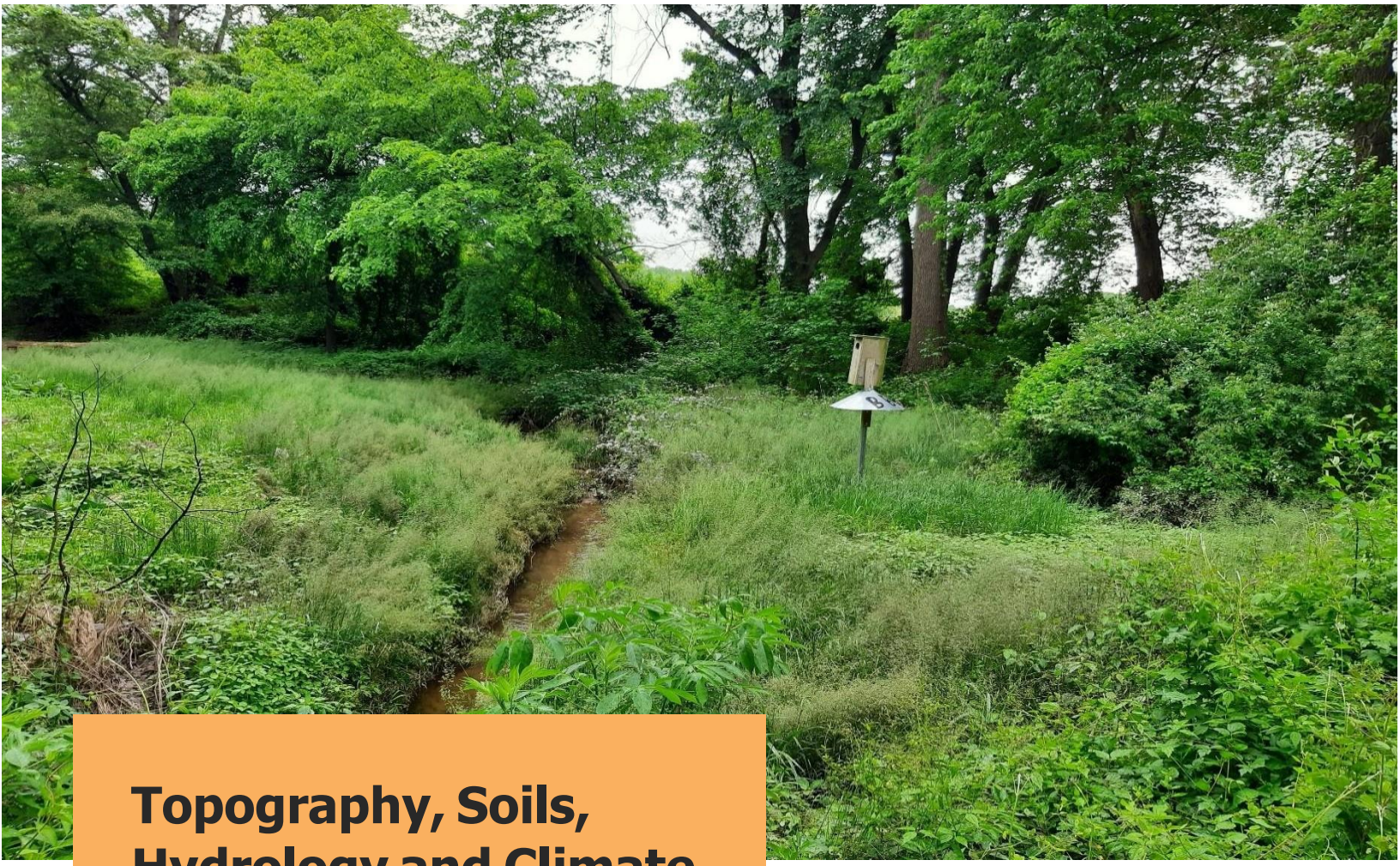
The goals of the WMA system are:

- To maintain, enhance or protect sustainable and diverse wildlife populations.
- Create, enhance or protect appropriate habitats, natural communities and ecologically sensitive areas.
- Conserve rare, threatened and endangered species by protecting the habitats that support them.
- With a focused emphasis on hunting, provide wildlife-dependent recreation on areas with minimal capital improvements or other development.
  Provide a venue to educate citizens on the value and needs of wildlife and plant communities through outreach, demonstration and sound management.

Physical Description

Brown's Branch WMA is located in north-central Queen Anne's County, approximately 2 miles northeast of the town of Church Hill, Maryland between State Route 300 and 301 and Hall Road (Appendix 1). The surrounding landscape is mostly rural with agriculture fields dominating the landscape, with deciduous forestland interspersed. This 1,172 tract currently consists of 682 acres of agriculture land, with the majority of the remaining acreage consisting of deciduous forests. Several non-tidal streams, man-made freshwater ponds, along with numerous cool season CRP fields and buffers are also interspersed around the property. A portion of Brown's Branch, a non-tidal stream for which the tract is named, runs through the property, eventually flowing west into Southeast Creek, a tributary of the Chester River.

Browns Branch WMA by DNR Staff



Browns Branch WMA by DNR Staff

Topography, Soils, Hydrology and Climate

Queen Anne's County is located within the Mid-Atlantic Coastal Plain. The highest point in the county is 87 feet, located near Starr. The many tidal marshes in the county represent the lowest point, which are at sea level or slightly below. Elevation changes are generally slight. The county can be divided into two topographic zones. The Talbot Terrace makes up the western portion of the county and is between 0-40 feet above sea level, with soils being generally poorly to moderately well drained. The Wicomico Plain makes up the eastern portion of the county and is generally between 40-80 feet above sea level. Topography in this region is gently undulating with well drained soils. A low escarpment that runs from Rolphs Wharf, on the Chester River, to Wye Narrows is the dividing line between the Talbot Terrace and the Wicomico Plain. This area marks the eastern shore of an ancestral Chesapeake Bay. The Chester River drains the northwestern portion of the county and provides the major water outlet. The southwestern portion of the county is drained by the Wye River and Eastern Bay, with Tuckahoe Creek draining the eastern portion of the county.

Queen Anne's County has a humid, semi continental climate. Summertime temperatures average about 74 degrees. The hottest time of the year is the end of July, with average maximum afternoon temperatures around 87 degrees. Wintertime temperatures average about 36 degrees. The coldest time of the year is the end of January, with an average low temperature around 24 degrees. Rainfall averages about 43 inches per year, with a fairly even distribution throughout the year, although it is less variable in the winter. Local thunderstorms are common between May and August. Average snowfall is 21 inches, but the amount varies from year to year. The prevailing wind is from the west for most of the year.

Several soil series are associated with Brown's Branch WMA (Appendix 2). The Ingleside and Unicorn series make up the majority of the agricultural land. These areas are well drained with a 2-5 percent slope and are prime farmland. Pockets of Carmichael and Whitemarsh series are also found in certain areas of the agriculture fields. These soils are poorly drained on a 0-2 percent slope. The Whitemarsh series makes up the majority of the soils found in the deciduous forest located in the southwestern corner of the property. The soils along the non-tidal streams are made up of the Longmarsh and Indiantown series. These soils are very poorly drained and are frequently flooded. Other soil series associated with the area include Hammonton, Pineyneck, Hurlock, Othello, and Corsica, but these are found over a much smaller area.

Beaver (Castor Canadensis) by Angela Genito for DNR Photo Contest

Capital Improvements

Current capital improvements at Brown's Branch WMA include approximately 2 miles of dirt road access, 3 parking lots, a 120' x 50' pole barn and 4 agriculture grain dryers. The barn and accompanying grain dryers are being used to store equipment and grain by the current agriculture lease holder. Present plans call for DNR Engineering and Construction to replace the existing pole barn with a new structure using stabilization funds. The four grain dryers will be razed after the current 5-year agriculture lease expires. Other capital improvements to be pursued using stabilization funds include the relocation of parking lots, installation of gates and parking lot barriers, culvert pipe replacements, cable barrier installation, removal of an old water well, and the installation of an ADA hunter access road.

Browns Branch WMA by DNR Staff

Browns Branch WMA by DNR Staff

Unique or Sensitive Areas

Key Wildlife Habitats

Beaver felled tree by Alicja via Pixabay

Although the WMA has not been well inventoried, at least eight Key Wildlife Habitats (KWHs) occur on the property (Appendix 3). Coastal Plain Floodplain forests occur along Browns Branch and some of its tributaries. Open beaver impounded sections occur along some stream sections. Green ash (*Fraxinus pennsylvanica*) was formerly common in the floodplain forests, but it has been decimated in recent years by emerald ash borer (*Agrilus planipennis*), leaving numerous snags and canopy light gaps. Coastal Plain Seepage Swamp can be found scattered along the outer edges of some floodplain areas and adjacent upland slopes and ravines.

