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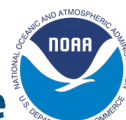
Browns Branch Climate Change Adaptation and Resilience Planning Guide

Supporting natural resources in
the face of climate change



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For questions about this plan please contact
kate.vogel@maryland.gov.



Maryland Department of Natural Resources
Chesapeake and Coastal Service
dnr.maryland.gov
580 Taylor Ave, Annapolis, MD, 21401

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Authors

Kate Vogel -NOAA, Coastal Management Fellow, DNR, Chesapeake and Coastal Service-
Sandi Olek -DNR, Chesapeake and Coastal Service-
Ryan Haley -DNR, Wildlife and Heritage Service-
Dana Limpert -DNR, Wildlife and Heritage Service-

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Advisory Committee Members

Alexander S Clark -DNR-
Alexandra DeWeese -DNR-
Allison Breitenother -DNR-
Angela Baldwin -DNR-
Benjamin P Degenhard -DNR-
Bhaskar Subramanian -DNR-
Catherine McCall -DNR-
Charles Mazurek -DNR-
Christine Conn -DNR-
Craig Weedon -DNR-
Dana L. Limpert -DNR-
Dante Daniels -DNR-
Elliott T Campbell -DNR-
George Edmonds -DNR-
Heather Disque -MDA-
Jack Perdue -DNR-
Jacqueline R.S. Tahsuda -DNR-
Jason Dubow -MDP-
Jeb Deickman -DNR-

Kevin Smith -MD Coastal Bays-
Kevin J. Coyne -DNR-
P. Sanford -DNR-
LeeAnne Chandler -DNR-
Lester "Kelly" Wright -DNR-
Madeline M. Williams -DNR-
Matthew Hurd -DNR-
Meghan Rhode -DNR-
Meredith A. House -DNR-
Mike Schofield -DNR-
Nicole Carlozo -DNR-
Perry Otwell -DNR-
Russ Hill -DNR-
Ryan Haley -DNR-
Sarah Hilderbrand -DNR-
Sasha Land -DNR-
Stephen VanRyswick -DNR-
Sandra Olek -DNR-

The technical advisory committee acknowledges the historical and continuing connection between Indigenous peoples and their native lands. Browns Branch is located on the ancestral land of the Nanticoke Tribe who shared this area and whose descendants include the Cedarville Band of the Piscataway Conoy, the Piscataway Indian Nation, and the Piscataway Conoy Tribe.

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Executive Summary

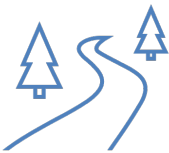
This plan serves as a climate change adaptation and planning outline for Browns Branch Wildlife Management Area (WMA). Browns Branch is one of the DNR's newest state lands, acquired in 2019 to further goals of conservation, restoration, and recreation.

Climate Impacts to WMA Resources:



Natural Resources

Increased precipitation will lead to increased erosion and sediment deposition, negatively impacting water quality and flow on site. Increasing erosion places aquatic wildlife, especially the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*), at risk. Invasive species are also a concern due to their ability to outcompete native plants and reduce resource availability.



Infrastructure

Infrastructure that may eventually be vulnerable to the threats of climate change at Browns Branch include water control structures, gravel roads and parking lots. Precipitation increases runoff and flooding, and can damage roads and structures.



Recreation

Climate change does not appear to have a significant impact on recreation at Browns Branch, though warming temperatures may impact opportunities for birding and fishing as populations shift. Walking and community access may decline after storm and flooding events, impacting the recreational value.



Human Resources

There may be increasing pressure on WMA staff to respond to problems that may arise from storms, including responding to debris, erosion, and decreased access. There will also be the added challenge of accounting for changing temperatures and precipitation when planting native species.



Cultural and Historical Resources

There are no known cultural or historical resources located on site. If any are identified in the future, the technical advisory committee will look at issues and impacts to operations.

Efforts currently underway include monitoring surveys for endangered species and mussels, water quality, and post restoration trends. Future partnerships could include working with the United States Fish and Wildlife Service (USFWS), Ducks Unlimited (DU), the Wild Turkey Federation (NWTF), Quail Forever and The Nature Conservancy (TNC).

Opportunities for adaptation that exist for Browns Branch include restoration and reforestation. Enhancing vegetation buffers, reducing erosion, and facilitating the phasing out of agricultural leases on site will provide an opportunity for riverbanks to stabilize, thus reducing sediment deposition and degrading water quality. Removing invasive species and preserving habitats will protect existing species and allow Browns Branch to continue serving as a refugium for rare, threatened and endangered (RTE) species.

Key Recommendations



Restore and monitor wetlands



Maximize habitats using native plants



Increase vegetative buffers



Habitat & trail maintenance



Prepare for climate change in advance

Within the next five years the opportunity may exist to transition away from agricultural leases on site to meadows or reforested areas. Agricultural lease acreage will diminish overtime as wildlife habitat is established and wetland areas are restored. Invasive species removal will likely become a priority as will floodplain connection.

To implement these projects, Browns Branch may be eligible for funding through the natural filters cost-share grant. This grant funds stream restoration projects that have positive impacts on water quality and ecosystems. There is also a Delmarva woodland project that specifically mentions the endangered mussels on site and offers opportunities for restoration. DNR will continue identifying partnership opportunities and participate in outreach.

Introduction/Overview

The Maryland Wildlife & Heritage Service has partnered with Chesapeake and Coastal Service to prepare a climate change adaptation and resilience planning guide for Browns Branch Wildlife Management Area that evaluates climate hazards, impacts from climate change, and potential adaptation strategies and implementation opportunities. It is intended that this guide will support Wildlife and Heritage staff in decision making and resilience planning.

Objective and Resilience Statement

This document will provide recommendations and solutions that support the Browns Branch Wildlife Management Area climate change resilience statement: to conserve and foster an appreciation of the natural resources of Browns Branch Wildlife Management Area and continue providing recreational opportunities in a sustainable manner.

RESILIENCE STATEMENT

To conserve and foster an appreciation of the natural resources of Browns Branch Wildlife Management Area and continue providing recreational opportunities in a sustainable manner.

Document Organization

Throughout this document climate change impacts to Browns Branch will be separated into five categories including impacts to: natural resources, infrastructure, recreation, human resources, and cultural resources. Each category is described below.



Natural resources: flora and fauna of the forest, in addition to the stream



Infrastructure: physical and organizational structures and facilities located at Browns Branch, such as roads



Recreation: opportunities for visitor engagement such as hiking and hunting



Human resources: number of employees, staff time, and financial resources



Cultural resources: historical information and archaeological sites

For each category described above, two scenarios are described in detail: no action and adaptation options and opportunities.

