Guidance for Stream Restoration Based on Key Wildlife Habitats:

Upper Coastal Plain Stream-associated Wetlands

2022

Prepared by:

Maryland Department of the Environment

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Introduction

This guidance has been developed to help address a specific management need for stream restoration projects proposed under the approved watershed implementation plan (WIP) for the Chesapeake Bay and the State of Maryland and its local jurisdictions to meet waste load allocations for reducing nutrients and sediment. Certain practices eligible for credit toward load reductions (stream restoration, shoreline stabilization, and wetland restoration) typically require MDE authorizations, and hundreds to thousands of additional applications are anticipated over the next few years. Although MDE must process incoming applications in a timely manner, by using existing policies, methods, guidance and tools, MDE is seeking to continuously improve its methods, approaches and tools to ensure that these activities are effective and that the processes MDE uses to review these activities are cost-effective and efficient.

Most stream restoration projects are proposed in clearly degraded areas as a result of excessive stormwater flows and/or other nutrient and sediment inputs from eroding banks. This often results in an incised stream channel as it adjusts to higher discharges and a disconnection between stream flow and the floodplain, and with subsequent loss or decline of associated processes for retention of transported sediment and retention/transformation of nutrients. Floodplains and wetlands within the riparian area may also be altered by changes in inundation and saturation, resulting in plant community shifts that represent less desirable habitat. However, there are also areas where the stream and associated wetland resources in the riparian area have more limited degradation, and still provide habitat benefits that would potentially be lost if the restoration design did not consider the existing resource condition. The debate over tradeoffs between a design objective of maximizing reduction of nutrients and sediment versus improving a riparian corridor as an integrated system with multiple benefits can lead to delays in application review, and ultimately, construction of a project.

Especially in sensitive areas like wetlands, basic restoration principles should be followed, such as do no harm; minimize disturbance and maintain existing function/services through the use of minimally invasive techniques; create or maintain landscape and hydrologic connections; and, where site conditions allow, restore an area to the natural vegetation community/HGM type appropriate for the site. Special care should be taken in areas with rare species, rare vegetation communities, and high ecological integrity sites. Complex ecosystems and associated habitat features cannot be created via simple and artificial construction of selected components. Ecological restoration requires a holistic approach that cannot be achieved through isolated manipulations of individual elements, but through approaches ensuring that natural ecological processes occur and can be sustained. Natural structure and function should be restored and work should be done in the context of the landscape and watershed for the greatest long-term benefit.

This guidance, a rapid assessment method for habitat condition, and recommendations have been prepared to better ensure that restoration projects are designed to protect aquatic/wetland resources that may be present or dependent on the site while still allowing for projects which can receive credit toward nutrient and sediment reduction. The rapid assessment method, presented in a separate document, was developed to classify and provide information on the condition of the vegetation communities of Key Wildlife Habitats (KWH), which support designated Species of Greatest Conservation Need according to the Maryland State Wildlife Action Plan, with

corresponding hydrogeomorphic (HGM) classifications. The assessment includes a description of target wetland Key Wildlife Habitats excerpted from the Maryland Wildlife Action Plan, with accompanying photos, and an office and field assessment to characterize wetland condition in relation to reference communities of KWH.

Here we present an approach to recommendations for restoration based on the extent of degradation and condition of the KWH riparian wetland resources. This guidance is intended for restoration practitioners, planners, and regulators. It is assumed that the user is familiar with requirements of "Wetland Delineation Manual" and regional supplements used in Maryland. Information on the condition of the KWH at the project site from the rapid assessment should be taken into account.

Key Wildlife Habitat Classification and Descriptions

The Maryland State Wildlife Action Plan forms the blueprint for the conservation of priority species and habitats over a 10-year period. The plan identifies 610 animal species considered to be Species of Greatest Conservation Need (SGCN), including all state- and federally listed Threatened or Endangered species, rare species, endemic species, declining species, and responsibility species for which Maryland harbors a significant portion of the overall population. Because of the strong tie between species and habitats, it is critical to identify those habitats that support SGCN in order to conserve them. In general, the term "habitat" is described as the physical and biological environment that provides the necessary food, shelter, and other needs of a particular animal, plant, or other organism. Key Wildlife Habitats are no different in concept with the exception that the species dependent upon those habitats are considered Species of Greatest Conservation Need (SGCN). These habitats serve as critical foundations and support networks not only for SGCN but for all plant and animal species in Maryland.

Key Wildlife Habitats (KWH) are structured as ecological cover types based primarily on vegetation for most habitats, since vegetation typically reflects biological and ecological patterns across the landscape. Wetland and terrestrial KWH are organized into a simple classification scheme which is scalable, allowing for compatibility with other ecological classifications (Table 1). In riparian areas, terrestrial and wetland Key Wildlife Habitats are associated with stream and river habitats. These aquatic habitats are characterized into KWH types based on variables known to influence stream and river habitats at various spatial scales such as stream slope, size, elevation, climate, and geology.

Table 1: Maryland Key Wildlife Habitat Classification Key for non-tidal wetland habitats of the Upper Coastal Plain, including HGM Class.

1a. Wetlands bordering streams and rivers with overland, non-tidal flooding regimes (i.e., floodplains). Distinct alluvial landforms (e.g., backswamps, levees, terraces) and indicators present (e.g., scour marks, recent sediment deposition, vegetation damaged/bent in one direction, soils with alternating deposits, channel banks with flood marks). Structurally and compositionally diverse vegetation present ranging from closed mixed forests to open, beaver-created pools with floating aquatics**……COASTAL PLAIN FLOODPLAIN** HGM Class: Riverine

1b.Wetlands primarily controlled via groundwater discharge often associated with depressional and slope geomorphic features as well as the margins of small stream (1st and 2nd order) floodplain wetlands.

2a. Wetlands associated with toe slopes and floodplains of small streams of the coastal plain where groundwater discharge is a major contributing input source (mixed hydrological regime: occurs in very narrow part of the groundwater driven complex that is influenced by overbank flooding) with alluvial landform a minor part of the complex; smaller order stream floodplain margins where groundwater input also contributes to overall hydrology. These areas are generally small features along streams and are usually not as well-developed as seepage swamps in larger stream systems……**COASTAL PLAIN FLOODPLAIN** HGM Class: Riverine or Slope

2b. Wetlands associated with distinct depressional and slope geomorphic features.

3a. Basin wetlands, depressions, or very flat areas with evidence of ponded water, unidirectional flow not evident, lacks natural outlet, maintained by high water tables and seasonal precipitation. Hydrologic regimes range from saturated to seasonally flooded.

4. Seasonally flooded to saturated forested flats and depressions of broad coastal plain terraces (i.e., "wet flatwoods") with fluctuating water levels and intermittently ponded depressions. Soils are silt, sand, and clay loams, sometimes with a thin (< 30 cm [12 in]) mantle of coarse, fibric peat.

5a. Located on flat terraces and shallow depressions with seasonally perched water tables and braided channels…….. **COASTAL PLAIN FLATWOOD AND DEPRESSION SWAMP** Flatwood: HGM Class- Flat; Depression Swamp: HGM Class- Depression

5b. Small (<0.1 ha- 2 ha) shallow pools with a well-defined, discrete basin overlying a clay hardpan or other impermeable soil or rock layer impeding drainage, may or may not have vegetation in basin**……VERNAL POOL** HGM Class: Depression

3b. Slope wetlands associated with groundwater discharge zones (i.e., seeps, springs) and perennial, unidirectional flow towards a natural outlet such as a stream.

6a. Small (usually <1m^2), localized area of groundwater discharge, point source, generally mountain and piedmont regions only…..**SPRING** HGM Class: Slope

6b. Larger wetland systems with diffuse drainage patterns, widespread.

7a. Open wetlands characterized by predominantly shrub and herbaceous vegetation and localized groundwater discharge zones. (*note. Lack of natural disturbances [e.g., fire, beaver activity, grazing] in these habitats often promote woody plant succession.)* Saturated "bog-like" wetlands along gently sloping headwater streams, seepage toe-slopes, and oligotrophic spring-heads with considerable accumulation of peat mosses (*Sphagnum spp*.) at varying depths, soils acidic and infertile (*note. The term "bog" applied here is a technical misnomer since none of these wetland systems in Maryland are ombrotrophic.)*…….**COASTAL PLAIN SEEPAGE BOG AND FEN** HGM Class: Organic Soil Flat; Slope

7b. Saturated forests of sloping stream headwaters, large spring seeps, lateral seeps in ravines and stream bottoms with diffuse drainage patterns. Braided stream channels, muck-filled depressions, and hummock-and-hollow microtopographic features evident.……**COASTAL PLAIN SEEPAGE SWAMP** HGM Class: Slope

Typical species of these KWH in the Upper Coastal Plain can also be useful to classify an area to the correct KWH type:

Key Wildlife Habitat*	Trees	Shrubs	Herbs	Vines	Indicator**
Coastal Plain Floodplain	*Platanus occidentalis, Liquidambar styraciflua, Liriodendron tulipifera, Quercus michauxii, Fraxinus pennsylvanica, Betula nigra*	*Lindera benzoin, Asimina triloba, Ilex opaca, Ilex verticillata, Carpinus caroliniana*	*Thelypteris noveboracensis, Mitchella repens, Arisaema triphyllum, Boehmeria cylindrica, Saururus cernuus, Cinna arundinacea, Galium circaezans, Medeola virginiana, Thalictrum thalictroides, Impatiens capensis, Glyceria striata*	*Toxicodendron radicans, Parthenocissus quinquefolia, Campsis radicans*	*Platanus occidentalis, Betula nigra, Thelyperis noveboracensis, Saururus cernuus, Cinna arundinacea*
Coastal Plain Flatwood and Depression Swamp	*Quercus phellos, Quercus palustris, Quercus michauxii, Quercus pagoda, Liquidambar styraciflua*	*Eubotrys racemosa, Vaccinium corymbosum, Clethra alnifolia,*	*Woodwardia areolata, Osmunda cinnamomea, Mitchella repens, Osmunda regalis, Chasmanthium laxum*	*Smilax rotundifolia*	*Quercus pagoda, Quercus michauxii*
Vernal Pool	Varies	Varies	Varies	Varies	
Spring	Varies	Varies	Varies	Varies	
Coastal Plain Seepage Bog and Fen	*Nyssa sylvatica, Acer rubrum, Pinus rigida*	*Rhododendron viscosum, Toxicodendron vernix, Rubus hispidus, Ilex glabra, Clethra alnifolia*	*Carex atlantica, Andropogon glomeratus, Rhynchospora gracilenta, Eupatorium pilosum, Dichanthelium dichotomum var. dichotomum*	*Smilax pseudochina*	*Smilax pseudochina, Pinus rigida, Andropogon glomeratus, Rhynchospora gracilenta*
Coastal Plain Seepage Swamp	*Nyssa sylvatica, Acer rubrum, Magnolia virginiana*	*Clethra alnifolia, Viburnum nudum, Rhododendron viscosum*	*Woodwardia areolata, Osmunda cinnamomea, Osmunda regalis, Carex folliculata*	*Smilax rotundifolia*	*Magnolia virginica, Clethra alnifolia, Viburnum nudum*

*Species listed in each stratum represent species with high constancy values (>75%) for finer community types (i.e., association level) of Key Wildlife Habitats.