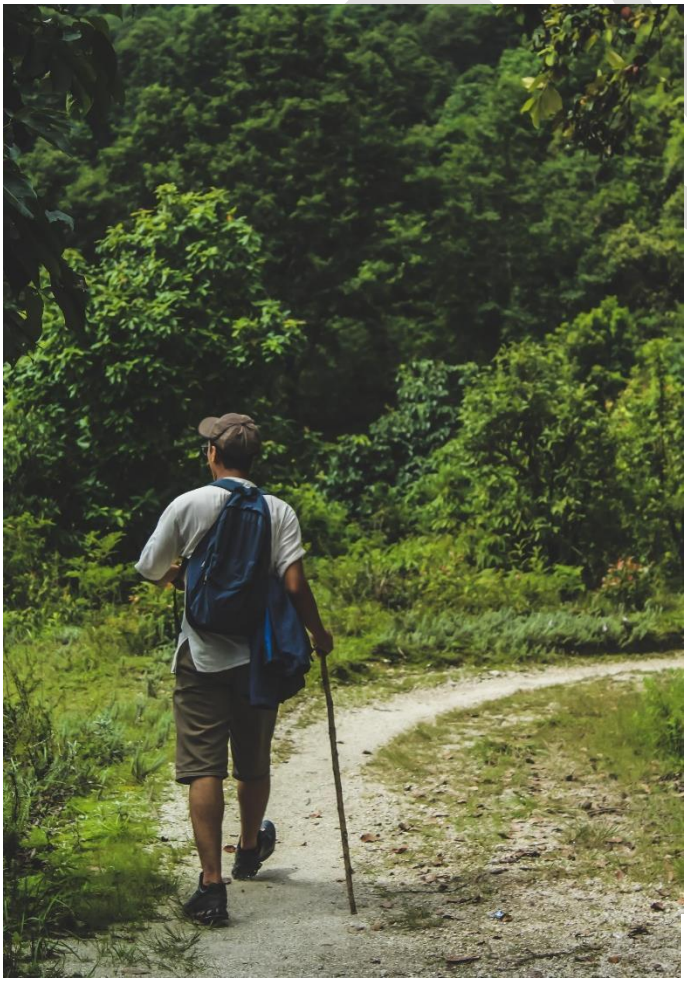


Image by Saroj Gajurel via Pexels

The surrounding upland forests are dominated by mature Mesic Mixed Hardwood Forest and, in richer, more calcareous areas, Basic Mesic Forest. The largest forest tract, located in the southern part of the WMA, contains multiple Vernal Pools within a matrix of mature Coastal Plain Flatwoods and Depression Swamp and Mesic Mixed Hardwood Forest.

Managed Grasslands, another KWH, occur along the periphery of agricultural fields in the form of narrow strips of CRP cool season grasses. The agricultural fields also include several man-made, freshwater ponds which represent a KWH called Artificial Impoundment and Artificial Wetland.

Rare, Threatened, and Endangered Species

Browns Branch is the namesake and centerpiece of the WMA. This small, 3rd-order coastal plain stream flows westward for nearly 6 miles from its headwaters in the northeastern part of the WMA to its confluence with the upper tidal reaches of Southeast Creek, a tributary of the Chester River. The WMA contains most of the Browns Branch headwaters including the uppermost 1.3 miles of the mainstem and 4 miles of tributaries. The Browns Branch watershed encompasses 6,854 acres with 73% of the area in agriculture, 25% forested, and less than 1% urban. Most of the WMA (84%, 979 acres) lies within this watershed; the remainder (16%, 193 acres) occurs in the Southeast Creek watershed to the south.

The Browns Branch stream system and surrounding watershed are a high conservation priority with state and regional significance for freshwater mussels. Freshwater mussels occur primarily in streams and rivers and most species are sensitive to habitat degradation. They represent one of the most imperiled faunal groups in the U.S. Nearly 70% of the nation's approximately 300 mussel species are extinct or imperiled. In Maryland, a similar pattern holds with 13 of the state's 16 species on the Maryland Rare, Threatened and Endangered Animal Species List. Browns Branch supports exceptionally high mussel species richness with eight species documented, four of which are rare, threatened, or endangered. These include the State and Federally Endangered dwarf wedgemussel (*Alasmidonta heterodon*), the State Threatened triangle floater (*Alasmidonta undulata*) and creeper (*Strophitus undulatus*) which is state listed as In Need of Conservation. Other mussels present are alewife floater (*Anodonta implicata*, Watchlist species), eastern lampmussel (*Lampsilis radiata*, Status Uncertain), eastern elliptio *Elliptio complanata*), northern lance (*Elliptio fisheriana*) and eastern floater (*Pyganodon cataracta*).

Biologists from the department and the U.S. Fish and Wildlife Service collect, measure, number and tag freshwater mussels from Deer Creek at Rocks State Park to reintroduce the species to the Patapsco River. Image by Stephen Badger for MD DNR

Browns Branch is one of only four Maryland streams where dwarf wedgemussel is still known to occur. The stream also formerly supported a significant population of the State Threatened triangle floater, although it is now greatly reduced. Browns Branch has been identified by DNR as a Tier 1 Ecologically Significant Area (ESA), the highest ESA tier designation, indicating an area that is critically significant for biodiversity conservation. It also forms a key part of the Southeast Creek Stronghold Watershed, a DNR designation that identifies watersheds that support the state's best remaining populations of rare, threatened, and endangered aquatic species. The segment of Browns Branch that occurs on the WMA is designated and regulated as Tier II, high quality waters which are stream segments with water quality that is significantly better than the minimum requirements, as specified in MDE water quality standards.

Freshwater mussels by Pixabay via Pexels

The first systematic inventory of the freshwater mussel fauna in Browns Branch was conducted by DNR in 2002-2003. A similar survey in 2012-2013 documented declines in several rare mussel species. This included a 63% reduction in the distribution of dwarf wedgemussel, from 5.7 to 2.1 km of occupied stream length, all of which was confined to the upper headwaters. These findings were further corroborated by eDNA sampling in 2014-2015. During 2021 monitoring, the population contracted even further to 1.6 km of stream length. It continued to be limited to the upper headwaters with the majority of the population now occurring on the WMA. Triangle floater and creeper both experienced even more severe declines with just two live triangle floaters found, both in the headwaters, and only one creeper observed, located below the Rt 213 bridge.

The causes of mussel declines in Browns Branch are probably due to the cumulative effects of multiple factors including inadequate riparian buffers, the lack of forest cover in the surrounding watershed, and chronic agricultural impacts, all leading to degraded stream conditions via high nutrient levels, pesticide runoff, sedimentation and altered hydrological conditions. Of particular concern are recent findings of high ammonia levels in the stream's surface and pore waters, likely due to farm runoff, which may reduce mussel

Image by Kindel Media via Pexels

recruitment. It is suspected that periods of severe drought in 2002-2003 followed by an unusually strong storm surge and salinity spike associated with Tropical Storm Isabel in September 2003 also contributed to mussel declines. Climate change impacts are a growing concern. In addition to rising sea levels and higher stream temperatures, the Delmarva will likely experience more frequent and severe coastal storms, localized rain events and periods of drought. Sea level rise projections predict a nearly 20% loss of freshwater mussel habitat in lower Browns Branch by 2100 as freshwater reaches become tidal. DNR mussel surveys have also noted expanding populations of Asiatic clam (*Corbicula fluminea*), a highly invasive nonnative bivalve, which may displace native mussels. MBSS stream monitoring has also documented lower densities of tessellated darter (*Etheostoma olmstedi)*, the host fish for dwarf wedgemussel, in some reaches which may limit the mussel's reproduction and dispersal.

The WMA is critical to the recovery and protection of Browns Branch and the rare mussels found here, especially dwarf wedgemussel.

The WMA is critical to the recovery and protection of Browns Branch and the rare mussels found here, especially dwarf wedgemussel. This will require expanded riparian forest buffers, wetland restoration, and the reforestation of existing agricultural fields while also establishing managed grasslands for other species of concern, especially northern bobwhite (*Colinus virginianus*). The WMA's importance will likely grow over time as the stream's lower nontidal reaches are lost to sea level rise and as the threat of suburban sprawl looms in the surrounding watershed. The WMA provides a unique opportunity to restore a forested stream ecosystem in a region where few high-quality streams and large forested areas remain, while also contributing to the Chester River and Chesapeake Bay's recovery.

Eastern Box Turtle in hand by Kerry Wixted

Other Species of Concern

The 2015 Maryland State Wildlife Action Plan identified 610 Species of Greatest Conservation Need (SGCN). As the name implies, this diverse group represents those species in Maryland that are most at risk of decline or extirpation and in need of conservation. It includes 260 vertebrates (34 mammals, 141 birds, 25 reptiles, 17 amphibians, 40 fish) and 350 invertebrates (272 insects, 40 crustaceans, 28 mollusks, 10 other misc. species). Below is a summary of SGCN that occur on or near Browns Branch WMA, as well as some potentially occurring species of concern. The 2nd Maryland and Washington DC Breeding Bird Atlas (BBA), conducted in 2002-2006, documented a total of 73 bird species as possible, probable or confirmed breeders in the two atlas blocks (Church Hill SE, SW) that include the WMA. This includes 15 SGCN and some other notable species.