No climate action: analyzes the impacts of climate change to the specific resource category if no mitigation or adaptation actions are taken (i.e., “business as usual”)

Adaptation opportunities: discusses potential adaptation and resilience opportunities to respond to and address the previously analyzed impacts of climate change

Background

The Browns Branch Wildlife Management Area was acquired in 2019 by the Maryland Department of Natural Resources (MDDNR) to further goals of conservation, restoration, and recreation. Located in Queen Anne’s County, Browns Branch is host to 1172 acres; 682 acres are dedicated to agricultural uses, and forested areas and small freshwater ponds and streams make up the remainder. At 1172 acres, the main land uses are for hunting and agriculture, although other recreational opportunities include: hiking, fishing, biking, bird watching, and nature photography. One endangered species has been found on the property, the dwarf wedgemussel (*Alasmidonta heterodon*), a freshwater mollusk.

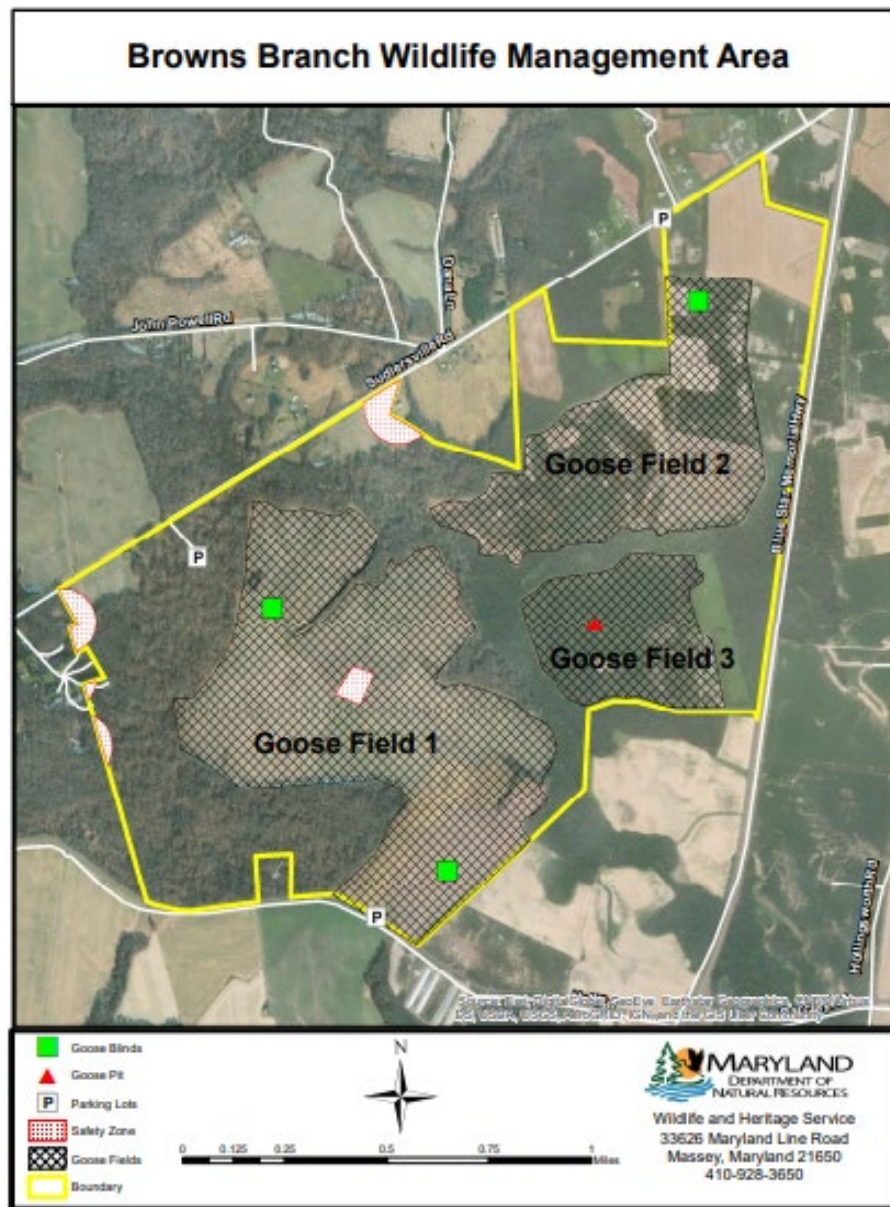


Figure 1: This is a map of Browns Branch Wildlife Management Area.

Physical Description

Located east of the Chester River and Chesapeake Bay, the land cover at Browns Branch is mostly forest and agricultural. Forest cover is composed of coastal plains flatwood and depression swamps, basic mesic, and mesic mixed hardwood forests. Soil types at Browns Branch are most commonly unicorn sassafras loam, whitemarsh silt loam, ingleside loam, and carmichael loam, with soil depths ranging from deep to very deep, with poor-well drained characteristics (NRCS, 2019).



This photo shows one view of Browns Branch, with an agricultural field on the left and forest on the right.

WMA Assets and Resources

Valuable natural resources in the area include agricultural lands, forested lands, and freshwater resources. Browns Branch is known for its white-tailed deer, wild turkey, squirrels, rabbits, migratory waterfowl, and songbirds, though the nontidal wetlands at Browns Branch are also home to various fish species, amphibians, and macroinvertebrates. Of particular importance, the dwarf wedgemussel (*Alasmidonta heterodon*), an endangered freshwater mollusk, has also been found on the property. Current infrastructure located on the Browns Branch property includes gravel parking lots and roads, gates and signage, and various water control structures. Recreational uses include hunting, hiking, fishing, and biking in established areas and trails. The site is also great for bird watching and nature photography. No sites of cultural significance have been identified on this property. There are three primary staff members responsible for the management of this site, Ryan Haley, the site manager, and two technicians.

Climate Change Impacts and Threats to WMA Resources

Although it is located inland, Browns Branch is not free of impacts from climate change. Across Maryland, climate change is leading to increased temperatures, changing precipitation patterns, stronger storms, declines in biodiversity, increased disease risk, and changes in crop production. Over half of the lands at Browns Branch are agricultural leases. The impact of temperature on agriculture is thus far unpredictable -- as temperatures increase, crops may perform better at first, but suffer in the long-term.

Temperature

[Temperatures in Maryland have already increased by an average of 2.5°F since the beginning of the 20th century.](#)

Changing temperatures encourage unique species migrations, meaning that invasive species could be a potential problem for agricultural production and native species found on site.

Changing Precipitation Patterns

[Annual mean precipitation has been above average for the last two decades.](#) The [Projected Intensity-Duration-Frequency \(IDF\) Curve Data Tool for the Chesapeake Bay Watershed and Virginia](#)

shows how precipitation patterns may change across the state under low (RCP 4.5) and high (RCP 8.5) emissions scenarios by the end of the century. For example, the Worcester County projections show that small, frequent storms (having a 2-year return period or 50% chance of being exceeded in any given year) that currently generate 2.77 inches of rainfall over 12 hours may generate a median of 3.13 inches under the low emissions scenario and 3.3 inches under the high emissions scenario by year 2100. Increasing precipitation could lead to numerous problems at Browns Branch including increased flooding of roads, parking lots, and trails, further decreasing access to recreational and agricultural resources. Increased precipitation also leads to increased nutrient runoff, erosion, and sedimentation which will further endanger the dwarf wedge mussel found on site. It is also possible that stronger storms and increased disease risk may not only impact growth seasons for crops, but also the forested stands.