**Indicator species = High diagnostic value to type, high fidelity, and high relative cover

The best available current information regarding the description, condition, and distribution of wetland Key Wildlife Habitats in the Upper Coastal Plain and associated streams and rivers is provided below. Statewide general location maps and county distributions for KWH are presented in this document (Appendix A), along with statewide examples of public lands to visit, signature state rare plants, and state rare natural communities where relevant. These maps should

be viewed as only generalized range maps, rather than depicting the full and complete distribution of habitats, especially for small wetland areas.

While the guidance has been developed for stream restoration qualifying for Chesapeake Bay TMDL reduction credit, the method and guidance are also useful for selecting and designing mitigation or voluntary restoration projects.

Recommendations and Management Practices

In general, restoration techniques for Chesapeake Bay TMDL credit should be designed and constructed according to the assessment results and following guidance. For floodplain reconnection projects, projects may be designed to put more water on the floodplain by:

- raising bed by using fill
- placing structures (stone, beaver analog)
- excavating to buried soil layers
- re-shaping channel geometry

In addition, the following approaches may be needed to improve restoration success:

- properly size pipes/culverts for non-erosive flows
- upland treatments and soil treatments (e.g., organic amendments and techniques to remediate compaction).

Given the characteristics of the wetland Key Wildlife Habitats and the species of concern that they support, the following recommendations are made based on the results of the KWH condition assessment and general best practices for stream restoration projects.

Special Notes

Restoration projects in areas that are known or found to have sensitive species or are known as high quality areas should be designed to support or improve the high quality habitat. The Maryland Watershed Resources Registry shows designated areas such as sensitive species project review areas, forest interior bird habitat, targeted ecological areas, nontidal wetlands of special State concern, or other nontidal wetlands having significant plant or wildlife value (see COMAR 26.23.01.01B(80). Consultation with MDE, DNR, and federal agencies is strongly encouraged when proposing a stream restoration project in areas that may contain high quality resources.

MDE does not authorize increases in flood levels on adjacent properties without permission of the affected landowners.

Climate change considerations

Applicants may be required to demonstrate to the Department's satisfaction that they have taken into account future physical climate change-related risks associated with storm surges, sea-level rise or projected changes in the duration, frequency and magnitude of rainfall events. Specific requirements have not yet been developed. MDE strongly encourages jurisdictions to use "supersized" upland treatment facilities and, for MS-4 counties, receive additional impervious surface credit reduction through the Watershed Management Credit. In addition to improving

pollutant removal, these upsized stormwater control practices will capture more runoff volume to enhance climate change resilience to localized flooding.

Another benefit besides helping to address climate change is the additional quantity treatment which benefits streams which have been degraded by urban stormwater discharges. However, over design and excessive disturbance for stream restoration within channels and floodplains is not generally justified as a basis for future climate adaptation.

Some stream restoration practices use impervious structures within channels and sometimes floodplains to retain water and transported nutrients and sediment. While typically not meeting the definition of "dams," these structures are vulnerable to damage and structural failure from increased storm events. Lower structures which do not excessively impound water are desirable both for climate adaptation to protect against flood damages, to retain trees, and maintain habitat.

More specific guidance may be developed in the future to incorporate climate change considerations into stream restoration designs.

Pre-Construction – planning and site identification

The entity and prospective designers/contractors should use the Watershed Resources Registry (WRR) to identify sensitive species resources, nontidal wetlands of special State concern, and check for other designations (e.g., forest interior bird habitat) and other features which may be potential constraints on design or need specialized construction practices. The WRR also has identified priority areas for restoration and protection.

Entities that will seek contractors to design and/or build a restoration projects are encouraged to seek experienced contractors and designers. Ask for:

- Experience and references on successful restoration projects, including photographs and monitoring results
- History of additional site remediation, and meeting any performance standards.
- If the project site is known or suspected to have sensitive resources, seek practitioners with experience in maintaining or improving habitat for sensitive resources.
- Familiarity and experience with different types of design
- Description of equipment to be used. Entities doing the hiring may wish to specify certain types of equipment to reduce impacts

Note: The following standards are generally recommended and may be required. Project-specific deviations may be allowed, when justified for specific projects.

Pre-application

Entities should contact regulatory agencies to participate in field visits at sites under consideration for restoration. Project proponents should be able to identify sources of degradation affecting the stream/riparian/wetland area proposed for restoration. An assessment

of the existing stream condition, as documented by IBIs or measures of stream stability and erosion, should be performed prior to application submission. While the associated assessment for this guidance is not specifically mandatory, MDE will require an assessment of the riparian floodplain condition for TMDL stream restoration projects. MDE also recommends that applicant consultants perform the associated ecological assessment for this grant project, as described in "Field Manual for Pilot Method to Apply Rapid Ecological Field Assessments in Wetlands in Riparian Areas in Maryland: Upper Coastal Plain," for Western Shore counties in the Coastal Plain. MDE will perform this assessment if not done by consultants, to verify wetland/riparian area condition.

Comments and recommendations from regulatory agencies should be used in planning the design of the project.

Consider the effect that additional upland treatment may have on the design. What happens to the effectiveness of the design if upland treatment affecting discharges is implemented?

Note that water quality and improvements to aquatic life may require more than the specific stream restoration project. Treatment in the contributing watershed and addressing other stressors may be necessary for overall ecological restoration.

Have early meetings with contractors, designers, regulators to understand performance standards and anticipated requirements.

To reduce the spread of non-native invasive species (NNIS), inventory for and locate NNIS infestations consistent with the scale and intensity of the proposed activity (U.S. Forest Service 2012). The extent and intensity of inventorying should be appropriate to the threat posed by NNIS in or likely to be in the area, and by the potential effect of the activities on the spread, release, or control of those species. Focus inventories for NNIS plants at likely introduction sites such as access points, landings, skid trails, and other areas to be disturbed during the project. Determine a plan for action, if needed, based on the degree of invasiveness of the species found, severity of the current infestation, potential impacts of the project, and feasibility of control with available methods and resources. If pre-treatment of NNIS is warranted, consider postponing the activity until the infestation can be treated. Consider practical seasonal timing options that minimize the risk of introducing or moving an NNIS.

Using the results of the KWH condition assessment analysis

Overall Hydrology Scores Good - Excellent

When the overall hydrology, hydroperiod, and hydrologic connectivity range from "Good" to "Excellent," the stream channel overtops its banks frequently, is not eroding, and does not need restoration. If Key Wildlife Habitat and vegetation scores range from "Good –

Excellent," the riparian area should be protected, especially in areas with "Good – Excellent" landscape condition.

Scores of "Fair" or "Poor" for Key Wildlife Habitat and vegetation may indicate the utility of structural and/or vegetation enhancements in the form of coarse woody debris additions or other structural enhancements, plantings, or removal of invasive species in the riparian/wetland area depending on the KWH type.

Overall Hydrology Scores Fair

Overall hydrology, hydroperiod, and hydrologic connectivity scoring as "Fair" condition generally indicate that the stream overtops its banks so water enters the floodplain less frequently (e.g., at 10-year recurrence interval storms) than if it were less disturbed. Limited near-channel and/or in-channel work may be needed to improve stream functions with slight water level increases. In-channel structures should mimic natural features of the stream in its physiographic region. Some changes to channel geometry and close to the channel may be appropriate.

The removal or lessening of stressors in the contributing watershed, such as road crossings or impervious surface, is highly recommended. Correction of offsite stressors which may allow natural recovery of the stream should be considered, especially if the landscape condition of the project area is "Fair – Poor."

Extent of work in the riparian area, if any, should be commensurate with level of degradation. Habitat structure and vegetation scores of "Good-Excellent" for KWH type indicate only minor alterations within the floodplain may be appropriate, especially if landscape condition is "Good – Excellent."

Post-construction water levels should generally mimic hydroperiod of the soil type. Information on water levels and duration of particular soils is available from the Natural Resources Conservation Service web soil survey:
https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Overall Hydrology Scores Poor

Overall hydrology, hydroperiod, and hydrologic connectivity scoring as "Poor" condition generally indicate that the stream is incised and flooding rarely, if ever, occurs.

Re-connection to the floodplain should be achieved by in-channel work and/or minor changes to channel geometry when Key Wildlife Habitat and vegetation scores are "Good-Excellent." Restored hydroperiod should reflect indicators in reference soil profiles, as indicated in Natural Resource Conservation service (NRCS) web soil survey or determined by a certified soil scientist.

Vegetation scores of "Fair" may indicate the utility of vegetation enhancements in the form of plantings or removal of invasive species in the riparian/wetland area. Habitat structure scores of "Fair" or "Poor" may indicate the utility of structural enhancements. Consult with regulatory agencies about potential for legacy sediment removals prior to selecting this as a design approach. Also, when not working in nontidal wetlands having significant plant or wildlife value or other priority ecological designations, consult with MDE to determine when designs other than those which support the historic Key Wildlife Habitat onsite may be appropriate for the site. Upland treatment is always preferred when quantity through increased discharge from stormwater is contributing to the degradation.