Among the species recorded were ten forest interior dwelling bird species (FIDS), including several highly area-sensitive species such as Kentucky warbler (*Geothlypis formosa*) and black-and-white warbler (*Mniotilta varia*).

FIDS are forest nesting bird species that require large, contiguous forest areas and forest dominated landscapes to successfully breed and maintain viable populations. On Maryland's Coastal Plain, FIDS are represented by 25 bird species. The relatively low number of FIDS recorded in the two atlas blocks is an indication of the lack of large, unfragmented forest tracts on the WMA and in the surrounding landscape. Few large, forested areas remain on the upper Eastern Shore. In Queen Anne's County, only two forest tracts are large enough to be considered FIDS Core Areas. Such areas generally contain at least 500 acres of forest interior habitat and tend to be large enough to support most of the potentially occurring FIDS in a given area. This large, diverse suite of species would benefit from expanding the extent of native mature forest on the WMA in a way that increases the amount of forest interior area and minimizes forest fragmentation.

Kentucky Warbler by RStainfield

Bats will also benefit from large, mature forest tracts and the retention of larger trees and snags, especially along riparian corridors. Although no bat surveys have yet been conducted on the WMA, seven of the state's ten bat species potentially occur here. These include the State and Federally Threatened northern long-eared bat (*Myotis septentrionalis*) as well as the little brown bat (*Myotis lucifugus*) and tricolored bat (*Perimyotis subflavus*) which are being considered for listing. The greatest threat to these species is White-nose Syndrome which has devastated populations of many bat species in North America. Other threats include human disturbance to their hibernacula, maternity sites and roost sites, and forest habitat loss and degradation.

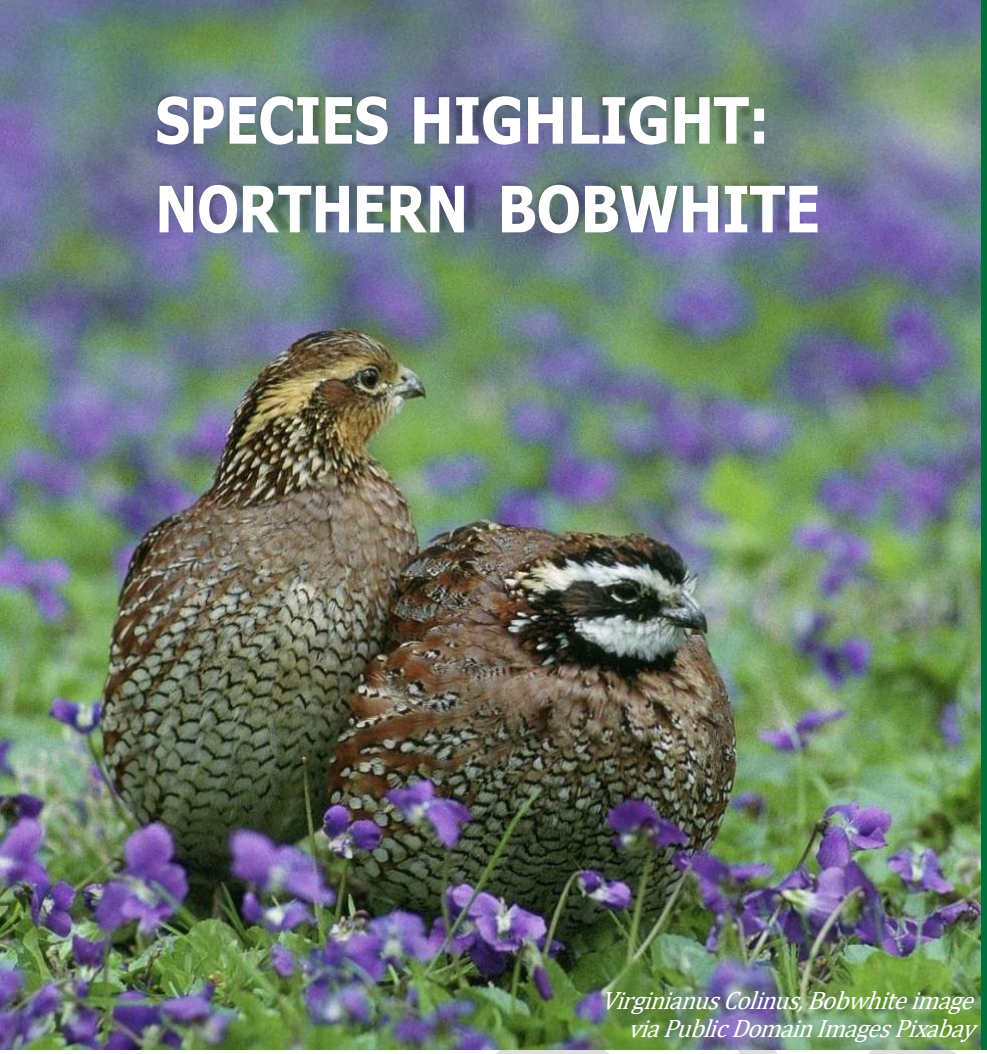
The BBA also documented the following six SGCN birds that are grassland and early successional habitat specialists: northern bobwhite, American kestrel (*Falco sparverius*), grasshopper sparrow (*Ammodramus savannarum*), dickcissel (*Spiza americana*), eastern meadowlark (*Sturnella magna*) and yellow-breasted chat (*Icteria virens*). Although not recorded in the two Church Hill atlas blocks, American woodcock (*Scolopax minor*), an early successional species, is a potential breeder and likely uses the WMA as migratory stopover and winter habitat. Many grassland and early successional bird species have experienced significant declines. The causes include habitat loss due to development and agriculture, incompatible farming practices, the disruption of natural disturbance regimes (e.g., the lack of fire that historically played an important role in maintaining native grassland, shrubland and woodland habitats) and forest maturation.





Top, left to right: American Kestrel Falconry image by Steve Bidmead via Pixabay, Eastern Red Bat by JanetandPhil CC by NC ND 2.0, Northern Lonng-eared bat by NYDEC
Bottom, left to right: Male yellow-breasted chat by Will Parson – Chesapeake Bay Program via Flickr CC by NC 2.0, Little Brown Bat by Ann Froschauer for USFWS

SPECIES HIGHLIGHT: NORTHERN BOBWHITE



Virginianus Colinus, Bobwhite image via Public Domain Images Pixabay

This species has declined over 99% in Maryland during the past 50 years. Remaining populations are becoming increasingly isolated and more vulnerable to local extirpations. Habitat establishment and management is needed to reverse the decline of this and other co-occurring grassland and shrubland specialists.

A grassland/early successional species of especially high concern is northern bobwhite. Although northern bobwhite has not been documented recently on Browns Branch WMA, potential source populations exist nearby within reasonable dispersal distances. Most other co-occurring bird species are migratory and can be expected to inhabit the area quickly with appropriate management.

The Maryland Amphibian and Reptile Atlas (MARA) was a 5-year cooperative effort (2010-14) between DNR and the Maryland Natural History Society. Using a block grid approach similar to the BBA, 25 reptile and amphibian species were recorded in the Churchill SE and SW blocks. This comprised two salamanders, ten frogs and toads, one lizard, five turtles and seven snake species. Highlights included two SGCN, the eastern box turtle (*Terrapene carolina carolina*) and eastern ribbonsnake (*Thamnophis saurita*). The ribbonsnake is an uncommon, semi-aquatic species occurring along freshwater streams, wetlands and ponds where it feeds mainly on small amphibians, especially frogs, as well as small fish. This species should benefit from stream restoration efforts on the WMA. The eastern box turtle is primarily a mixed and deciduous forest inhabitant, but it can be found in a wide range of habitats (e.g., meadows, wooded backyards, etc.). Although still fairly widespread and common in some areas, it has declined throughout most of its range. The primary threats are habitat loss and degradation, especially due to suburban sprawl, road mortality, disease and illegal collecting. The forests and managed grasslands on the WMA should provide much needed refugia for this familiar species.

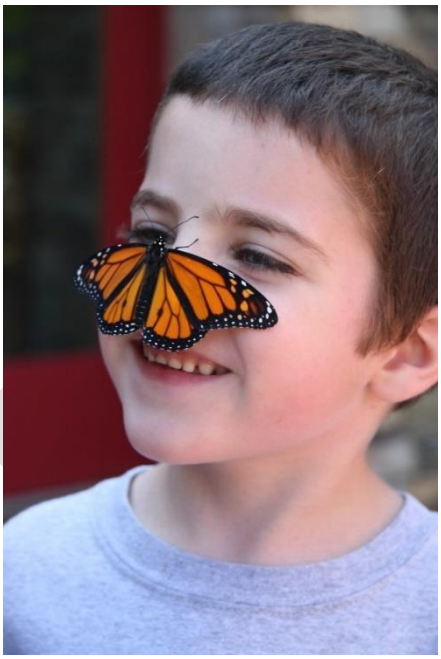
Other notable herps recorded in the vicinity of the WMA are two vernal pool specialists, the marbled salamander (*Ambystoma opacum*) and wood frog (*Lithobates sylvaticus*). Vernal pools provide critical breeding habitat for these, and several other amphibians and they support unique invertebrate communities. Protection measures for these unique habitats should include maintaining undisturbed forest buffers around the pools and forest connectivity between nearby vernal pools.