Maryland's wetland habitats are characterized by groundwater recharge and/or seasonal flooding. Many of Maryland's wetland habitats support plant and animal species of greatest conservation need (SGCN) – species that are highly vulnerable in sustained patterns of low precipitation and high evapotranspiration rates (MDDNR, 2015).

CLIMATE IMPACTS

Increasing temperatures

Changing precipitation patterns

Increased flooding

Increasing invasive species

More frequent storms

Biodiversity declines

Increased disease risk

Changes in crop production

Storm Frequency

While tropical storms and hurricanes are not expected to increase due to climate change, there is an expected increase in the frequency and intensity of more severe storms. More extreme storms lead to increased flooding and damaging winds, placing natural resources, recreation, and infrastructure at risk.

**Maryland State Lands
Browns Branch Wildlife Management Area
Climate Change Resiliency - Wetland Adaptation**

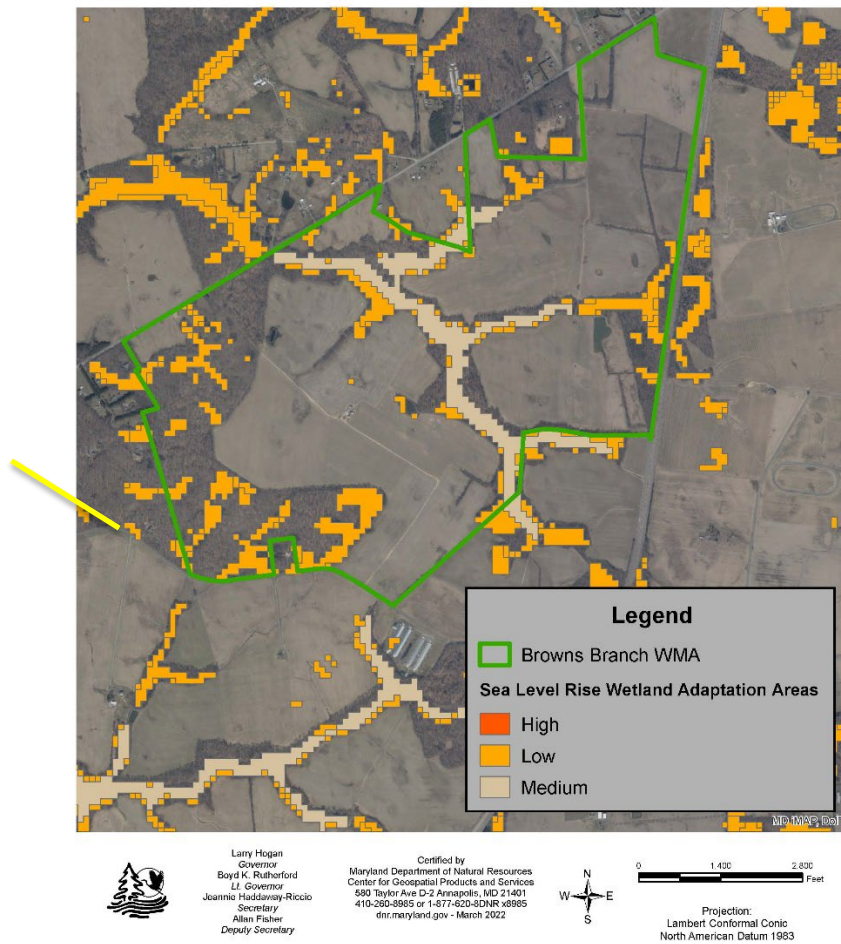


Figure 2: This figure shows where wetlands occur on site, in addition to areas where there might be opportunities for wetland adaptation areas to respond to sea level rise in the future.

Climate Impacts on the Resources at Browns Branch Wildlife Management Area

INCREASING TEMPERATURES CLIMATE CHANGE IMPACTS AND ADAPTATIONS

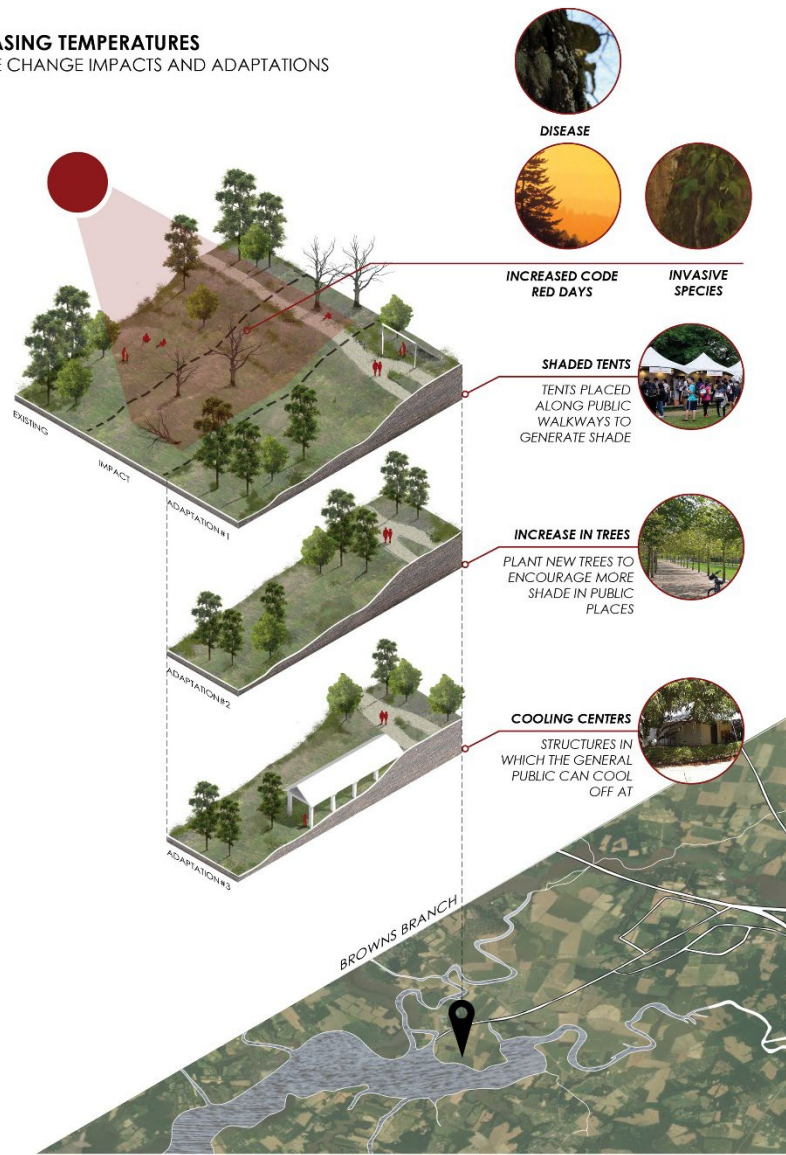


Figure 3: Impacts and adaptation opportunities of increasing temperatures.