Vegetation scores of "Poor" also indicate the need for vegetation enhancements. However, when not working in nontidal wetlands having significant plant or wildlife value or other priority ecological designations, consult with MDE to determine when designs other than those which support the historic Key Wildlife Habitat onsite may be appropriate for the site.

Additional work in the riparian area may be more extensive than in higher scoring sites. Upland treatment is always preferred when quantity through increased discharge from stormwater is contributing to the degradation.

The presence of limited native vegetation may support additional grading in the floodplain. Construction practices to prevent soil compaction should be used when soil scores range from "Fair-Excellent."

Design Considerations

Design to support other Chesapeake Bay Agreement goals beyond nutrient and sediment reduction. Goals include stream health, improving IBI scores, riparian forest buffer, fish passage, and wetland acreage and functional gains.

Design stream restoration to maintain or improve habitats for other sensitive species, their habitats, and rare communities.

Post-construction water levels are generally recommended to mimic the hydroperiod of the soil type, however, increased water levels and flood frequency may be approved provided there are no increases in flooding on adjacent properties without permission, and the design approach satisfies any MDE concerns and requirements.

Designer, construction manager, agency, and other required environmental inspectors/monitors should walk the site together to identify trees to be cut, removed, and protected, and where access points and staging areas should be located.

Design for a minimal limit of disturbance.

Limit disturbance of strongly, very strongly, or extremely acidic soils.

Design and place instream structures based on channel slope, rather than at set intervals.

Do not overdesign. Minimal alterations in areas of limited degradation help to maintain the quality of existing natural and water resources. Likewise, in heavily degraded areas, intensive disturbance may further worsen aquatic life conditions and other water quality or habitat parameters (Hilderbrand et al., 2018, Filoso et al. 2015, Palmer et al. 2014). Minimizing soil disturbance can also help to prevent the spread of non-native invasive species (NNIS). Consider the impacts of different types of equipment, and, where feasible, plan to use equipment that minimizes soil and vegetation disturbance. Retain native vegetation in and around the activity area to the greatest extent possible. Consider the option to choose not to carry out an activity where the spread of NNIS is likely to negatively impact the restoration project (U.S. Forest Service 2012).

To minimize the spread of non-native invasive species (NNIS), use existing roads to the extent possible. Avoid constructing new roads, skid trails and landings in areas infested with NNIS where possible and limit the number, width, and length of roads, skid trails and landings to help minimize soil disturbance and to limit the risk of unintentionally transporting NNIS into non- infested areas.

Most nontidal wetland Key Wildlife Habitat types associated with Upper Coastal Plain streams are forested. Designs should follow the Maryland Wildlife Action Plan recommendations for these habitat types to be managed to maintain closed or semi-open canopy. The exception is the Coastal Plain Seepage Bog and Fen category, which have shrub/emergent communities.

Approach the restoration project without a pre-determined design. Site-specific considerations should determine the type of design appropriate for the site.

Sites with field, measured, or modelled indicators of recent overbank flooding (2- year recurrence interval) storms should limit increasing additional inundation of floodplain. Flooding at 10-year recurrence interval may have some additional increased connection, without increasing flooding on adjacent properties or threatening survival of desired species.

Legacy sediment removal projects involve a high amount of disturbance and remove existing surface vegetation. The practice is generally not desirable in forested systems, and requires additional justification. Existing riparian wetland areas with low-scoring assessments, and existing trees in poor condition, extensive coverage of invasive species, adjacent to deeply incised streams with a buried organic soil layer, may be considered for approval. Legacy sediment removal should not be done over existing underground infrastructure.

If restoration out of type is necessary, this may be best in the most degraded sites or where there are other constraints.

Construction techniques for minimizing impacts should be selected and post construction adjustments, e.g., too much water, blockage from structural movement, may be necessary.

Construction Specification

Oversight

An environmental monitor/inspector, and agency participation is highly recommended during construction and may be required, depending upon the sensitivity and condition of the resources and detailed design requirements.

Cleaning of clothing, footwear, and equipment should be considered in order to limit the introduction and spread of non-native invasive plant species as well as introduced diseases that affect reptiles and amphibians (e.g., ranavirus). Preferred locations for cleaning equipment area are those where monitoring can be conducted at a later date, equipment is unloaded and loaded, non-native species are less likely to spread from cleaned equipment or where they are already established. Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting invasive species. Routinely remove soil, seeds, vegetative matter, or other debris from shoes, clothing, and tools. To avoid the transport of disease organisms, such as ranavirus and chytrid, proper disinfection procedures should be followed between sites. After removing mud and debris, field equipment and footwear should be disinfected between sites by rinsing or soaking them with a 10% bleach and water solution, letting them sit for 5 minutes, then rinsing with fresh water. Felt sole boots/waders should not be used. Skin that comes into contact with eggs, tadpoles, or water in the field should be cleaned with alcohol-based hand sanitizer as part of the disinfection procedure. Disinfection should be done at least 50' away from wetlands or streams to avoid chlorine kills of amphibian and fish larvae.

Completed grade control structures should have flow over the apex during baseflow conditions with consistent arm slopes up from the apex to a stable sill tie-in at bankfull into existing ground. Riffles shall have surface flow along the thalweg throughout the entire riffle length and tie-up to bankfull on both banks. The contractor is responsible for ensuring smooth transitions at upstream and downstream ends of work areas and between the streambed and its banks.

Equipment selection

Use the smallest equipment practicable that can safely be used for construction. Some sites may be accessed by smaller motorized vehicles such as ATVs, or entry and material placement by hand-operated equipment. Applicants may be asked to provide rationale for their equipment selection in some cases to ensure that adverse and unnecessary impacts are reduced.

Larger equipment which may have lower operating psi, may be allowed if justified to agency satisfaction.

Use smaller pipes and pumps where practicable to reduce the limit of disturbance.

Access

When designing access for construction, the tree locations and attributes should be evaluated to identify whether they are to be removed or retained. It may be necessary to design a meandering access path to maximize tree retention. Look for gaps between trees onsite and locate the access road in these areas to minimize tree removal.

Access roads, if necessary, should be designed and constructed to prevent soil compaction and protect tree roots. Roots subject to heavy equipment disturbance may be damaged and unable to have air exchange necessary for tree survival. In especially sensitive areas, the use of more specialized equipment with less load bearing may be considered. Placement of adequate wood mulch, (generally minimum of 12") mats on top of mulch, and another layer of mulch may help prevent compaction. An additional standard of < 8 psi may be required in sensitive areas with potentially less mulch application. See details from M-NCPPC in Appendix C. Contact MDE to determine the information requirements necessary to justify alternate methods, lesser amounts of mulch, use of or elimination of filter fabric, or equipment with higher psi, and other specifications for equipment access. Documentation must demonstrate that equipment operation will not result in compaction nor damage to tree roots based on site conditions, including soil properties.

A minimum of 4" of mulch should be retained in the access road.

Access roads are generally limited to 12 feet or less in width. If MDE determines that the width is not appropriate, the width may be increased or further narrowed.

Staging areas may have limited excavations after use is completed to create microtopogaphy.

Operating equipment in stream channels must be pre-approved and at selected locations only, if approving agencies determine that it is preferable to additional riparian area disturbance.

Preferably, conduct activity when soils are at most dry condition.

Set up activity boundaries to exclude travel through areas infested with non-native invasive species that could be moved by equipment and personnel. Consider options for the sequence of operations within the activity area and, where feasible, plan to enter areas infested with non-native invasive plant species last.

Tree Retention

If trees must be removed, select smaller trees < 24" or those which are not healthy. Pine plantations may be removed.

Do not grub trees after cutting except in specifically approved areas. Cut the stump to the ground to allow the root system to remain when a tree is used to instream structure. If wood is not used onsite for instream structures, retain material in the riparian area as woody debris. Plans should indicate where trees must be cut flush to the ground or when complete removal of tree and roots is allowed.

When tree removal is needed for access, push selected trees down, so some roots remain in contact with soil.

Install protection measures such as tree planking, root aeration mats, protective fencing before construction equipment enters the work site to protect remaining trees.

Tree roots must not be cut to install trenches for erosion control and silt fences. Prune tree roots as necessary for placement of erosion control structures. See sample drawing in Appendix C.

In designing new slopes for channel banks (e.g. 3:1) the slope does not have to be homogenous. The grading for the bank should not be continuous if trees are on the bank, and ratios for slopes may be adjusted along the bank. Selected trees on the bank should be retained and bank grading should resume outside of the area of influence of remaining trees.

Stabilization

Stabilization is required at the end of each day as construction progresses to reduce exposed bare soil. Cover bare soil at the end of each day with erosion control matting or mulch, which can be removed for the next days' work.

If a pump is used for stream diversions, and the pump is removed each day, stabilize the site at the end of each work day. Cease operation of the pump at the end of the working day.

Permanent stabilization mixes shall be of native wetland or riparian seed mix appropriate for the physiographic region. Straw mulch must be certified by the supplier as being weed-free.

Performance standards

A performance bond may be required to ensure that projects are constructed as approved.

Projects shall be designed and constructed to allow for further modification if performance standards are not met.

Design and install instream structures so that aquatic life can pass over, around, or through the structure at base flow. Use certified weed-free mulch, if needed, to prevent the introduction of non-native invasive plants. Ensure, to the extent practical, that fill and gravel are free of non-native invasive species and their propagules.

Water levels must not exceed authorized increases on other properties.

Design the project to restore hydroperiods which are appropriate for the site and soil type. Most forested wetland have fluctuating water levels. Soil properties indicate what previously existing hydroperiods were.

Fill placed in streams or floodplains to raise elevation of stream beds must not reduce existing spring flow contributions to the stream.

Vegetation Performance Standards

Example: retain 40 square feet of basal area, evenly distributed without major gaps, per acre. This is commonly used in forest harvest practices in streamside management zones.

MDE may specify that remaining forested wetlands remain predominantly forested or at a certain amount of forest canopy cover post construction, and after water level increases. Structures and other features which raise water levels to result in unacceptable tree mortality or plant community changes shall be modified to MDE's satisfaction to restore desirable water levels and hydroperiod in the wetland.

Additional plantings or seeding may be recommended to restore missing or limited plant strata. Protection will likely be necessary to prevent herbivory.