Top to Bottom: Wood Frog by planet_fox via pixabay, Marbled Salamander by Kerry Wixted, Frog image by Mx_A via Pixabay

Browns Branch has received some limited stream sampling by MBSS. One site, sampled in 2000 and located just downstream from Rt. 300 and the WMA boundary, yielded a fish index of biotic integrity of 4.33 out of 5 and a benthic index of biotic integrity of 5.00 for a combined biotic integrity score of 4.67, indicating good biotic integrity. Fish species found include tessellated darter, the required fish host for dwarf wedgemussel. Also present were least brook lamprey (*Lampetra aepyptera*), American eel (*Anguilla rostrata)*, fallfish (*Semotilus corporalis*), tadpole madtom (*Aphredoderus sayanus*), pirate perch (*Aphredoderus sayanus*), eastern mudminnow (*Umbra pygmaea*) pumpkinseed (*Lepomis gibbosus*) and red-breasted sunfish (*Lepomis auritus*). The presence of least brook lamprey, an SGCN, is notable. This uncommon freshwater fish occurs in small Coastal Plain streams. Spawning adults concentrate in clear, clean sand-gravel riffles and runs. Unlike sea lampreys (*Petromyzon marinus*), it is non-parasitic, and the larvae remain buried in the stream bottom for 5-6 years feeding on plankton and microscopic detritus; the short-lived adults do not feed and die following spawning.

Monarch on New England Aster by Greg Thompson for USFWS

Browns Branch and seepage wetlands along the stream's floodplain and floodplain terrace may support several rare dragonflies and damselflies. Potentially occurring species include the tiger spiketail (*Cordulegaster erronea*, Watchlist), Sely's sundragon (*Helocordulia selysii*, State Threatened) and sparkling jewelwing (*Calopteryx dimidiata*, State Rare). High quality seeps and springs may also contain highly specialized groundwater invertebrates (e.g., isopods, amphipods), some of which are globally rare local endemics.



Zack and Madison by Caroline Blizzard

Large patches of native flowering plants on the WMA will likely attract a host of pollinating insects. These may include several SGCN known to occur on the Eastern Shore such as American bumble bee (*Bombus pensylvanicus*), the black-and-gold bumble bee (*B. auricomus*) and the lemon cuckoo bumble bee (*B. citrinus*). Many *Bombus* species have declined in recent decades due to a variety of factors such as pesticide use, habitat destruction and pathogen spillover. Increasing nesting and foraging habitat for these species on protected land is important for their continued persistence on the landscape. Other bees, including species of mining bees (*Andrena spp.*) and hairy-tongue bees (*Lasioglossum spp.*), many of which are data-deficient, may also use areas that offer a variety of pollen resources that flower-rich grasslands provide. The WMA's forest, wetland and grassland habitats also likely support a variety of butterfly species as well as numerous moths, many of which are data deficient but may warrant conservation attention. These may include some SGCN butterflies such as monarch (*Danaus plexippus*), bronze copper (*Lycaena hyllus)*, dusted skipper (*Atrytonopsis hianna*) and cobweb skipper (*Hesperia metea*).

Ribbon Snake by Judy Gallagher via Flickr CC by 2.0

Image by E.Katerina Bolovtsova via Pexels

Recreational Use

The primary use of this property will be public hunting. Hunting access is by daily reservation only, managed through the Central Region public hunting permit reservation system. Forest game species, such as white-tailed deer (*Odocoileus virginianus*) and eastern wild turkey (*Meleagris gallopavo*), will make up the majority of the hunter usage on this property. Hunting opportunities for mourning dove (*Zenaida macroura*), as well as upland game species, including eastern cottontail (*Sylvilagus floridanus*) and northern bobwhite, will be encouraged through future habitat management activities. Waterfowl hunting opportunities exist in the agriculture fields, creeks, and ponds. Furbearer trapping is allowed on the area by permit only.

Opportunities for non-hunting activities, such as hiking, bird watching, biking, horseback riding, and nature photography are also available.

In accordance with Federal Aid in Wildlife Restoration guidelines, only wildlife dependent recreation will be promoted or allowed on this area.

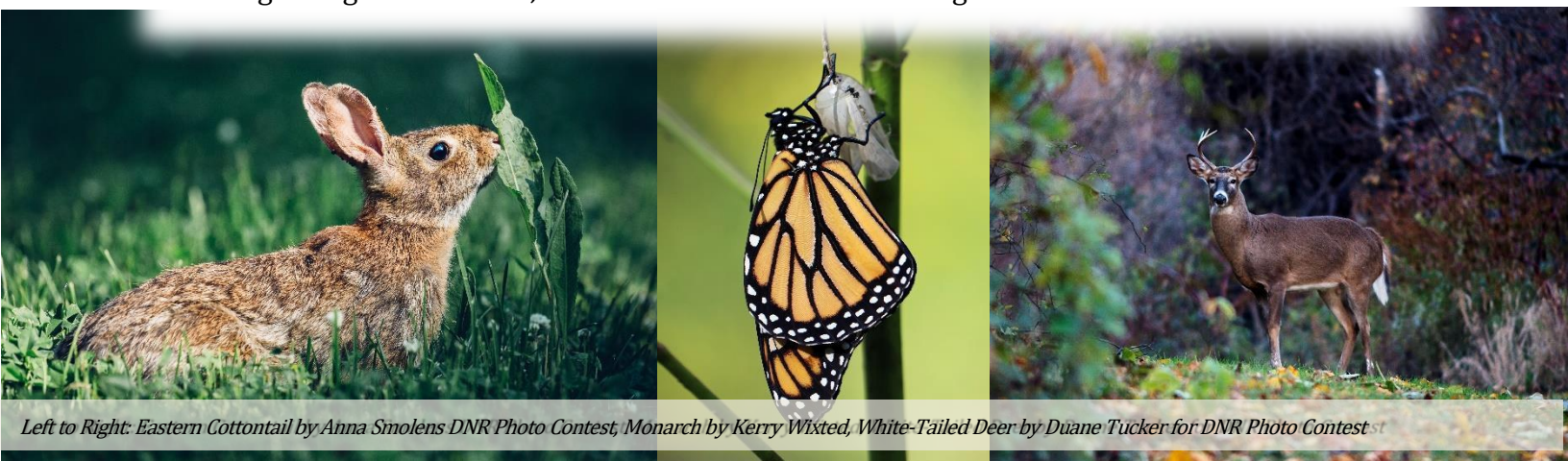
Women Turkey Hunting by James Mackey

Climate Change Adaptation Considerations

Climate change is likely to have a variety of impacts on the natural resources at Browns Branch WMA. To help address these future impacts, a technical advisory team was formed in 2020 to draft a climate change and resiliency plan for the property. Increasing temperatures can lead to species loss and reduced population viability. The timing of the annual life cycles of plants and animals may be disrupted, affecting species interactions and ecosystem function. Increased precipitation and worsening storms will lead to increased flooding, erosion, sediment deposition, and nutrient runoff, causing degraded stream conditions. This, in turn, will affect aquatic communities including freshwater mussels and fish. Conversely, increasingly prolonged droughts will place additional stress on both aquatic and terrestrial species. Warmer temperatures may also create more conducive environments for invasive species while native species may become more vulnerable to pathogens, parasites, and other health threats.

Mitigating the effects of climate change requires planning and an understanding of the tools and conservation measures that are needed to respond effectively. The WMA has tremendous potential for restoring both aquatic and terrestrial habitats and improving habitat connectivity for dispersal. The conversion of existing farmland to forest and grassland habitats will significantly improve stream conditions in Browns Branch and its tributaries by reducing bank erosion, sedimentation, and excessive nutrient levels. The control and removal of invasive species, along with preventing the establishment of additional nonnative species will help protect native species and habitats. Planting native vegetation that matches climate predictions will be essential in preventing invasive species from colonizing a space before native species become established. Removing invasive species will also help wildlife populations meet their habitat needs at Browns Branch. All of these measures should collectively help the WMA's natural resources build greater resilience to climate change. However, habitat management and restoration will likely become more challenging with increasing temperatures, greater rainfall, more frequent and severe storms, along with prolonged periods of drought. Prescribed burn plans, for example, will need to take these factors into account to achieve burn goals safely and effectively.

Infrastructure on the WMA may also be impacted by climate change. To help maintain gravel roads, native vegetative buffers along roadsides and parking areas will help improve soil stabilization, water infiltration, and nutrient uptake. The removal of agricultural tiles and installation of water control structures will help facilitate the collection of water during drought conditions, and the removal of water during wet conditions.