Climate Impacts on WMA Resources

The threats of climate change may not be felt immediately at Browns Branch, but it is essential to prepare for them by mitigating climate change threats before they occur and acquiring the tools to respond to changing environmental conditions. This includes taking the time to prepare for increasing temperatures and precipitation, and understanding how climate change will impact infrastructure, recreation, human resources/economic development, cultural resources, and natural resources.

Natural Resources

Natural resources at Browns Branch include forested lands, agricultural and meadow areas, aquatic resources and a variety of flora and fauna. The habitats and wildlife at Browns Branch all contribute to its ecological significance.

Ecological significance is determined by an area's rare, threatened, or endangered plant and animal species. The more species there are, the greater ecological significance.

Ecological significance is scored by BioNet and divided into tiers from 1-5, with a BioNet Tier 1 score indicating an area is critically significant for biodiversity conservation.

CLIMATE IMPACTS

Increasing temperatures

- changing species distributions
- increasing water temperatures
- greater rates of evapotranspiration

Increasing precipitation

- increased surface runoff
- increased erosion
- degraded water quality
- loss of tree species

Biodiversity Conservation Network - - BioNet

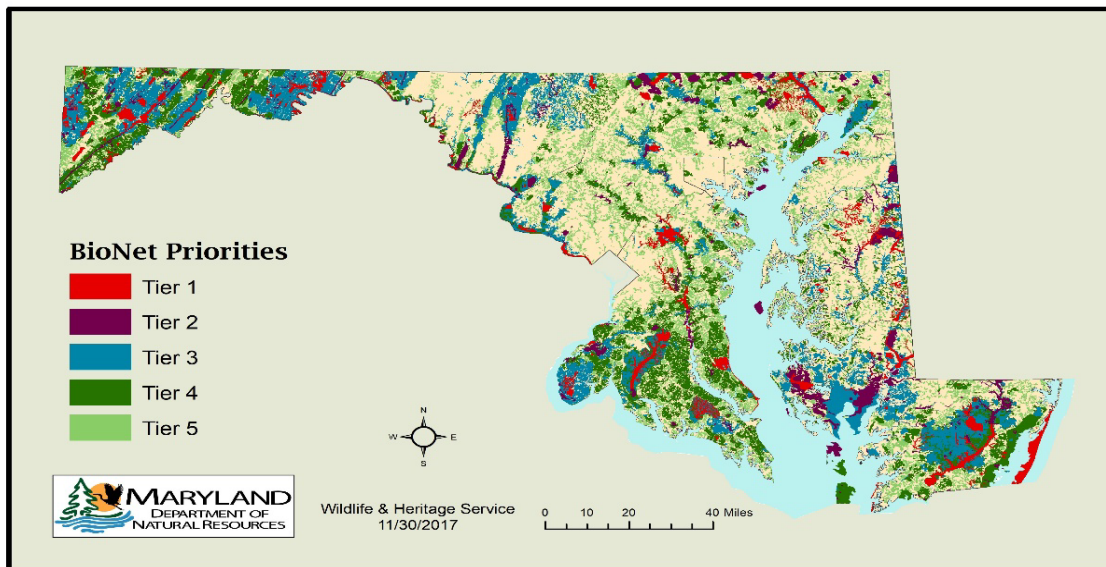
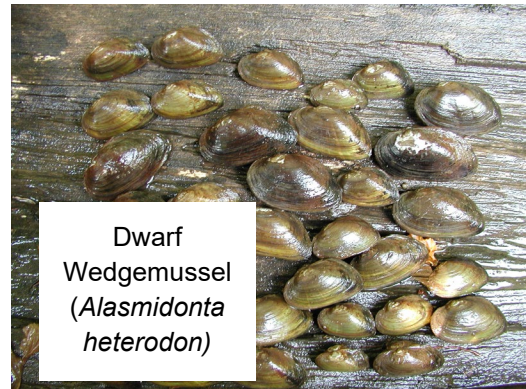


Figure 4: This map represents the BioNet Priorities across the state of Maryland.



Browns Branch is a creek that runs west across Queen Anne's County to the tidal waters of Southeast Creek. The catchment area for the creek totals nearly 8,000 acres, with 73% of the area in agriculture, 25% forested, and less than 1% urban. The segment of Browns Branch that flows through the WMA is designated as Tier II – high quality waters that have an existing water quality that is significantly better than the minimum requirements, specified in water quality standards.



Browns Branch supports the Dwarf Wedgemussel (*Alasmidonta heterodon*, federally listed as Endangered, state-listed as Endangered), the triangle floater (*Alasmidonta undulata*, state-listed as Endangered) and the creeper (*Strophitus undulatus*, state-listed as In Need of Conservation). Other mussel species documented in this creek include eastern elliptio, northern lance (*Elliptio fisheriana*, watchlist), alewife floater (*Anodonta implicata*, watchlist), and eastern floater. Freshwater mussels require fish hosts for part of their life cycle, and are filter feeders; therefore, water quality is of crucial importance to their continued existence. The portions of Browns Branch where these rare mussels were documented tend to be small, shallow areas of stream with little gradient and possibly some small riffles and runs. The substrate is usually a mix of sand and small gravel. Rare dragonflies and damselflies may also occur in this system, as they require high water quality streams and associated habitat for the larval stage of their life cycle.

Climate change is likely to impact many aspects of the natural resources at Browns Branch. Increasing temperatures can lead to a loss of species diversity due to warmer temperatures being intolerable for more sensitive species. For the 2015 State Wildlife Action Plan, NHP used NatureServe's CCVI to index 265 Species of Greatest Conservation Need for climate change vulnerability. In general, freshwater mussels and freshwater fish (which serve as hosts for mussels to complete their life cycle), amphibians, and snails were predicted to be moderately to extremely vulnerable as predicted by climate change models. Dwarf wedge mussels are extremely vulnerable. Agricultural runoff from storm events, particularly ammonia from manure or commercial fertilizer applied improperly, is toxic to mussels and fish.

In addition, warming temperatures could create preferable environments for invasive species. As species ranges shift, native plants might lose their ability to outcompete nonnative species, leading to a loss of ecosystem services due to biodiversity loss. Warming temperatures are also leading to increased pests and diseases, which can be very harmful to native species that do not have the adaptation responses necessary to survive. Invasive species could impact the ability to restore agricultural lands if it takes the native species longer to become established.

There may also be shifts in the carbon cycle due to warming temperatures -- decreased carbon sequestration is a loss of a beneficial ecosystem service. Increased precipitation and worsening storms will lead to increased flooding, erosion, sediment deposition, and nutrient runoff, causing degraded water quality.



No Climate Action: Natural Resources

Browns Branch Wildlife Management Area offers a prime example of the interconnectedness of natural resources and ecosystems, where a degraded area in one part of the system may impact every area around it.