Special Habitat Standards

MDE may require site-specific conditions and standards to protect or improve habitat for rare species or plant communities, or areas of high quality natural or aquatic resources.

Onsite monitors/inspectors may be required in highly sensitive areas with specific protection measures. Monitors may be required to report and consult with regulatory agencies prior to deviating from any approved plans.

Post Construction

After final construction is complete, determine if flow will be non-erosive through the altered channel. Adjust channel geometries as necessary if flow was found to be erosive.

Straw mulch should consist of wheat, barley, oat or rye straw, and should not be musty, dusty, or of low quality. See details in Appendix C for mulch application.

Plantings must be species native to the physiographic region. Tree and shrub plantings must be protected from herbivory, and replaced as needed. Repeated monitoring, maintenance, and remediation may be necessary to achieve success of planted vegetation. After the activity is completed, it may be necessary to monitor for non-native invasive plant species (NNIS) and follow up with treatments. Plan ahead to obtain resources to monitor the site for new NNIS or the spread of existing populations, and to treat NNIS as needed.

Protection from white-tailed deer and other herbivores may be necessary to protect tree plantings. Recommendations are summarized in Bulletin 354 Managing Deer Damage in Maryland, Maryland Cooperative Extension https://extension.umd.edu/sites/extension.umd.edu/files/publications/EB354_ManagingDeerDamage.pdf.

Modify structures as needed to ensure that surface and ground water are at approved and desired levels to maintain desired vegetation.

Modify, repair, or replace failed structures. Remove material which may threaten infrastructure.

Next Steps

This guidance is subject to revision as new information becomes available and user feedback and recommendations are considered. MDE may modify the assessment method as a result of ongoing MDE and DNR work on the next phase of stream/wetland restoration guidance being developed in other parts of the State under a separate U.S. Environmental Protection Agency grant. Other modifications to the assessment may be made by MDE in the future for consistency with other assessments for stream mitigation and regulatory nontidal wetland impacts under development by the U.S. Army Corps of Engineers and partnering agencies.

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Appendix A

Key Wildlife Habitats

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 *(Acer rubrum)*, and plants tolerant of fluctuating water levels such as lizard's-tail. Bald Cypress Swamps and Atlantic White Cedar Swamps are rare natural communities that are also associated with poorly drained settings in seasonally flooded floodplains. Both are associated with slow-moving Blackwater Streams such as those in the Pocomoke and Nanticoke River watersheds. Only 6 acres have been identified by the Maryland Department of Natural Resources as old growth on state lands.

Richard Wiegand, MD DNR

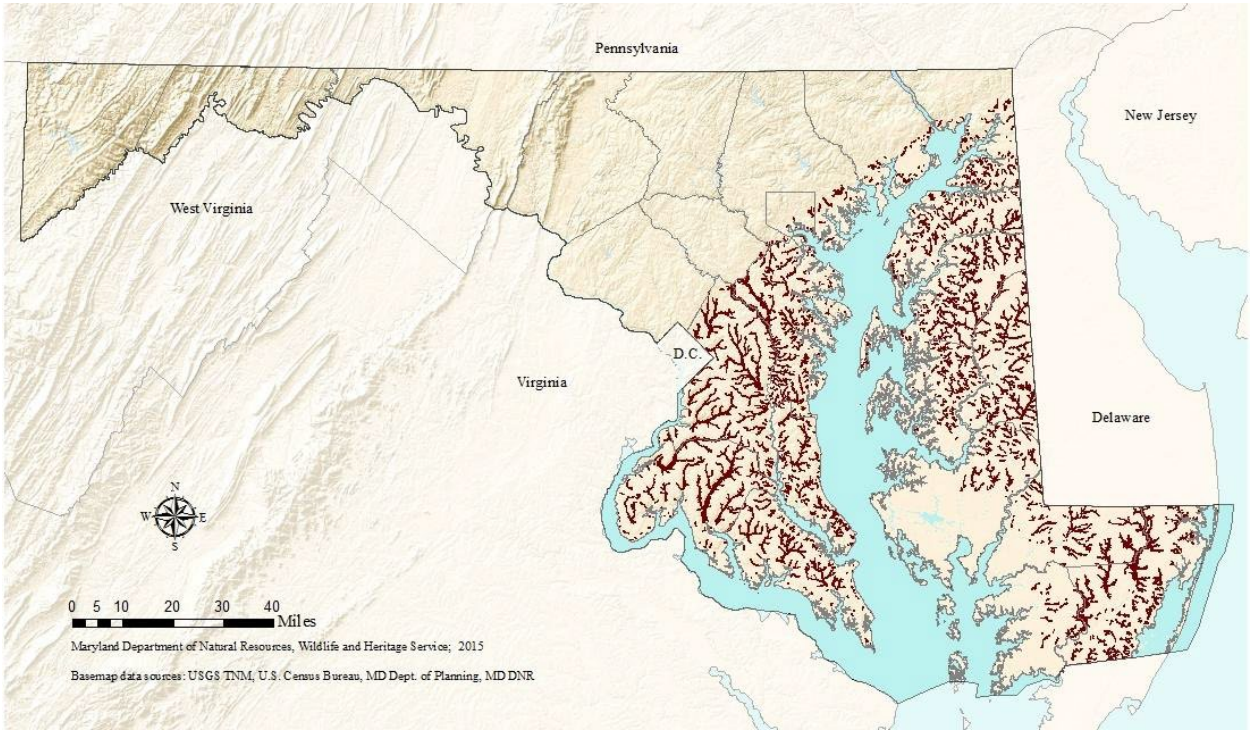
Floodplain pools, beaver ponds, and other open water habitats are also characteristic of Coastal Plain Floodplains. These habitats are subjected to irregular disturbances that change water levels, such as the breaching of beaver dams and storm events. These habitats are highly variable in size, structure, 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)*, broad-leaved cattail *(Typha latifolia)*, American bur-reed *(Sparganium americanum)*, swamp loosestrife *(Decodon verticillatus)*, and common buttonbush *(Cephalanthus occidentalis)*.
County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, Worcester

Places to Visit: Merkle Wildlife Sanctuary, Idylwild Wildlife Management Area, Pocomoke State Forest

Signature State Rare Plants: Flat-stem Spikerush (*Eleocharis compressa*), water-plantain spearwort (*Ranunculus ambigens*), catchfly cutgrass (*Leersia lenticularis*), veined skullcap (*Scutellaria nervosa*), red turtlehead (*Chelone obliqua*)

State Rare Natural Communities: Bald Cypress Swamp, Atlantic White Cedar Swamp



Mapped Locations of Coastal Plain Floodplains in Maryland. Sources: MD DNR, FEMA.

Coastal Plain Seepage Swamp

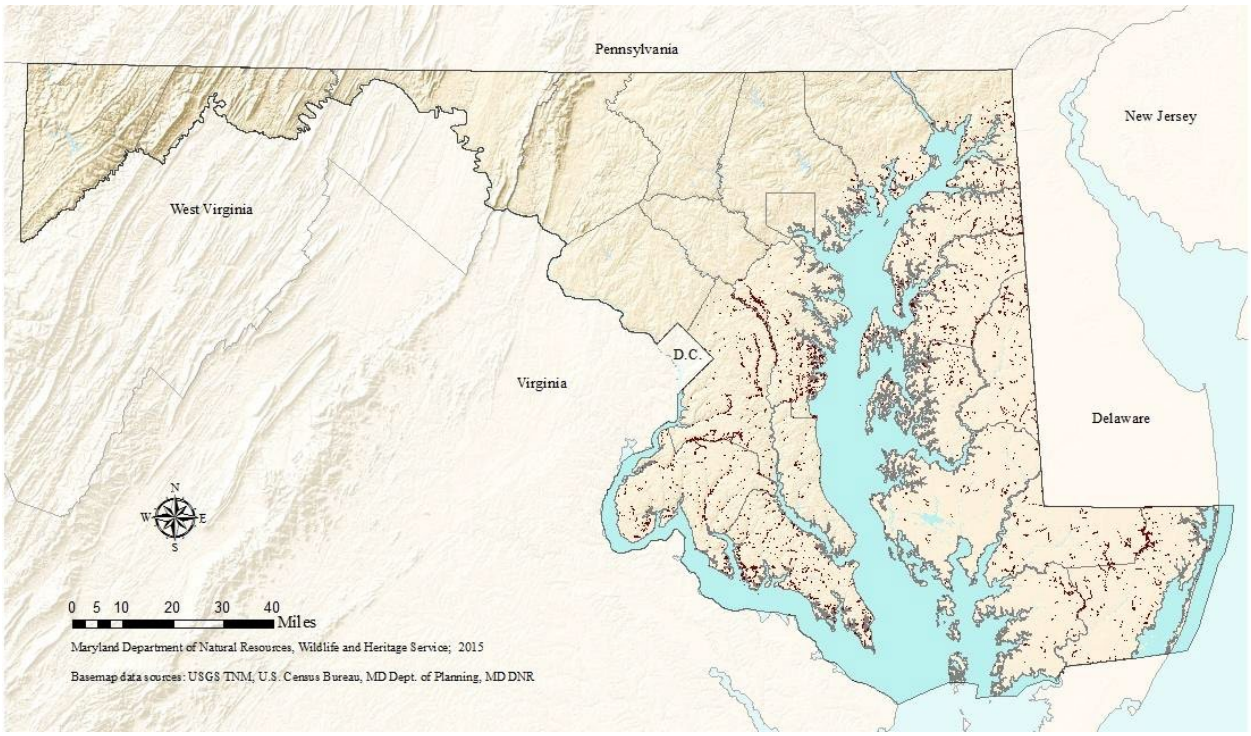
Richard Wiegand, MD DNR

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.

County Distribution: Anne Arundel, Baltimore, Calvert, Caroline, Cecil, Charles, Dorchester, Harford, Kent, Prince George's, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, Worcester
Places to Visit: Elk Neck State Forest, Tuckahoe State Park, Pocomoke State Forest

Signature State Rare Plants: Swamp pink (*Helonias bullata),* dwarf huckleberry (*Gaylussacia dumosa)*

State Rare Natural Community: Coastal Plain-Piedmont Acidic Seepage Swamp



Mapped Locations of Coastal Plain Seepage Swamps in Maryland. Sources: MD DNR, USFWS.