Left to Right: Eastern Cottontail by Anna Smolens DNR Photo Contest, Monarch by Kerry Wixted, White-Tailed Deer by Duane Tucker for DNR Photo Contest

Acquisition

Brown's Branch WMA currently encompasses approximately 1,172 acres. It was purchased in 2019 with Program Open Space funds and is managed with Pittman-Robertson Federal Aid in Wildlife Restoration (PR) Funds. The potential to increase the acreage at Browns Branch WMA is predicated on the Department's policy of working with willing sellers and available funding and Program Open Space priorities. The planning team has made the recommendation to pursue the acquisition of adjacent parcels to Brown's Branch WMA as they become available if they provide wildlife habitat that support the goals and objectives of the Vision Plan and/or improve operational efficiencies such as simplifying boundaries or improving access.

Woodcock by Arlen Breiholz via Flickr CC by NC ND 2.0

Habitat Management Units

Browns Branch WMA by DNR Staff

A Wildlife and Heritage Service planning team was formed in September 2020 to initiate the wildlife management area planning process for Browns Branch WMA. To assist with the development of specific goals and objectives for the property, habitat management units (HMU's) were delineated based on factors including vegetative cover, sensitive species, present land use and other factors (Appendix 4). The delineation of these HMU's was then used to facilitate development of site-specific habitat management objectives and strategies for each unit. Each HMU is titled according to a key wildlife habitat description from the Maryland State Wildlife Action Plan (2015). Descriptions of each key wildlife habitat type can be found on the Wildlife and Heritage website.

Habitat Management Unit #1

Managed Grassland

Description:

HMU 1 will total approximately 545 acres of former agriculture land. The majority (90-95%) of this acreage will consist of native warm season grasses, wildflowers, and legumes. Native shrub plantings will be interspersed throughout the grass planting units and may be used to create a more gradual ecotone along the adjacent grassland-forest edge. The remaining acreage will consist of annual and perennial food plots, primarily around the perimeter of the grass plantings.

Habitat Management Goal:

The goal of this HMU will be to create and maintain early successional habitat that will benefit a variety of species including northern bobwhite, eastern wild turkey, eastern cottontail, and white-tailed deer. A primary focus of this HMU will be to provide habitat of sufficient quality and quantity to encourage northern bobwhite to colonize, and eventually, persist in sustainable numbers on the WMA. A minimum of approximately 500 acres of habitat is thought to be needed to sustain a viable bobwhite population. Management activities in this unit will also provide an abundance of habitat for grassland and shrubland-dependent non-game birds, mammals, and pollinators that share similar habitat requirements.

Objectives:

- To provide suitable habitat for early successional species, with an emphasis on northern bobwhite.
- To provide grassland and shrubland habitat, with an emphasis on SGCN nongame birds and insect pollinators.
- To provide high-quality hunting opportunities for popular game species.
- To help restore and protect the stream ecosystem, including state and federally protected mussels, throughout the WMA portion of Browns Branch and its tributaries.

Strategies:

- Establish native grass, wildflowers, legumes, and shrubs via planting or natural regeneration.
- Manage and maintain native grass plantings via prescribed fire, mechanical, or chemical methods as required depending on conditions.
- Plant annual and perennial food plots to provide food and cover for a variety of wildlife species.
- Monitor for invasive species and conduct control efforts as needed.

Habitat Management Unit #2

Coastal Plain Forest

Description:

HMU 2 will comprise approximately 593 acres. This includes 433 acres of existing forest and 160 acres of former agriculture land (of which ~10 acres are former wetlands included in HMU 3). This acreage will be focused around Browns Branch, its tributaries, and the surrounding uplands. The forest along Browns Branch and its tributaries is dominated by mature Coastal Plain Floodplain Forest bordered by narrow (~50-300' wide) bands of mature upland forest. The upland forest is dominated by Mesic Mixed Hardwood Forest and some Basic Mesic Forest where soils are richer and more calcareous. Scattered along the outer edges of the floodplain and in adjacent small ravines are Coastal Plain Seepage Swamp. Beaver activity has created scattered open to semi-open forest conditions along some floodplain areas. The floodplain also contains numerous snags and canopy light gaps due to green ash mortality caused by emerald ash borer. The forest tract in the southwest part of the WMA includes scattered vernal pools of varying size and hydroperiods within a matrix of mature Mesic Mixed Hardwood Forest and Coastal Plain Flatwoods and Depression Swamp.

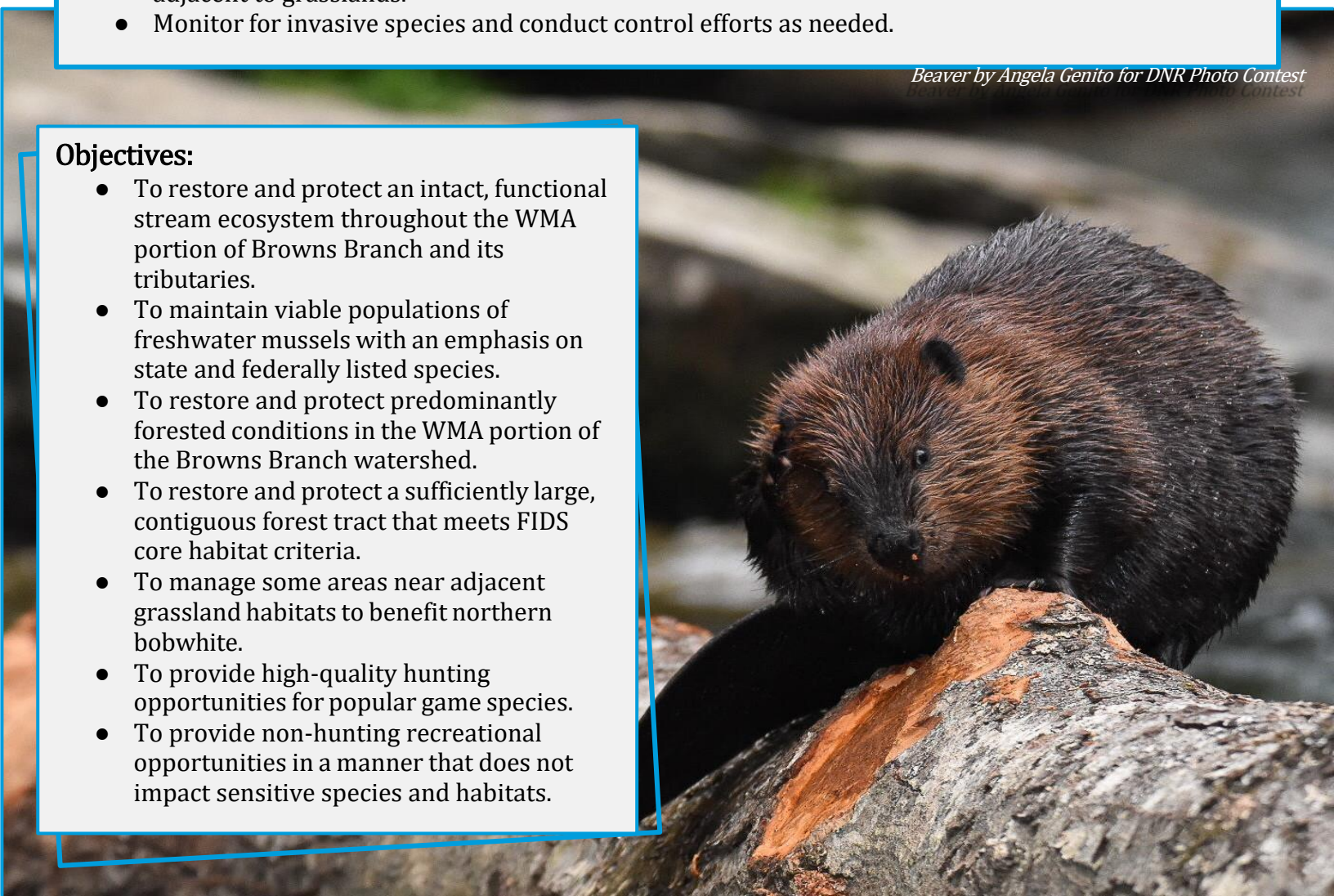
Habitat Management Goal:

The goal of this HMU will be to restore and protect the WMA portion of Browns Branch, its tributaries, and the surrounding watershed to maintain viable populations of freshwater mussels within an intact, functional stream ecosystem, with a focus on state and federally listed mussel species. This will be done in a manner that reestablishes a predominantly forested watershed and a sufficiently large, contiguous forest tract to meet FIDS core habitat criteria while allowing for some management to benefit northern bobwhite near adjacent grassland areas. Hunting and some forms of non-hunting recreation (e.g., hiking, birding) will be encouraged; recreational activities (e.g., equestrian use, biking) that may impact sensitive species and habitats may be excluded or limited to avoid such impacts.