Aquatic Resources

If no restoration and conservation efforts take place at Browns Branch it is likely that stream bank erosion and nutrient deposition will continue. The surface runoff from these events will negatively impact endangered mussel species and sensitive macroinvertebrate and fish populations as it decreases water quality and increases stream pollutants. Additionally, more intense storms, microbursts and flash flooding, especially after dry periods, have the potential to degrade stream banks, creating or increasing areas of erosion and deposition throughout the stream corridor. As this happens, the stream may further channelize, disconnecting it from its floodplain and changing the way the stream and surrounding wetlands interact both upstream and downstream. This can affect groundwater interaction with the stream, and exacerbate temperature issues, due to an increase in runoff and a decrease of groundwater to the stream. Erosion may also increase the death of trees, decreasing shading and impacting the microclimate of the stream, potentially decreasing nutrient uptake.



This photo shows erosion at Browns Branch.

Dry soil conditions caused by intermittent precipitation are making it more difficult for seeds to germinate, causing problems for cover crops in the off season. Decreasing seed germination could lead to more surface runoff in the winter as well, further degrading water quality and species habitats.

Wildlife

Many species found at Browns Branch will not survive in warmer water temperatures.

Invasive species may become more prevalent, leading to species shifts and biodiversity loss. Currently, phragmites, thistle, honeysuckle, Japanese stiltgrass, multiflora rose, Japanese knotweed, and mile-a-minute are found at Browns Branch.



This photo is of multiflora rose.



Forests and Agriculture

The forest ecosystems present at Browns Branch are susceptible to warming temperatures from climate change. Increasing drought potential may decrease the opportunities to perform prescribed burns, an essential form of maintenance for maintaining early successional species and grasslands.

Adaptation Options and Opportunities: Natural Resources

Adaptation opportunities exist that will lessen the impacts of climate change at Browns Branch and encourage stabilization of the ecosystems.

Aquatic Resources

Near agricultural sites, the stream is currently protected by buffers put in place by the Conservation Reserve Program (CRP), a land conservation program administered by the Farm Service Agency (FSA). As agriculture is phased out, restoration and rehabilitation are going to be essential in protecting the natural resources and ecosystem services at Browns Branch. Removing agricultural lands and encouraging the growth of native species for a meadow or forest will promote water infiltration and decrease erosion and nutrient runoff into the stream. Figure x highlights areas of Browns Branch that have been identified as wetland restoration sites.

Restoration upstream of Browns Branch may also prove valuable in order to reduce large flooding events during storms. Beaver analogs could be another nature-based solution to reduce stream erosion and facilitate sediment accretion. In areas of extreme erosion, there is potential to create a regenerative step pool conveyance area to slow erosion and increase sediment accretion along the stream bank.

Increased water quality monitoring will also be valuable when determining the success of restoration efforts. The use of drones to fly stream corridors and provide 3D models of existing erosion would also increase understanding of problem areas and potential restoration opportunities.

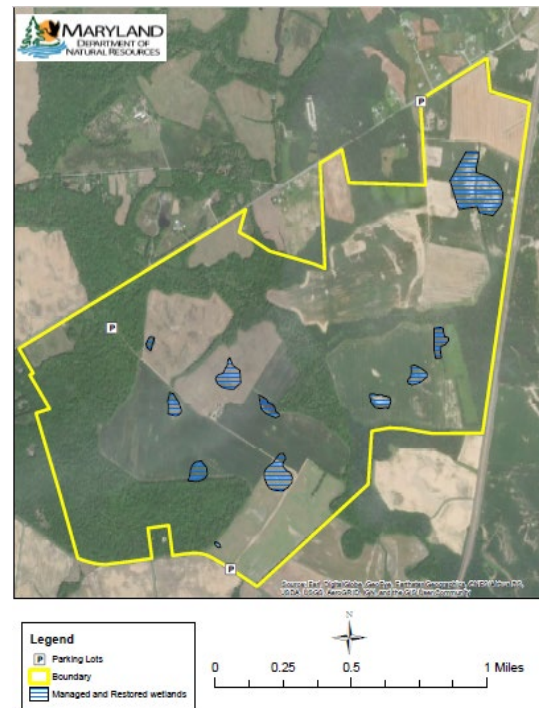


Figure 5: this is a map of proposed wetland restoration sites based on their poorly drained soils and ability to collect water.



Wildlife

Reconnecting the floodplain and allowing for natural stream flow and drainage will reduce water temperatures, increasing chances of survival for the aquatic species at Browns Branch.

The prevention and removal of invasive species will be important as temperatures rise. Planting vegetation in line with climate predictions will be essential in preventing invasive species from colonizing a space before native species become established. Removing invasive species will also guarantee natural food and nourishment for wildlife populations at Browns Branch.

Maintaining habitats for waterfowl will help address changing migratory patterns. A waterfowl impoundment serves to collect water and provide habitat for migratory birds while also collecting runoff from storms at the same time.

Overall, increased monitoring to better understand ecosystem services and current conditions will help predict climatic impacts to the area. Monitoring and controlling invasive species, through mapping, physical removal and prevention, and habitat restoration will be one of the best ways to protect natural resources at Browns Branch.

Forests and Agriculture

Planting grassland and early successional species as agriculture leases shift over time will promote healthy ecosystems and wildlife habitat on site.



This is a picture of a wet depression on site.