Coastal Plain Flatwood 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 mixtures 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.

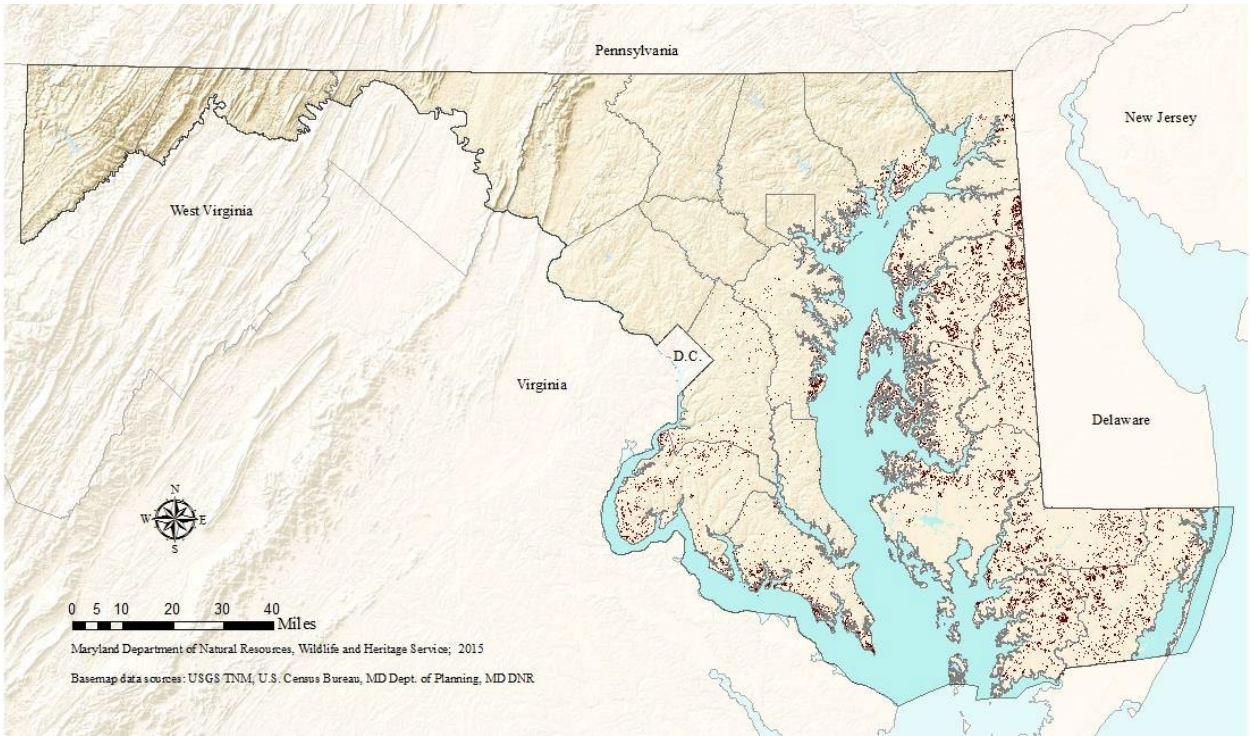
Scott Smith, MD DNR

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

Places to Visit: Blackwater National Wildlife Refuge, LeCompte Wildlife Management Area, Millington Wildlife Management Area, Third Haven Woods (The Nature Conservancy)

Signature State Rare Plants: Three-angle spikerush (*Eleocharis tricostata),* southern waxy sedge (*Carex glaucescens),* white-bracted boneset (*Eupatorium leucolepis)*

State Rare Natural Communities: Coastal Plain Non-Riverine Hardwood Swamps, Atlantic White Cedar Swamp, Upland Depression Swamp



Mapped Locations of Coastal Plain Flatwoods and Depression Swamps in Maryland. Source: MD DNR.

Coastal Plain Seepage Bog and Fen

Wesley Knapp, MD DNR

The Coastal Plain Seepage Bog and Fen key wildlife habitat is a rare, small-patched habitat associated with seepage toeslopes, small stream bottoms, and the margins of long established millponds and sandpits. They typically develop at the base of sand and gravel terraces near streams where groundwater seepage is abundant and forced to the surface by an impermeable clay lens or aquiclude. The soils are usually peaty or sandy, very acidic, infertile, and often covered by dense mats of mosses (*Sphagnum* spp.) that support a unique flora. The term "bog" as applied to these wetlands, is a technical misnomer, since not all of these habitats are true peatlands and none is an ombrotrophic (i.e., fed by rainwater) system. This term, however, is now so widely used in the southeastern United States as a descriptor for open, acidic seepage wetlands that we have adopted it here for consistency. In Maryland, Coastal Plain Seepage Bogs and Fens exist in a variety of open settings and many are relicts of older, larger systems. Many natural examples have been destroyed by hydrologic alterations (e.g., ditching, draining, and impoundment construction), beaver activity, and a long history of fire suppression across the landscape. Remaining sites that support bog flora persist in artificially maintained habitats such as millponds, powerline rights-of-way, and sandpits where woody plant succession is usually controlled. The vegetation of Coastal Plain Seepage Bogs and Fens is very heterogeneous and patchy with scattered shrubs and graminoid dominated patches. The small openings found along the margins of slow-moving streams, millponds, and abandoned sandpits often support shrubs such as leatherleaf *(Chamaedaphne calyculata)*, big cranberry *(Vaccinium macrocarpon)*, sweet pepper-bush *(Clethra alnifolia)*, swamp loosestrife *(Decodon verticillatus)*, and giant cane *(Arundinaria gigantean)*. Hummocks of *Sphagnum* mosses are characteristic and usually support species such as northern pitcher-plant *(Sarracenia* spp.*)*, white beak-sedge *(Rhynchospora alba)*, rose pogonia *(Pogonia ophioglossoides)*, St. John's-wort *(Hypericum* spp.*)*, and Virginia meadow-beauty *(Rhexia virginica)*. Orchids, sundews *(Drosera* spp.*)*, bladderworts *(Utricularia* spp.*)*, and yellow-eyed grasses *(Xyris* spp.*)* are also common. Near the fall-line, globally rare Magnolia Bogs occur and share many floristic similarities to the New Jersey Pine Barrens region. Unlike true bogs, Magnolia Bogs are not characterized by accumulations of peat or organic soils. Nutrient poor and acidic seepage flow from groundwater often forms mucky depressions and braided channels around hummocks of sphagnum mosses. Historic accounts of Magnolia Bogs describe these areas with sweet bay and various shrubs fringing and forming clumps within a more open center dominated by herbaceous plants. Today, remaining examples exist mostly as open woodlands of black gum *(Nyssa sylvatica)* and sweet bay *(Magnolia virginiana)* with very dense shrubs and very small, scattered herbaceous patches. Shrubs common to these habitats include sweet bay, swamp azalea *(Rhododendron viscosum)*, highbush blueberry *(Vaccinium fuscatum)*, fetterbush *(Leucothoe racemosa)*, dangleberry *(Gaylussacia frondosa)*, poison sumac *(Toxicodendron vernix)*, and Southern wild raisin *(Viburnum nudum).* Herbaceous openings include species such as cinnamon fern *(Osmunda cinnamomea)*, woolly

panicgrass *(Dichanthelium acuminatum)*, partridge berry *(Mitchella repens)*, halberd-leaved greenbrier *(Smilax pseudochina)*, wild yam *(Dioscorea* spp.*)*, Indian cucumber-root *(Medeola virginiana)*, and primrose-leaved violet *(Viola primulifolia)*. Regionally uncommon or rare "bog" species persisting in Magnolia Bogs include bog goldenrod *(Solidago uliginosa var. uliginosa)*, ten-angled pipewort *(Eriocaulon decangulare)*, Long's rush *(Juncus longii)*, spoon-leaved sundew *(Drosera intermedia)*, red milkweed *(Asclepias rubra)*, and sheep-laurel *(Kalmia angustifolia)*.

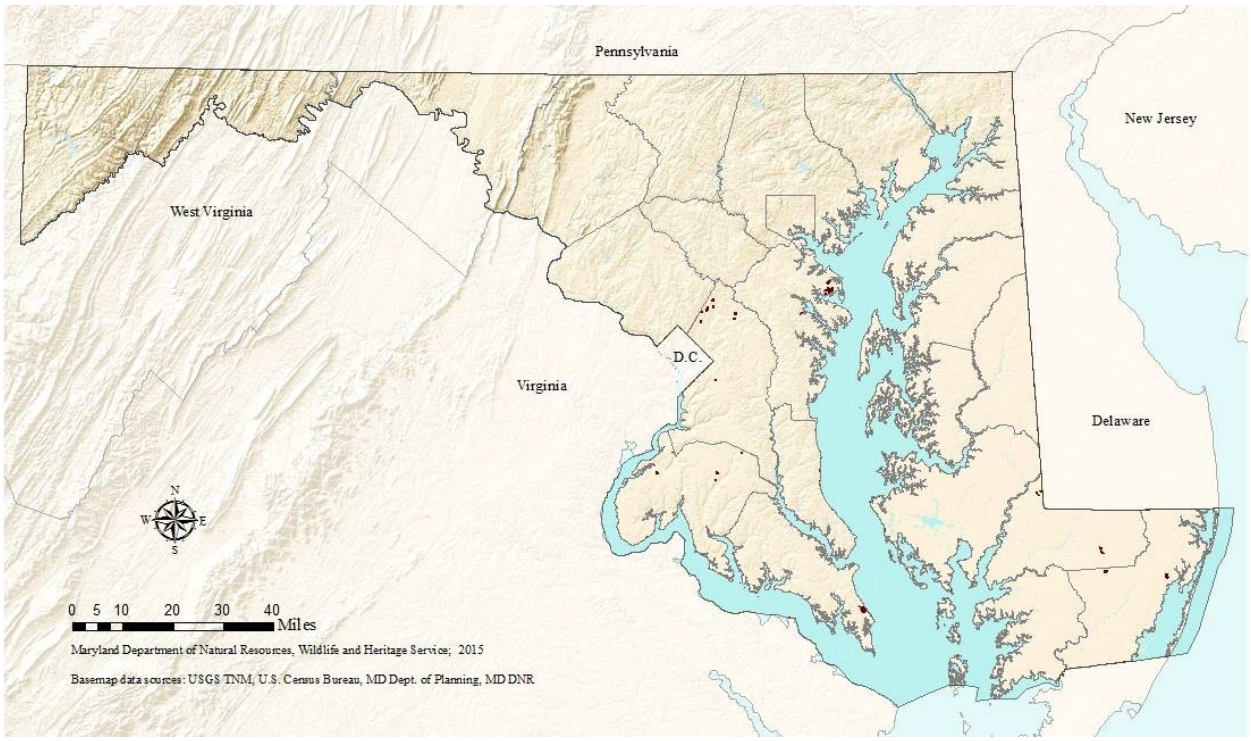
Sea-level Fens are small maritime seepage wetlands that occur above the high tide line at the bases of slopes where abundant groundwater discharges along the upper edges of estuarine bays. The hydrology of these sites is best characterized as saturated, although shallow standing water and small, muck-filled pools are locally present at all sites. Soils are characterized as organic and nutrient-poor. The vegetation exhibits characteristics of both inland seepage bogs and slightly brackish tidal marshes. Stands are generally a physiognomic mosaic of open woodland, scrub, and herbaceous patches. Woody species include red maple *(Acer rubrum)*, black gum *(Nyssa sylvatica)*, sweet bay *(Magnolia virginiana)*, and southern bayberry *(Morella cerifera)*. Characteristic herbs include twig rush *(Cladium mariscoides)*, beaked spikerush *(Eleocharis rostellata)*, white beaksedge *(Rhynchospora alba)*, spoon-leaved sundew *(Drosera intermedia)*, ten-angled pipewort *(Eriocaulon decangulare)*, coinleaf *(Centella erecta)*, brown-fruited rush *(Juncus pelocarpus)*, and bladderworts *(Utricularia* spp.*)*. Because of their small size and association with tidal salt marshes, Sea-level Fens are included as part of the Tidal Salt Marsh and Shrubland key wildlife habitat.