Image courtesy of Pexels stock project

Strategies & Objectives

- Working with DNR-MBSS, United States Fish and Wildlife Service (USFWS) and other partners, develop and implement freshwater mussel and stream monitoring protocols to evaluate the efficacy of stream/watershed restoration efforts and ensure that mussel population and stream restoration goals are met.
- Work with conservation partners to develop and implement plans to enhance riparian buffers and complete large-scale reforestation in the WMA portion of the Browns Branch watershed.
- Ensure that reforestation efforts are conducted in a way that meets or exceeds FIDS core habitat criteria.
- Work with partners to develop and implement plans to restore stream sections that have been ditched and channelized.
- Eliminate stream crossings over Browns Branch and its tributaries; where crossings must be maintained, install stream crossings that avoid stream and freshwater mussel impacts.
- In most of the HMU, allow existing forest and reforested areas to attain old growth conditions. Active management will be limited to management practices that help reestablish, to the extent possible and where needed, natural forest community conditions. Such practices may include invasive species control, prescribed burns, controlling deer herbivory, and silvicultural practices that restore and promote natural forest communities.
- Develop and implement plans for appropriate northern bobwhite habitat management in areas adjacent to grasslands.
- Monitor for invasive species and conduct control efforts as needed.



Beaver by Angela Genito for DNR Photo Contest

Objectives:

- To restore and protect an intact, functional stream ecosystem throughout the WMA portion of Browns Branch and its tributaries.
- To maintain viable populations of freshwater mussels with an emphasis on state and federally listed species.
- To restore and protect predominantly forested conditions in the WMA portion of the Browns Branch watershed.
- To restore and protect a sufficiently large, contiguous forest tract that meets FIDS core habitat criteria.
- To manage some areas near adjacent grassland habitats to benefit northern bobwhite.
- To provide high-quality hunting opportunities for popular game species.
- To provide non-hunting recreational opportunities in a manner that does not impact sensitive species and habitats.

Habitat Management Unit #3

Managed and Restored Wetlands

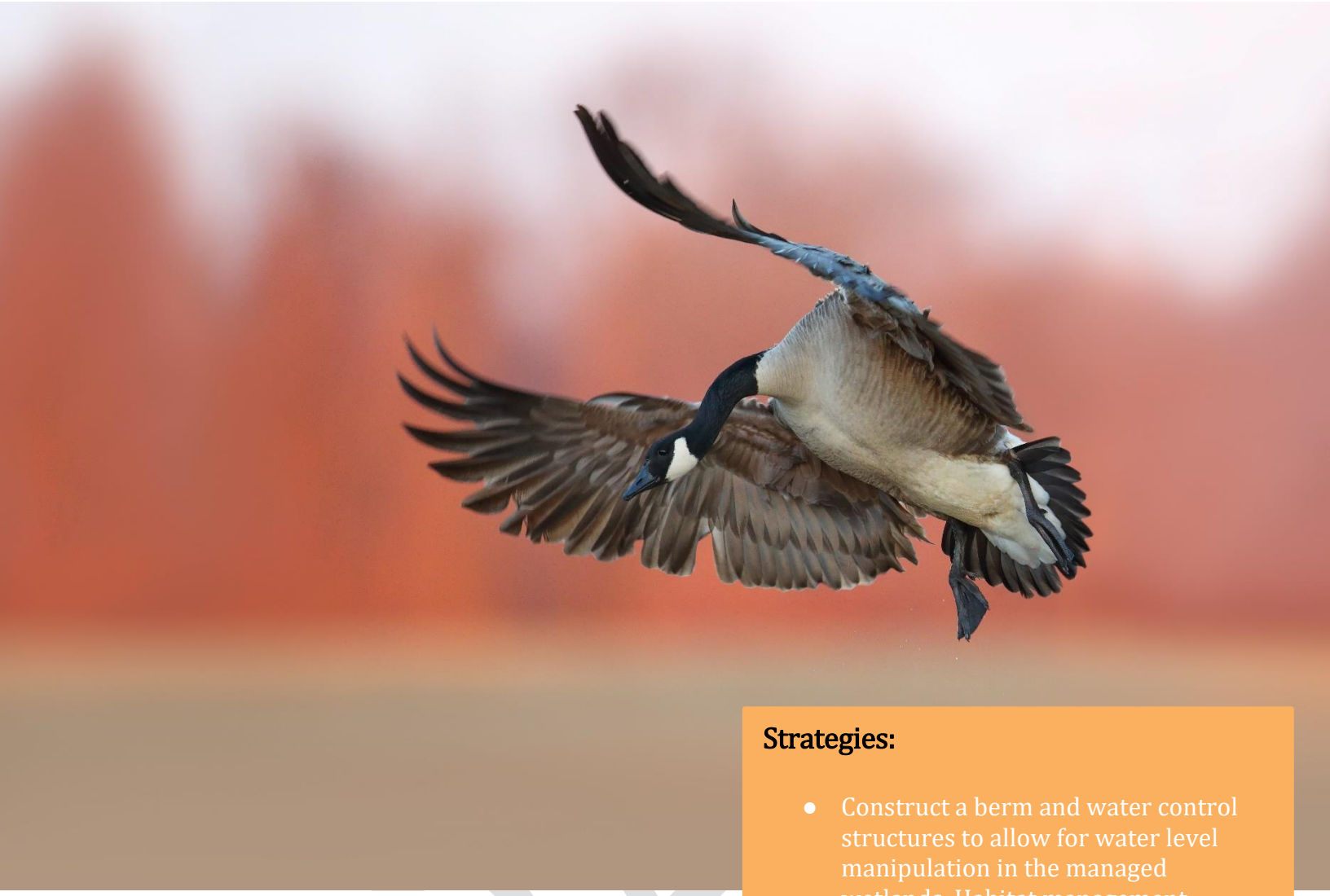
Description:

HMU 3 totals about 40 acres in 10 separate locations. Two wetlands (one existing, one to be constructed) totaling about 15 acres will include a water control structure to allow water levels to be managed. At the remaining wetlands (total of about 25 acres, all currently farmed), the natural hydrology will be restored by removing any field tiles and ditching allowing water levels to vary naturally and native vegetation to become established.

Habitat Management Goal:

The goal of this unit will be the enhancement of moist soil vegetation to attract a variety of waterfowl, wading birds and shorebirds in the managed wetlands and the restoration of natural hydrology and native wetland vegetation in the restored wetlands to create vernal pool habitats. These habitat conditions will also provide food and cover for waterfowl, wading birds, shorebirds, as well as amphibians, reptiles, and a host of other wildlife species. Wetland design and management will facilitate the use of natural hydrologic cycles and drying to manage drawdown so the potential for thermal pollution is minimized or eliminated. Water control structures should be used to drawdown impounded areas when natural cycles do not allow for management or for emergency measures (repairs, invasive species management, fish removal, etc.). Ditched streambeds downstream from the impounded areas should be regraded to historic topography and planted with appropriate native vegetation. Restoration of natural hydrology in the restored wetlands and immediate downstream area will improve water infiltration and decrease runoff, thus improving the quality of water entering Brown's Branch.

Wood Duck by Duane Tucker for DNR Photo Contest



Goose by Scott Moody for DNR Photo Contest

Objectives:

- Provide suitable hydrology, food, and cover in the managed wetlands for species that utilize moist soil vegetation with a focus on migratory waterfowl, wading birds, and shorebirds.
- Provide native wetland vegetation, slow stormwater runoff, create vernal pool habitats, and provide a sediment trap by restoring wetlands where soils and topography reasonably accommodate these actions.
- Provide hunting opportunities where appropriate.

Strategies:

- Construct a berm and water control structures to allow for water level manipulation in the managed wetlands. Habitat management practices in the managed wetlands will include water-level management, vegetation management, food plot establishment and invasive plant control. Managed wetlands will include about an acre of permanent water to facilitate water infiltration. Water levels will typically be decreased, preferably by natural drying, over a period of several months during the spring and summer to allow for growth of moist soil vegetation.

- Restore the natural hydrology and native wetland plants of wetlands that are currently farmed by breaking/blocking field tiles, plugging ditches, and/or implementing other applicable BMPs to create vernal pools. Management in the restored wetlands will be limited to control of invasive species and woody vegetation.