DECLINE IN BIODIVERSITY
CLIMATE CHANGE IMPACTS AND ADAPTATIONS

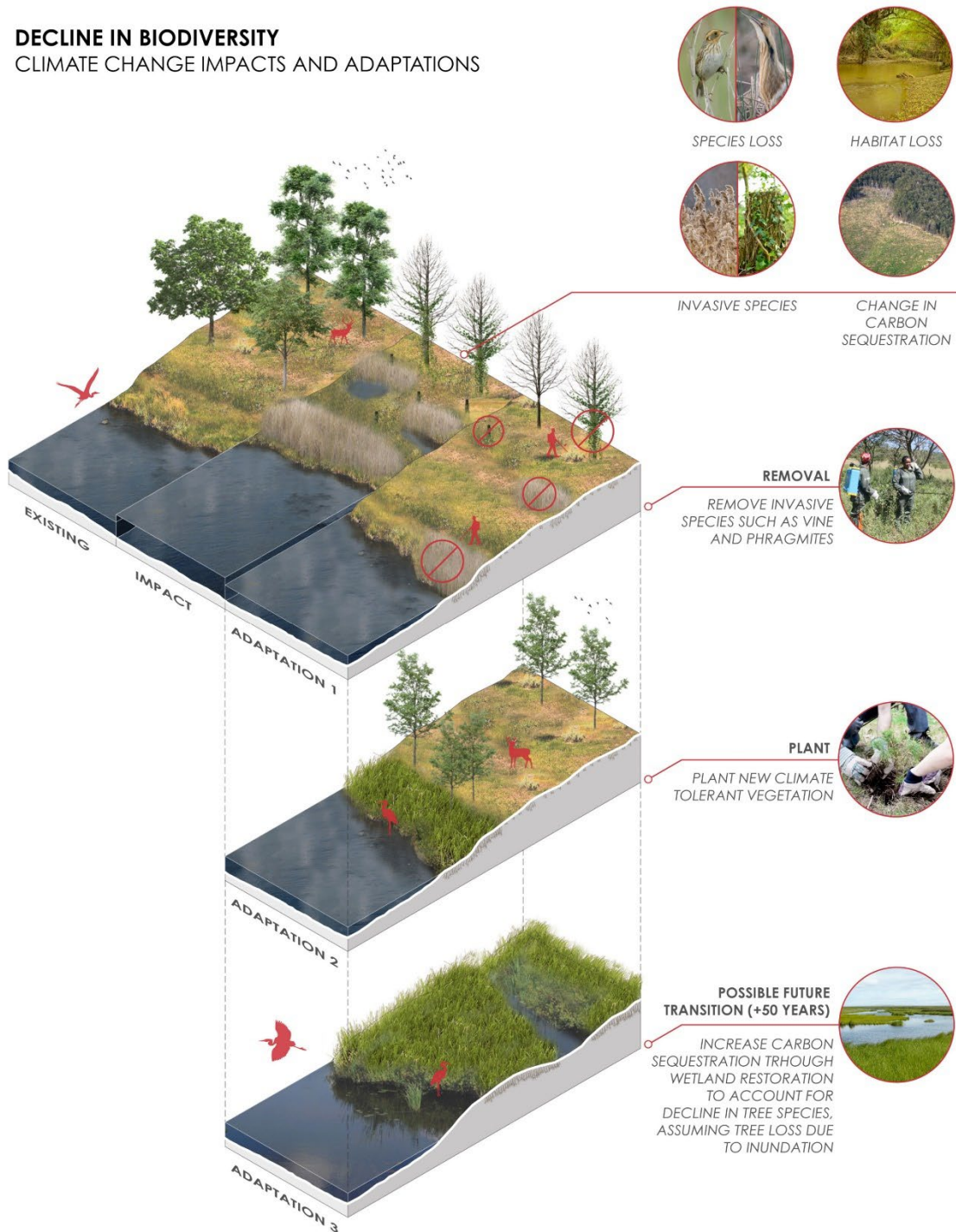


image courtesy of UMD School of Architecture, Planning & Preservation

Figure 6: This shows declines in biodiversity due to invasives species, and the benefits of removal.



Infrastructure

The most vulnerable infrastructure at Browns Branch Wildlife Management Area includes steep sloped roads that might be vulnerable to washout with increased precipitation. The gravel parking lots are also susceptible to increased precipitation and may experience more flooding and washout. Browns Branch also has old agricultural field tiles located on site that were previously used for drainage and are now damaged and unnaturally impacting the flow of water, creating flooding and impairing water quality. Until the tiles can be removed, they are susceptible to increasing precipitation.

No Climate Action: Infrastructure

The roads at Browns Branch are the primary form of transportation and are essential to management for the entire property. The agriculture tiles and water control structures located on site facilitate the drainage of surface water, but when in poor condition lead to increased flooding and erosion.

Roads and Culverts

If no action is taken to reduce climate impacts to infrastructure at Browns Branch, there will be increased surface runoff which will carry rocks, sediment, and nutrients from the roads and parking lots to the floodplain. Increased channelization along roads may create unstable and unsafe road conditions, in addition to increased erosion of the stream bed. Increased precipitation and sedimentation may also impact the already degraded agricultural field tiles, so drainage may not occur properly.



This is a photo of erosion near a culvert.

Drainage Tiles

Changing precipitation patterns may increase the amount of rainfall on site, which will put increased pressure on the existing drainage tiles.

The photo to the right shows an example of a wet area created by excess water and poor drainage. Situations like this are directing water to one specific spot, causing increasing erosion and damage to the natural resources.



This shows a wet area through the corn.

Adaptation Options and Opportunities: Infrastructure

There are natural and structure-based options to enhance resiliency at Browns Branch.

Roads and Culverts

Facilitating the growth of a vegetative buffer at the edges of roads and parking lots will assist in soil stabilization, water infiltration, and nutrient uptake. Year-round infrastructure maintenance will be more important in the events of increasing and worsening storms.

Drainage Tiles

There is also an opportunity to remove the agricultural tiles or install a water control structure that may facilitate the collection of water during drought conditions, and the removal of water during wet conditions.

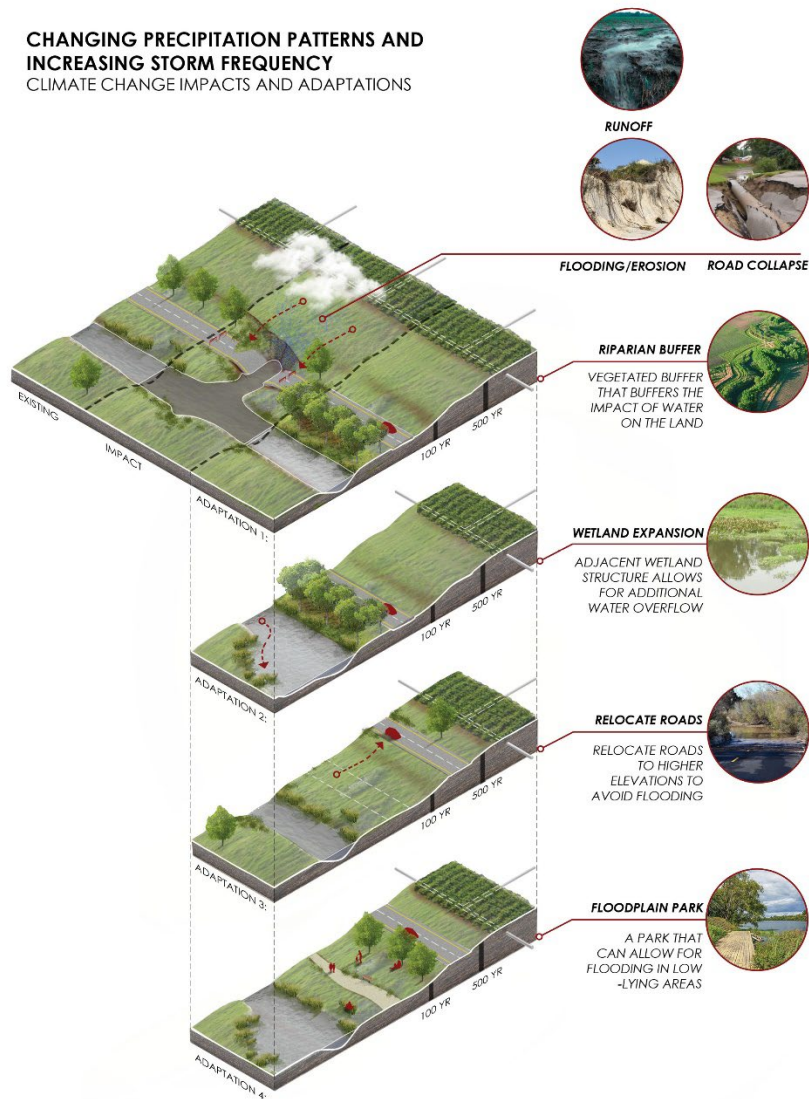


image courtesy of UMD School of Architecture, Planning & Preservation

Figure 7: This shows impacts of precipitation and opportunities to protect roadways.