County Distribution: Anne Arundel, Calvert, Caroline, Cecil, Charles, Dorchester, Prince George's, Somerset, Wicomico, Worcester

Places to Visit: Suitland Bog

Signature State Rare Plants: New Jersey rush (*Juncus caesariensis),* Long's rush (*Juncus longii),* red milkweed (*Asclepias rubra),* leatherleaf (*Chamaedaphne calyculata),* brown-fruit rush (*Juncus pelocarpus),* northern pitcher plant (*Sarracenia purpurea)*

State Rare Natural Community: Coastal Plain-Piedmont Acidic Seepage Bog/Fen



Mapped Locations of Coastal Plain Seepage Bogs and Fens in Maryland. Sources: MD DNR, USFWS.

Vernal Pool

James McCann, MD DNR

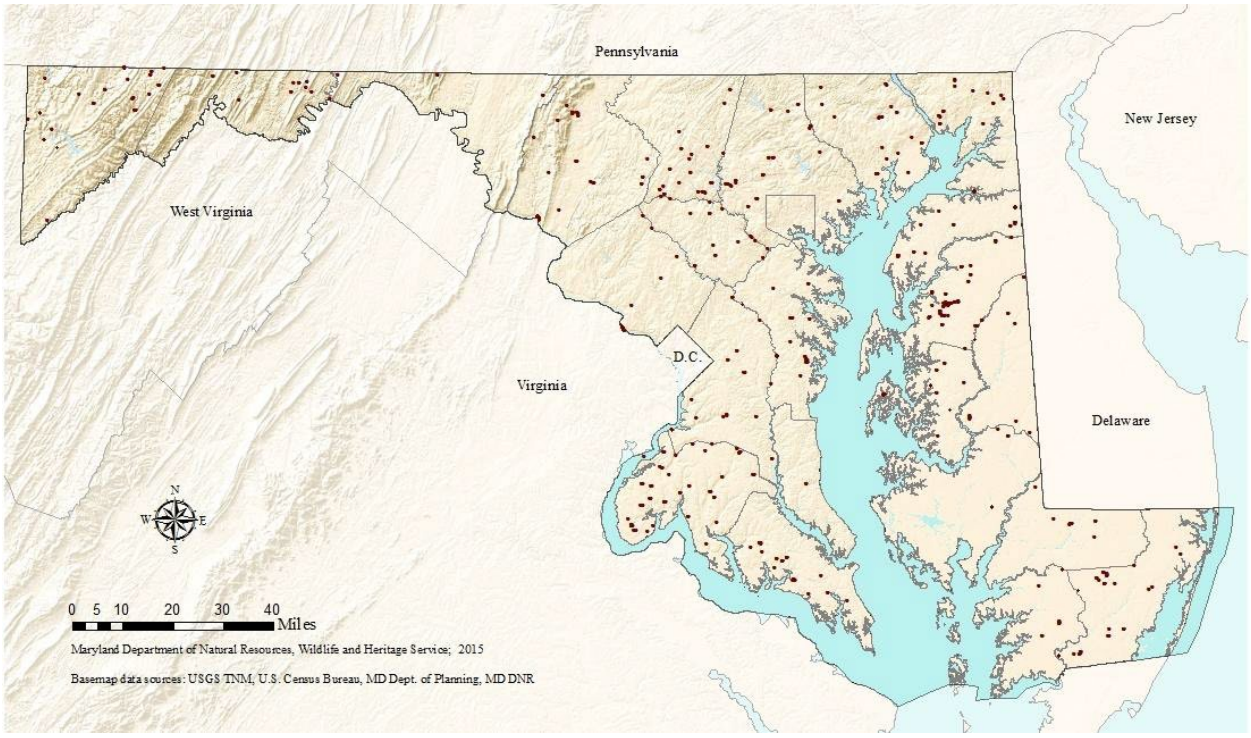
The Vernal Pool key wildlife habitat is defined as small (~0.1-2 ha), non-tidal palustrine forested wetlands. They exhibit a well-defined, discrete basin and lack a permanent, above-ground outlet. The basin overlies a clay hardpan or some other impermeable soil or rock layer that impedes drainage. As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

County Distribution: Statewide

Places to Visit: Seth Demonstration Forest

State Rare Natural Community: Vernal Pool



Mapped Locations of Vernal Pools in Maryland. Source: MD DNR.

James McCann, MD DNR

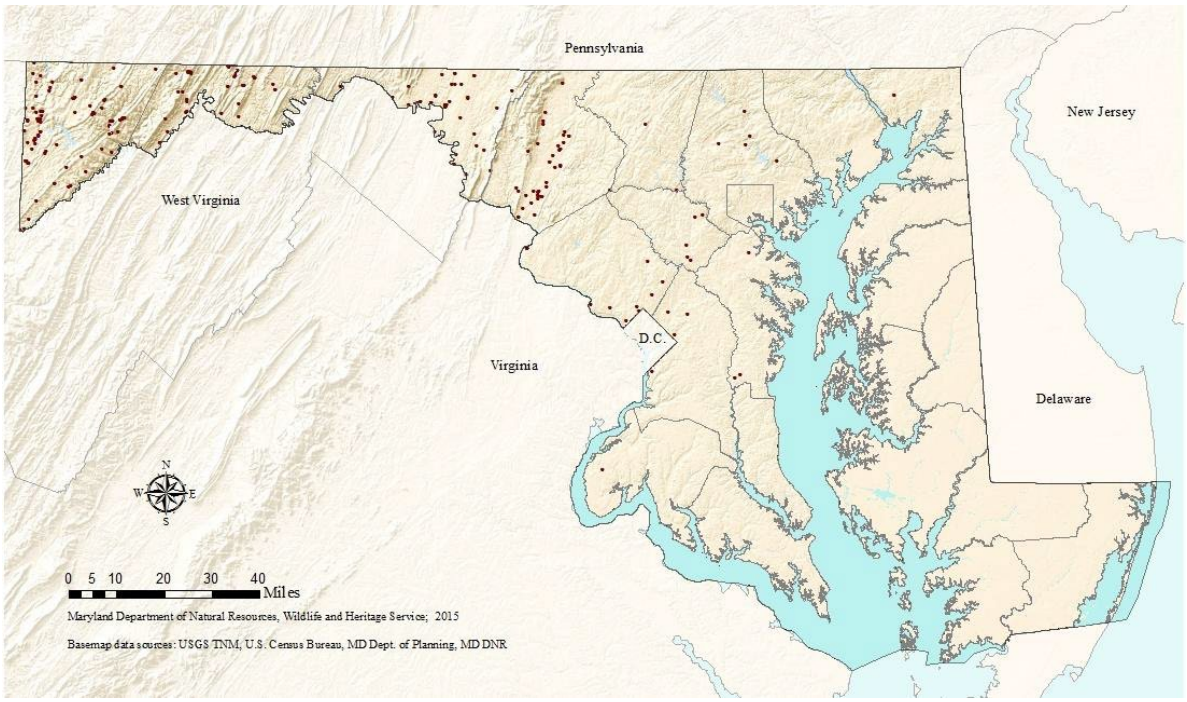
Spring

MD DNR

The Spring key wildlife habitat is a concentrated discharge of groundwater at a small (usually < 1 m^2), distinct site or opening in the ground. Springs are uncommon, isolated features and most occur west of the Fall Line. They provide critical habitat for highly rare aquatic snails and subterranean invertebrates, salamanders, crayfish and other invertebrates. Because some Springs discharge directly into streams or wetlands, they also play a vital role in maintaining the ecological integrity of these habitats which, in turn, may harbor species of conservation concern (e.g., pearl dace, brook trout, rare dragonflies and damselflies). Springs emit groundwater due to hydrostatic pressure resulting from gravity or artesian flow, although other physical forces may play a role (e.g., buoyant effect of dissolved gases). Several types of Spring key wildlife habitats exist in Maryland including contact, scree, and fault Springs. Perhaps the most common type is fracture or crevice springs. Here, groundwater moves downward due to gravity, flowing through fractures and crevices underneath the ground and emerging as a spring where a major fracture in a rock formation occurs at the earth's surface, usually along a ravine or swale. The flow or discharge rates of Maryland's Springs range from less than one gallon per minute to nearly 10,000 gallons per minute. Springs differ from seeps in that the latter appear on the ground surface as broad, diffuse zones of wetness or percolation rather than distinct discharge sites. Also, seeps and associated wetlands often support distinct plant communities while springs are essentially aquatic and geological features.