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Kathy McCarthy - Natural Heritage Habitat Program Manager - Wildlife and Heritage Service
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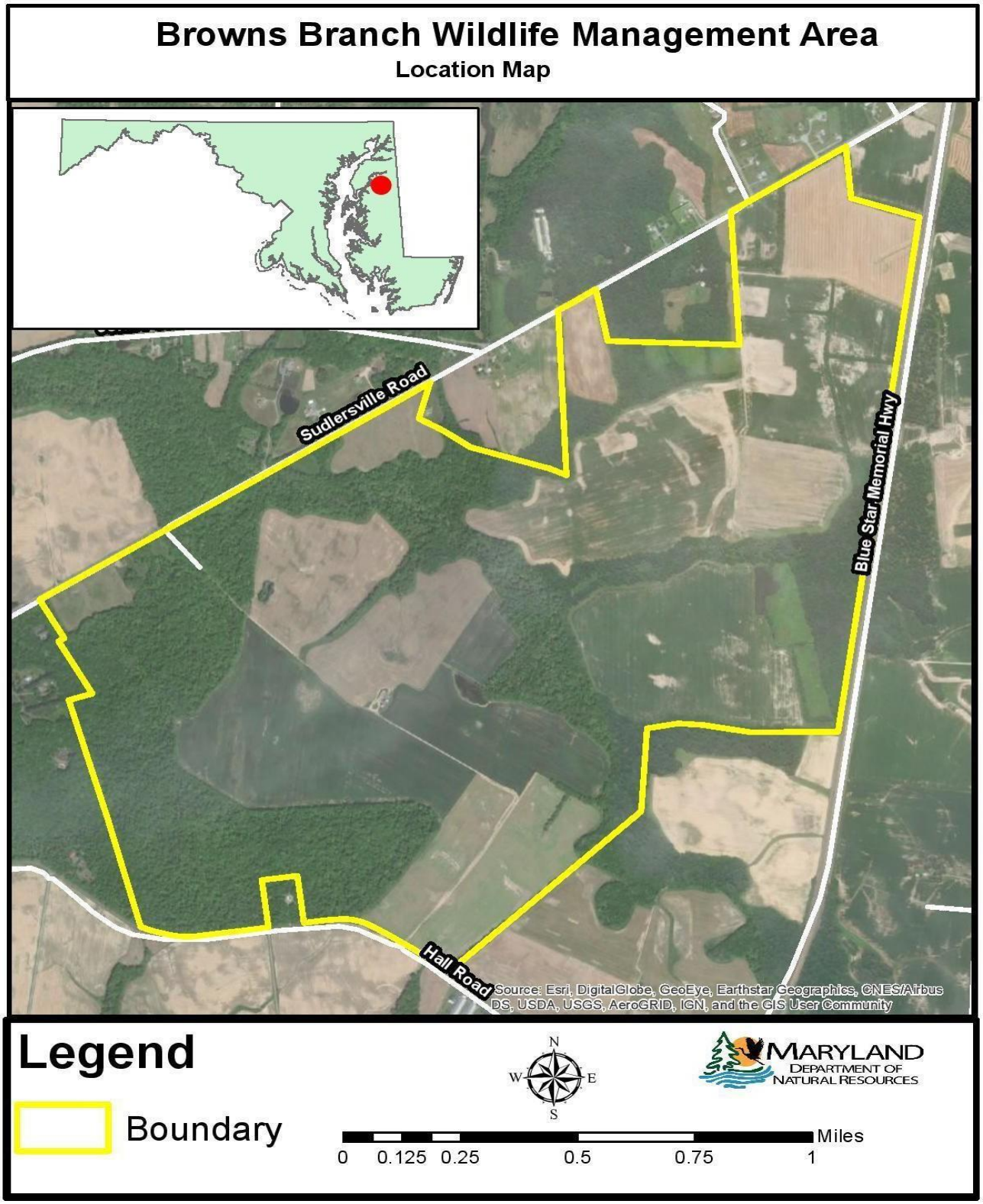
Harry Spiker - Associate Director - Regional Operations - Wildlife and Heritage Service
Richard Walls - Eastern Region Wildlife Response Manager - Wildlife and Heritage Service

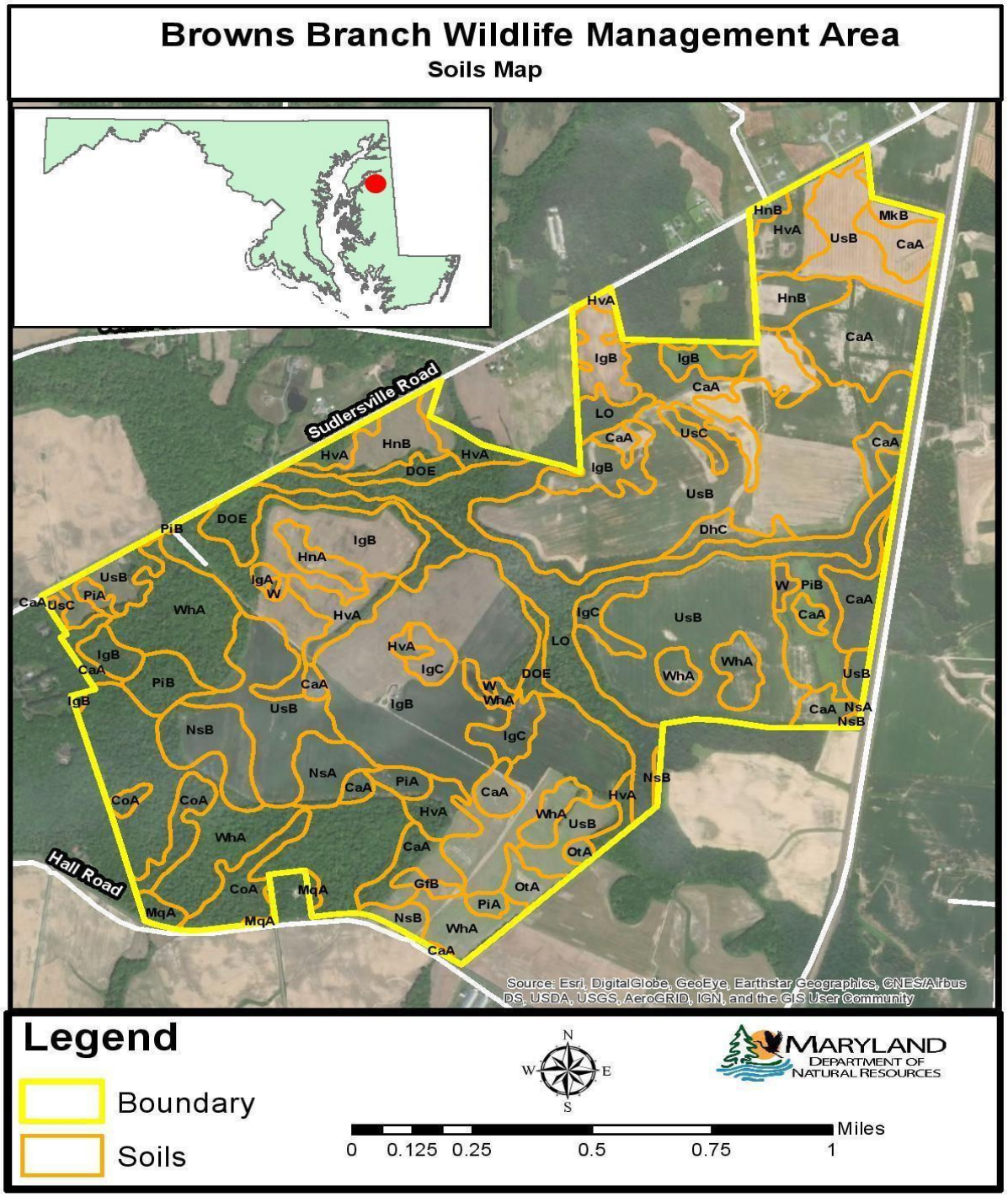
Appendices

1. General Location of Browns Branch WMA
2. Soils Map of Browns Branch WMA
3. Key Wildlife Habitats Found on Browns Branch
4. Browns Branch WMA Habitat Management Units

Appendix 1: General Location of Browns Branch WMA



Appendix 2: Soils Map of Browns Branch WMA



Appendix 3. Key Wildlife Habitats found on Browns Branch WMA; descriptions are taken from the 2015 MD State Wildlife Action Plan - https://dnr.maryland.gov/wildlife/Pages/plants_wildlife/SWAP_Submission.aspx.

Coastal Plain Floodplain - 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 American hornbeam (*Carpinus caroliniana*), pawpaw (*Asimina triloba*), American elm (*Ulmus americana*), American holly (*Ilex opaca* var. *opaca*), spicebush (*Lindera benzoin*) and herbs of Jack-in-the-pulpit (*Arisaema triphyllum*), false nettle (*Boehmeria cylindrical*), poison-ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), wood reedgrass (*Cinna arundinacea*), and various sedges. Similarly, floodplain forests of larger Coastal Plain Rivers with well-drained terraces or natural levees will often support species such as tulip-poplar (*Liriodendron tulipifera*), beech (*Fagus grandifolia*), and box elder (*Acer negundo*). Poorly drained floodplains, backswamps, and depressions of small Coastal Plain streams and rivers may support seasonally flooded swamps dominated by green ash, red maple and plants tolerant of fluctuating water levels such as lizard's-tail (*Saururus cernuus*).

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*), smartweeds (*Polygonum* spp.), pickerelweed (*Pontederia cordata*), arrow-arum (*Peltandra virginica*), three-way sedge (*Dulichium arundinaceum*), broadleaved cattail (*Typha latifolia*), American bur-reed (*Sparganium americanum*), swamp loosestrife (*Decodon verticillatus*), and common buttonbush (*Cephalanthus occidentalis*).