Recreation

Recreational opportunities are expected to remain constant at Browns Branch, as hiking and hunting opportunities will be able to continue without significant changes. Species that are commonly hunted at Browns Branch, such as deer, are not vulnerable to climate change and may only become impacted if habitat loss is significant. Birding opportunities may change, as increasing temperatures shift species ranges. Fishing on site for bluegill and bass occurs Browns Branch.

No Climate Action: Recreation

Recreational opportunities at Browns Branch are not expected to be heavily impacted by climate change in the near future. If no action is taken at Browns Branch, it is predicted that hiking, hunting, and horseback riding opportunities may remain fairly stable. Birding opportunities may decline if no action is taken to protect and restore habitats. Fishing opportunities may decline as fish populations change with rapid increases in temperature and declines in dissolved oxygen.

Adaptation Options and Opportunities: Recreation

Continuing to maintain habitats to support a wide range of native biodiversity will decrease the susceptibility of the land to invasive species and protect existing areas for use by wildlife. Stream bank restoration and nutrient pollution reduction via vegetation buffers and stabilization practices could help protect aquatic wildlife. Invasive species removal will be key in maintaining natural habitats for flora and fauna. Having a plan in place for events that might disturb habitats, such as wildfires, will also protect recreational opportunities by protecting wildlife and habitats.



A view of a Browns Branch tributary.



Human Resources/Economy

In three years, the agricultural leases at Browns Branch are reaching the end of their contracts. There is an opportunity to expand the leases or terminate them. Climate change could create both favorable and unfavorable conditions for agriculture. Warmer temperatures could mean longer growing seasons, which could mean year-round ground cover and increased agricultural opportunities. On the other hand, increased drought and precipitation may both occur, causing more stressful growing conditions over time. It may be expected that Browns Branch could benefit economically at first from improved growing conditions, with a loss of revenue overtime.

Additionally, increasing temperatures and increased drought will impact how the grasses and forest are managed. More drought conditions will influence the opportunities for prescribed burns, and increase the likelihood of wildfires occurring. Overall, there will be increased staff demands as a result of responding to these changing conditions.

No Climate Action: Human Resources

Browns Branch already has limited staff capacity, and it may become more difficult to respond to issues worsened by climate change unless action is taken early.

Staff Resources and Time

Under a no action scenario, WMA staff may not have enough resources to respond to climatic changes, leading to a loss of biodiversity, changing recreational opportunities, and even dangerous conditions for staff.

Agriculture

There is going to be a gradual reduction in agriculture over the next five years. Changing precipitation patterns may influence how well crops perform in addition to the amount of agricultural runoff created during precipitation events. If the area experiences more frequent droughts, stressful growing conditions may lead to agricultural declines, creating a need for cover crops to prevent runoff. If agricultural leases are to be continued on the property, agricultural crops may do better, providing for ground cover year-round due to a longer growing season, providing more economic benefits to the WMA.



This shows a view of the field in the winter.



Adaptation Options and Opportunities: Human Resources

Staff Resources and Time

Providing training on how to respond to new threats from climate change such as invasive species or forest fires is going to be essential to making staff feel prepared and safe. A wildfire plan and a prescribed burn plan that factors in hotter temperatures and drought conditions before a wildfire occurs is essential. Projects to increase resiliency at Browns Branch will take time and may have more upfront costs than operating under a no action scenario, but the long-term benefit of protecting the resources at Browns Branch is maintaining recreational and natural resources for as long as possible.

Agriculture

Continuing the requirement of farmers to plant year-round ground cover will be important in reducing surface runoff from increased precipitation. An observation has been made that increasing drought conditions are impacting the ability for groundcover to thrive, which should be something that is monitored. Hotter temperatures and increased drought may also lead to die off of agricultural crops, which would create the need to restore or replant areas. Terminating the agricultural leases would provide the opportunity to restore the area and increase vegetation buffers and native plants to respond to climatic changes, though there would be a loss in revenue.

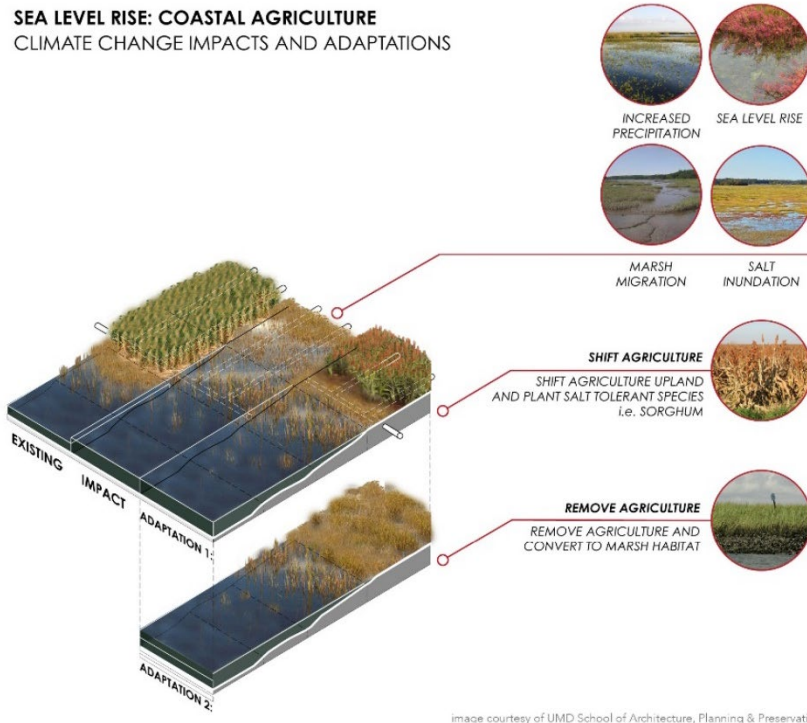


Figure 8: This shows the opportunity for a shift in agriculture.



Cultural Resources

No known sites of cultural or historical interest have been identified at Browns Branch WMA.

Overall Conclusions

Browns Branch is a site that has a lot of potential for habitat restoration and improvements in water quality. Recreational and cultural resources are not high priority climate concerns at Browns Branch, making climate impacts to infrastructure and natural resources the most important. Transitioning away from the agricultural resources and allowing for transition to forested and prairie habitats will slow erosion and protect water quality.



This photo shows some erosion near the stream bed.

Appendix B summarizes climate change impacts and opportunities for short term and long-term adaptation.

Existing Efforts

Existing efforts at Browns Branch include organizing water quality and stream restoration studies with the Fish and Wildlife Service to better understand the risks to the population of Dwarf wedgemussel on site.

WMA Long Term Goals

Five years

In the next five years general management goals at Browns Branch include:

- Transition to regenerative agriculture and phase out agricultural leases on site to reduce nutrient pollution by building soil organic matter and improving soil health
- Restore streams to protect dwarf wedgemussel by increasing vegetation buffers and reforestation
- Restore agricultural fields into grasslands and forested areas to promote bobwhite quail populations
- Encourage wetland establishment in poor drainage areas
- Identify prominent invasive species and increase monitoring to create a management plan for removal

Overall, the actions taken within the next five years have been chosen with the priority goals of improving water quality by reducing erosion and nutrient input to the land.

Ten Years

In ten years, it is expected that many of the agricultural lands will have successfully been established as meadow areas that promote quail habitat and the growth of native species. Invasive species are a large concern with climate change, so by increasing native plants soon after agricultural leases end, the odds of invasive species becoming a problem are likely to decrease.

Fifteen Years

In the next fifteen years WMA staff hope to have the opportunity for continued reforestation at Browns Branch. Ideally, reforestation will allow for soil accretion, which will prevent many harmful nutrients from entering the Browns Branch Creek. Decreased nutrient pollution and erosion will allow us to see increased dwarf wedge mussel populations.

Fifty Years

Browns Branch has wetlands that may be susceptible to increased flooding in the year of 2050 with a 1.3-foot sea level rise. To respond to increased flooding on site, or more wet areas, wetland restoration and creating wetland migration pathways could be a valuable tool in protecting wetland resources.



An exposed culvert at Browns Branch.

One hundred years

Browns Branch has wetlands that may be susceptible to increased flooding in the year of 2100 with a 3.4-foot sea level rise. To respond to increased flooding on site, or more wet areas, wetland restoration and creating wetland migration pathways could be a valuable tool in protecting wetland resources.

Identifying Projects and Partners

To implement these projects, Browns Branch may be eligible for funding through the natural filters cost-share grant. This grant funds stream restoration projects that have positive impacts on water quality and ecosystems. Browns Branch may also qualify for tree plantings through Maryland's 5 million trees program. There is also a Delmarva woodland project that specifically mentions the endangered mussels on site and offers opportunities for restoration. Funding from DNR's Trust Fund can help to provide an opportunity for wetland restoration and forest buffers. DNR will continue identifying partnership opportunities and participate in outreach.

References

1. United States Department of Agriculture, Natural Resources Conservation Service Web Soil Survey, 2019. <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>
2. Maryland Department of Natural Resources (MDDNR), Statewide Wildlife Action Plan, 2015. https://dnr.maryland.gov/wildlife/Pages/plants_wildlife/SWAP_Submission.aspx
3. Runkle, J., K.E. Kunkel, D.R. Easterling, B.C. Stewart, S.M. Champion, R. Frankson, W. Sweet, and J. Spaccio, 2022: Maryland and the District of Columbia State Climate Summary, 2022. NOAA Technical Report NESDIS 150-MD. NOAA/NESDIS, Silver Spring, MD, 5 pp. <https://statesummaries.ncics.org/chapter/md/>
4. "Mid-Atlantic IDF Curve Tool." Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA), <https://midatlantic-idf.rcc-acis.org/>.
5. "U.S. Climate Resilience Toolkit (Glossary)." toolkit.climate.gov. U.S. Climate Resilience Toolkit, March 2, 2021. <https://toolkit.climate.gov>
6. "Climate Change Impacts in Maryland (Graphics)." University of Maryland PALS & Maryland Department of Natural Resources, 2022. <https://www.flickr.com/photos/marylanddnr/albums/72177720298614252>

Thank you!

**Please contact Kate Vogel (MD DNR Chesapeake and Coastal Service),
kate.vogel@maryland.gov, (410)-934-2005, for questions.**

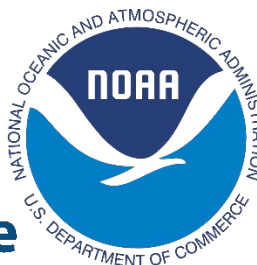
DNR Website: dnr.maryland.gov

Additional telephone contact information

1. Toll free in Maryland: 877-620-8367
 2. Out of state call: 410-260-8367
- TTY Users call via the MD Relay



This picture shows Browns Branch on a spring day.



Appendix A: Key Terms

Adaptation: the process of adjusting to current or expected climate change and its effects

Climate change: a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

Ecosystem services: the benefits provided by ecosystems that contribute to making human life both possible and worth living

Forest: deciduous forest

Land manager: a person responsible for program implementation and decision making on site

Resilience: the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate

Rare, threatened, and endangered animals: abbreviated as RTE, these animals include species occurring in Maryland that are on the federal list of Endangered and Threatened Wildlife and Plants under the Endangered Species Act (ESA), species currently on the State's Threatened and Endangered Species list, and additional species that are considered rare or under assessment by the Wildlife and Heritage Service

Wildlife Management Area: state lands managed by Maryland DNR's Wildlife & Heritage Service with the mission to conserve and enhance diverse wildlife populations and associated habitats while providing for public enjoyment of the State's wildlife resources through hunting and other wildlife-dependent recreation

Tide Gauge: a device for measuring the change in sea level relative to a vertical datum

Appendix B: Climate Change Impacts & Adaptation Opportunities

The following table highlights some of the climate threats and impacts at Browns Branch, in addition to short term and long-term adaptation and resilience options.

Climate Change Threat	Impact	Opportunities for Adaptation and Enhancing Resilience (short term on left and long term on right)	
Increasing Temperature	Changing species ranges → increased invasive species	Invasive species removal and treatment	-More research and monitoring -Allow for species regime shifts
	Decreased capacity for carbon sequestration	-Protect tree species -Restore soils	Restore carbon sequestering wetlands
	Increased potential for drought and wildfires	Develop training materials	-Create fire barriers -Install water structures to hold water during times of drought
Increased precipitation	Increased nutrient runoff → eutrophication	Riparian buffers Stream restoration	Reduce long term nutrient pollution on site Increased monitoring
	Increased sedimentation → degraded habitat for dwarf wedgemussel	-Expand habitat -Stream restoration/ floodplain connection	Increased monitoring
	Increased flooding	-Wetland restoration -Beaver analogs	Water control structures
Worse storms and increasing winds	Impact to roads → decreased access	Increase vegetative buffers	Shift to natural parking lots and roads (i.e. grass)
Biodiversity Declines	Loss of ecosystem services	Monitoring	Research to understand impact to the ecosystem
	Loss of RTE Species	Monitoring Remove invasives	Plant climate tolerant species
	Loss of agricultural crops	Plant climate tolerant species	Transition away from agricultural leases
Increased Disease Risk	Increased pests	Physical removal and barriers to invasive species	Allow for the transition Increased monitoring
Impact to agriculture	Less predictability, potential gains and losses	Monitoring Plant efficient cover crops	Planning for future leases Plant climate tolerant species

Appendix C: Photos from Browns Branch