Coastal Plain Seepage Swamp - The Coastal Plain Seepage Swamp key wildlife habitat is characterized by gently sloping forests of small headwaters, ravine bottoms, and toe-slopes where groundwater is discharged at ground surface and carried away as stream flow. Often the groundwater seepage is perennial and characterized by diffuse drainage and braided channels

with sand, gravel, or peaty substrates. Soils are typically moderately to strongly acidic and nutrient-poor; however, basic seepage swamps 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*). The shrub and herbaceous layers in many Coastal Plain Seepage Swamps are diverse and recognized 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 regalis* var. *spectabilis*), New York fern (*Thelypteris noveboracensis*), and netted chain fern (*Woodwardia areolata*). Other notable plants include jewelweed (*Impatiens* spp.), small green wood orchid (*Platanthera clavellata*), Virginia bugleweed (*Lycopus virginicus*), Jack-in-the-pulpit (*Arisaema triphyllum*), false nettle (*Boehmeria cylindrical*), and numerous sedges. In addition, hummocks of peat mosses can be quite abundant and diagnostic to Coastal Plain Seepage Swamps of acidic substrates. The shrub layer may include winterberry (*Ilex verticillata*), sweet pepper-bush (*Clethra alnifolia*), swamp azalea (*Rhododendron viscosum*), spicebush (*Lindera benzoin*), possum-haw (*Viburnum nudum*), highbush blueberry (*Vaccinium corymbosum*), and vines of poison-ivy (*Toxicodendron radicans*), greenbrier (*Smilax* spp.), and Virginia creeper (*Parthenocissus quinquefolia*). Coastal Plain Seepage Swamps are naturally small-patched habitats vulnerable to hydrological disturbances, beaver activity, logging, and surface runoff.

Mesic Mixed Hardwood Forest - The Mesic Mixed Hardwood Forest key wildlife habitat develops over acidic, nutrient poor soils of the Coastal Plain and Piedmont in a variety of moist landscape settings including ravines, lower slopes, undulating uplands, and flatwoods. These forests are characterized by mixed canopies of tulip-poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), mockernut hickory (*Carya alba*), pignut hickory (*Carya glabra*) and understories of flowering dogwood (*Cornus florida*), pawpaw (*Asimina triloba*), American strawberry-bush (*Duchesnea indica*), and American hop-hornbeam (*Ostrya virginiana*). Many of the oaks and other associated trees of these forests vary by region. For example, loblolly pine (*Pinus taeda*) and American holly (*Ilex opaca* var. *opaca*) are occasionally prominent in Coastal Plain Mesic Mixed Hardwood Forests, but are absent in Piedmont stands. The infertile soils of these forests rarely support lush layers of herbaceous vegetation like those in basic mesic forests; however, ferns such as Christmas fern (*Polystichum acrostichoides*) and New York fern (*Thelypteris noveboracensis*) may be locally abundant in patches. Other plants common to this key wildlife habitat include pink lady's-slipper (*Cypripedium acaule*), false Solomon's-seal, perfoliate bellwort (*Uvularia perfoliata*), Indian cucumber-root (*Medeola virginiana*), cranefly orchid, and spotted wintergreen (*Chimaphila maculata*). Although Mesic Mixed Hardwood Forests are widespread throughout the Coastal Plain and Piedmont of Maryland, their size and condition have been much reduced by logging, agriculture, and development. Only 14 acres have been identified by the Maryland Department of Natural Resources as old growth on state lands.

Basic Mesic Forest - The Basic Mesic Forest key wildlife habitat is characterized by rich, moist forests of the Coastal Plain, Piedmont, and low mountain regions that develop over calcareous substrates or mafic bedrock that when weathered produce basic soils high in calcium and magnesium. Basic Mesic Forests on the Coastal Plain are associated with tertiary-aged shell deposits common in ravines and slopes bordering streams and rivers. While these forests may differ in the substrate from which they develop, they share a number of similar species. Several tree species are characteristic and stands commonly include tulip-poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), black walnut (*Juglans nigra*), northern red oak (*Quercus rubra*), chinkapin oak (*Quercus muhlenbergii*), bitternut hickory (*Carya cordiformis*), white ash (*Fraxinus americana*), eastern redbud (*Cercis canadensis* var. *canadensis*), eastern hop hornbeam (*Ostrya virginiana*), and sugar maple (*Acer saccharum*) in the mountains. The shrub and herbaceous layers are typically lush and dense with numerous species of ferns and leafy forbs such as may-apple (*Podophyllum peltatum*), black cohosh (*Caulophyllum thalictroides*), and twinleaf (*Jeffersonia diphylla*). Basic Mesic Forests are similar to Cove Forests, but they are differentiated by the number of species restricted to lower elevations in Maryland.

Coastal Plain Flatwoods and Depression Swamp - The Coastal Plain Flatwood and Depression Swamp key wildlife habitat includes 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 forested canopy structure of flatwoods and depression swamps range from open to closed with composition ranging from hardwood dominated to a mixture of hardwoods and pines. 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*) are generally considered as higher quality because much of today's remaining stands are characterized by successional hardwoods such as red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), black gum (*Nyssa sylvatica*), and American holly (*Ilex opaca* var. *opaca*). Loblolly pine (*Pinus taeda*) is 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 key wildlife habitat 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 extent in Maryland through ditching, draining, logging, and conversion to agriculture and pine plantations.

Vernal Pools - The Vernal Pool key wildlife habitat is defined as small (~0.1-2 ha), non-tidal palustrine forested wetlands. They exhibit a well-defined, discrete basin and lack a permanent, above-ground outlet. The basin overlies a clay hardpan or some other impermeable soil or rock

layer that impedes drainage. 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. This periodic seasonal drying prevents fish populations from becoming established, an important biotic feature of Vernal Pools. Many species have evolved to use these temporary, fish-free wetlands. Some are obligate vernal pool species, so-called because they require a Vernal Pool to complete all or part of their life cycle. Vernal Pools occur throughout the state 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 persist in cleared areas such as cropland, pastures, and clearcuts, but usually in a highly 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. However, many Vernal Pools exhibit similar vegetative structure. For example, Pools tend to have a semi-open to closed forest canopy around them and the degree of canopy closure generally decreases with increasing pool size. The basin substrate consists of dense mats of submerged leaf litter and scattered, coarse woody debris. Herbaceous vegetation is usually absent to sparse in and around the basin, although small mossy patches frequently occur along the basin edge. A dense shrub layer may occur along the shoreline or in small patches within the basin, especially on the Coastal Plain, but many Pools also lack a well-developed shrub layer.

Artificial Impoundment and Artificial Wetland - No natural lakes occur in Maryland; the state lies well south of the southern extent of glaciation and lacks other natural lake–forming, geologically-based processes. However, numerous man-made wetlands, ponds, and lakes of varying sizes exist. 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. Maryland does, however, contain some small natural, open freshwater areas in the form of beaver impoundments, wetland openings (e.g., Delmarva Bays, vernal pools, montane bogs, and fens, flooded riverine floodplain openings) and river oxbows. A variety of species of conservation need inhabit such areas and also use some man-made impoundments and wetlands. In a few cases (e.g., black-banded sunfish), where natural aquatic habitats have been destroyed or degraded, Artificial Impoundment key wildlife habitats provide critical refugia. Today, 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. Also, beaver populations in many parts of the state have never fully recovered from pre-1900 declines due to fur trapping pressure; the effects on aquatic ecosystems and associated wildlife have been significant. Unfortunately, the suitability as habitat of many man-made ponds and wetlands, such as stormwater management ponds, is somewhat limited, if not entirely absent, for most SGCN.

Managed Grassland - 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, but those dominated by native species tend to have greater conservation value. Some scattered shrubs and small trees (<8 m tall) may be present, but it is usually limited (<25% cover), patchy, and/or confined to the outer periphery of the opening as a soft forest edge or ecotone. Generally, grasslands at least 4 ha in size to well over 100 ha are needed to support highly area-sensitive grassland species of conservation concern such as Henslow's Sparrow (*Centronyx henslowii*). In addition to grassland size, other patch (e.g., shape, edge: area ratio) and landscape metrics (e.g., proximity to other grasslands, percentage of grassland and openings in surrounding landscape) can be important predictors of the presence and abundance of these species.

Historically, parts of Maryland supported large expanses of natural grasslands and savanna-like habitats. Tens of thousands of acres of grassland dotted with blackjack (*Quercus marilandica*) and post (*Quercus stellata*) oaks once stretched across northern Maryland and nearby Pennsylvania. Prior to European settlement, much of Baltimore, Harford, and Carroll counties and adjacent counties in Pennsylvania were covered by this prairie-like grassland intermingled among wooded valleys (Mayre 1920). Also, early 18th and 19th century accounts 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 [*Bison bison*], elk [*Cervus canadensis*]), and periodic fires. These grassland ecosystems have since nearly vanished due to habitat loss resulting from development, agriculture, fire suppression, and the disappearance of large ungulates. The few remaining native grasslands are either wetland key wildlife habitats (e.g., Piedmont Seepage Wetland, Montane-Piedmont Floodplains, Montane Bog and Fen) or are upland key wildlife habitats described as small patch habitats within a larger woodland matrix (e.g., Shale Barren, Basic Glade and Barren). 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 15 years. Today, most of the state's remaining grassland fauna persists in one or more of the following anthropogenic 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 Plateaus.

Mayre, W. B. 1920. The old Indian road. Maryland Historical Magazine 15:107-395.

Mayre, W. B. 1955. The great Maryland barrens (Parts I, II, and III). Maryland Historical Magazine 50:11-23, 120-142, 234-252.

Appendix 4: Browns Branch WMA Habitat Management Units