County Distribution: Statewide

Places to Visit: Henryton Spring, Annapolis Rock Spring



Mapped Locations of Springs in Maryland. Sources: MD DNR, Geographic Names Information System (USGS).

Coldwater Stream

Richard Wiegand, MD DNR

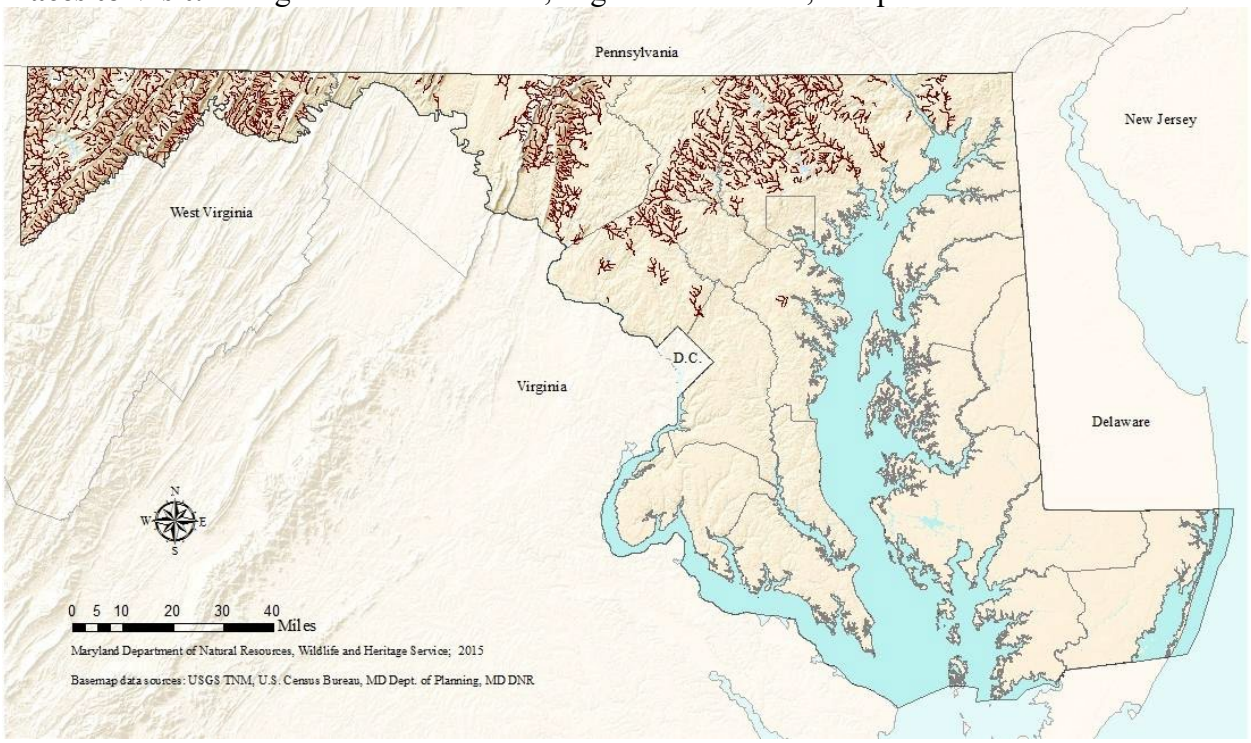
Coldwater Streams comprise approximately 2,750 miles of Maryland's freshwater streams and are unique in their form, function, and biota. They are most common in the Appalachian Plateau and Ridge and Valley physiographic provinces, particularly in the Youghiogheny and North Branch Potomac drainages, but are also found in the Piedmont physiographic province within the Middle Potomac, Susquehanna, Gunpowder, and Patapsco drainages. Characterized by a maximum daily mean water temperature of less than 20° C and dissolved oxygen levels greater than 5 mg/L, these streams are typically found only in the headwater reaches of a watershed. Most are riffle-dominated, high gradient (>2%) streams with well-shaded riparian canopies allowing for mechanical aeration and regulation of water temperature. Fallen trees and submerged logs play an important role in shaping Coldwater Stream channels, creating pools and slow-water areas beneficial to aquatic species. Logs and leaf litter are also a primary source of organic matter forming the base of the food web in these streams. Beaver activity along Coldwater Streams represents an important form of natural disturbance and creates habitat heterogeneity. Beaver impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Compared to

downstream and warm water streams, aquatic biodiversity and productivity are low, with few fish and benthic macroinvertebrate species, often occurring in low abundance. Brook trout, Maryland's only native trout species, are found in these streams along with introduced brown and rainbow trout. Common nongame species include mottled and Blue Ridge sculpin, longnose dace, and creek chub. Stoneflies of the genera *Sweltsa* and *Tallaperla* are considered coldwater obligate taxa – found only in these habitats. Mayflies of the genera *Ephemerella, Epeorus, Stenonema*, and *Paraleptophlebia* and stoneflies often dominate the benthic macroinvertebrate community. In contrast to the low diversity of fish species, Coldwater Streams support the greatest diversity of aquatic and semi-aquatic salamanders in the State, including spring *(Gyrinophilus porphyriticus)*, seal, and Allegheny mountain dusky salamanders *(Desmognathus ochrophaeus)*.

The quantity and quality of Coldwater Stream habitats have declined as a result of disturbance associated with agriculture and urban development. Although the historical extent of Coldwater Streams in Maryland is not known, this type of stream habitat was likely more widespread. Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), Coldwater Streams in Maryland are on average in fair condition, meaning that many of these streams are at least partially degraded. Seven percent of Coldwater Stream habitats are considered to be severely degraded and no longer support many of the species that make this key wildlife habitat unique. Thirty-six percent are in good condition and 7% of the approximately 2,750 miles of Coldwater Streams are considered "high quality waters" as designated in Maryland's Anti-degradation regulation (COMAR 26.08.02.04-1).

County Distribution: Allegany, Anne Arundel, Baltimore, Carroll, Cecil, Frederick, Garrett, Harford, Howard, Montgomery, Prince George's, Washington

Places to Visit: Savage River State Forest, Big Run State Park, Gunpowder Falls State Park



Locations of Coldwater Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Coastal Plain Stream

MBSS, MD DNR

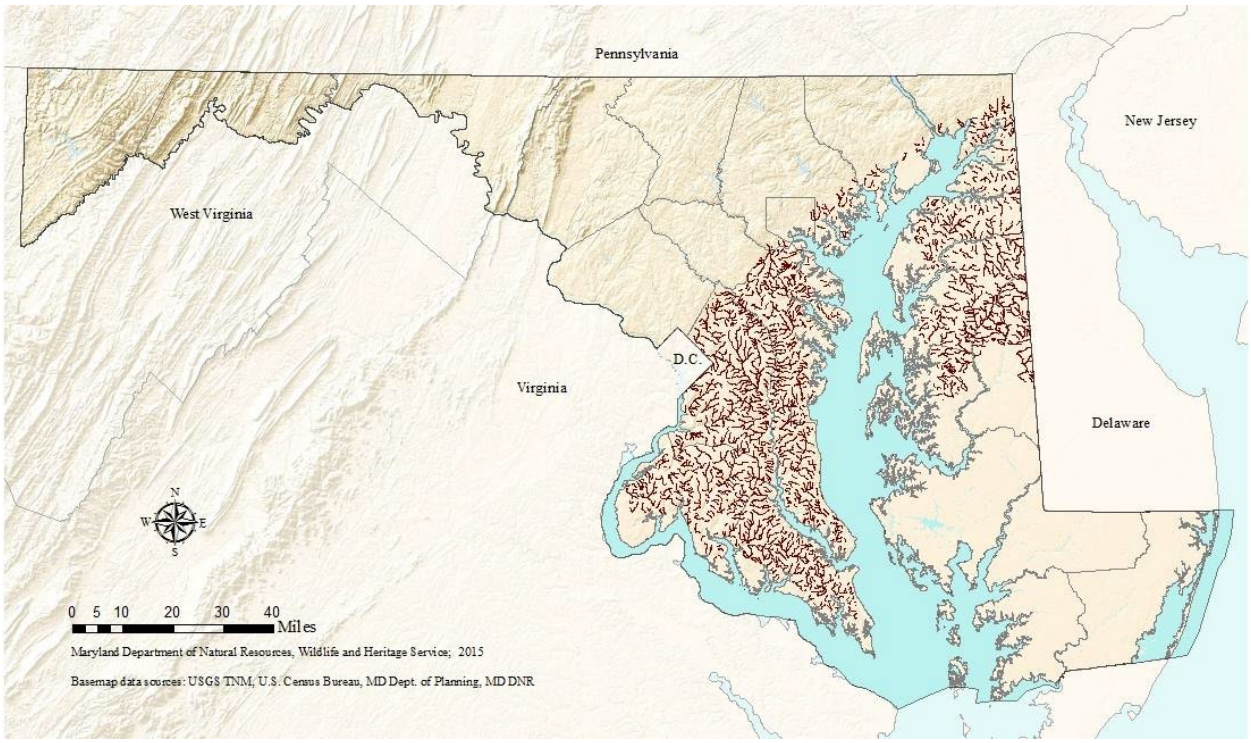
Maryland's Coastal Plain Streams extend from the Fall Line eastward toward the Atlantic Ocean. These streams are typically low in gradient (<1%) and found at elevations of less than 50 feet above sea level. They represent the lower non-tidal and upper fresh tidal (salinity < 0.5 ppt) sections of larger stream and river systems, and form transition zones between upper non-tidal reaches and increasingly larger, saline tidal sections. Silt, sand, gravel, and small cobble are the dominant substrates. Most Coastal Plain Streams contain only runs, glides and pools; however, gravel riffles are common in those streams draining the rolling hills on the western and upper eastern shore. Streams on the lower eastern shore are extremely sluggish with broad floodplains and braided channels. Since Coastal Plain Streams lack stable substrates such as bedrock and boulders, wood and submerged aquatic vegetation are important channel features. Submerged logs and tree roots slow the flow of nutrients and sediment, provide cover for fishes and stream insects, and control stream bank erosion. Beaver activity along Coastal Plain Streams

represents an important form of natural disturbance and creates habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Eastern mudminnow *(Umbra pygmaea)*, bluespotted sunfish *(Enneacanthus gloriosus)*, creek chubsucker *(Erimyzon oblongus)*, and least brook lamprey *(Lampetra aepyptera)* are common Coastal Plain Stream fishes. These streams are also important habitat for the American eel *(Anguilla rostrate)* from the juvenile to adult stage. Sandy and gravel substrates of Coastal Plain Streams support a diverse community of freshwater mussels (Unionidae), many of which are listed as In Need of Conservation, Threatened, or Endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. The Chester, Choptank, Nanticoke/Wicomico, Pocomoke, Lower Potomac, Patapsco, Gunpowder, Elk, Lower Susquehanna, Bush, Potomac Washington Metro, West Chesapeake, and Patuxent River basins all contain Coastal Plain Streams, comprising approximately 2,500 stream miles.

Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), the average condition of Coastal Plain Streams in Maryland is fair, meaning that many of these streams are at least partially degraded. Approximately 38% of Coastal Plain Streams are considered severely degraded. Thirty-four percent of Coastal Plain Streams are considered to be minimally impaired and 6% of the 2,500 miles of Coastal Plain Streams are designated as "high quality waters" by Maryland's Anti-degradation regulation (COMAR 26.08.02.04-1).

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

Places to Visit: Tuckahoe State Park, Millington Wildlife Management Area, Myrtle Grove Wildlife Management Area



Locations of Coastal Plain Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Blackwater Stream

Blackwater Streams are sluggish, low gradient (<1%) systems located within the Pocomoke and Nanticoke/Wicomico basins of Maryland's Coastal Plain physiographic province. They are characterized by low acidity, generally with pH levels less than 6, and dissolved organic carbon greater than 8 mg/L. In contrast to other streams, dissolved oxygen levels are low (< 5mg/L) due to increased bacterial respiration from the decomposition of organic matter. Substrate consists primarily of silt, sand, and organic matter, with minor and isolated amounts of small gravel. Because of the lack of larger, more stable substrate, instream wood is of critical importance in defining hydrologic features and providing cover for the aquatic biota. Biodiversity in Blackwater Streams is typically low, and limited to only those organisms that are tolerant of the naturally acidic conditions. Beaver activity along Blackwater Streams represents an important form of natural

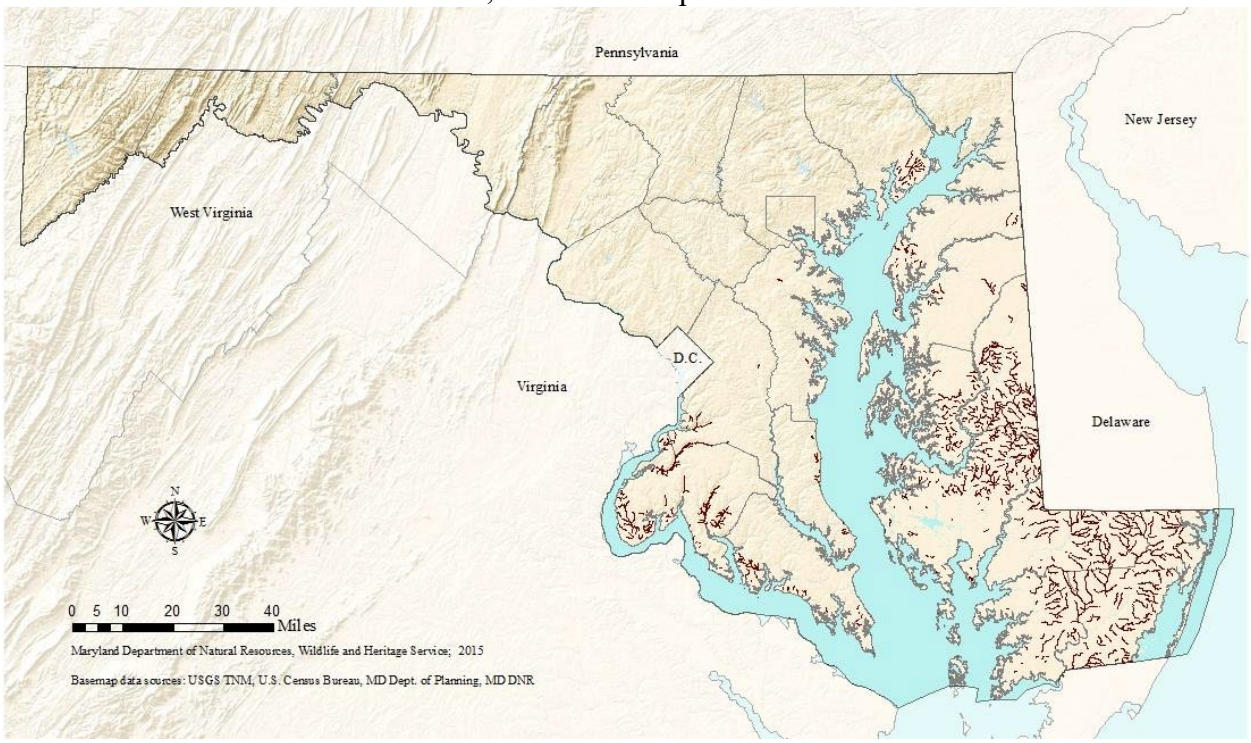
Jay Kilian, MD DNR

disturbance and creates habitat heterogeneity. Beaver-impounded stream sections help reduce sediment and nutrient loads in downstream areas, create shifting mosaics of different forest successional stages, and provide habitat for a variety of wildlife species of greatest conservation need. Common fishes include eastern mudminnow *(Umbra pygmaea)*, pirate perch *(Aphredoderus sayanus)*, golden shiner *(Notemigonus crysoleucas)*, creek chubsucker *(Erimyzon oblongus)*, tadpole madtom *(Noturus gyrinus)*, and redfin pickerel *(Esox americanus)*. The benthic macroinvertebrate community is dominated by dragonfly, amphipod, and isopod taxa. There are approximately 1,275 miles of Blackwater Streams in Maryland.

Based on fish and benthic macroinvertebrate community assessments (MBSS 2007-2009), 30 percent of Blackwater Streams remain in good biological condition. Approximately, 64 miles of Blackwater Streams are considered "high quality waters" as designated by Maryland's Anti-degradation regulation (COMAR 26.08.02.04-1). However, approximately half of all Blackwater Streams in Maryland are considered degraded, largely due to intensive agricultural practices, removal of forests, stream channelization, and other stressors.

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

Places to Visit: Pocomoke State Park, Zekiah Swamp Natural Environmental Area



Locations of Blackwater Streams in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Coastal Plain River

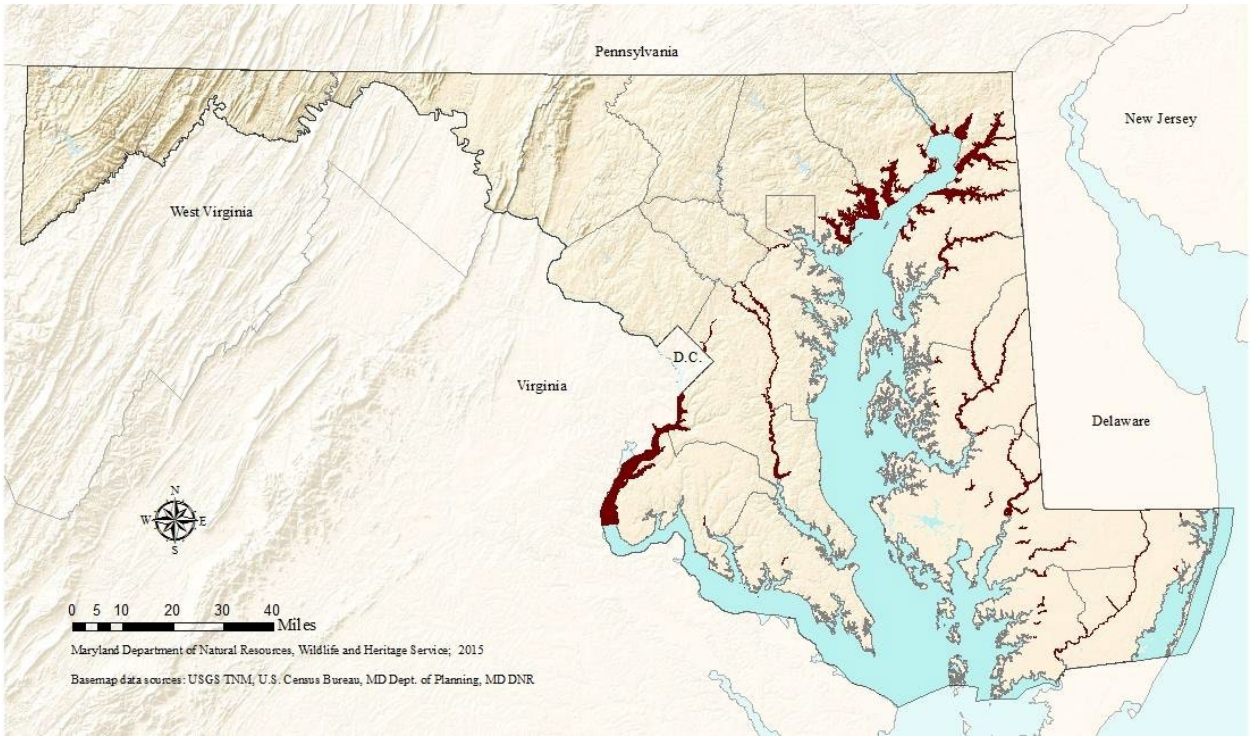
Jason Harrison, MD DNR

Coastal Plain Rivers are low gradient, slow flowing rivers (typically 5th order and larger) in the Lower and Upper Coastal Plain physiographic provinces. They represent the lower non-tidal and upper fresh tidal (salinity < 0.5 ppt) sections of larger river systems, and form transition zones between upper non-tidal river reaches and increasingly larger, saline tidal sections that eventually flow into and form part of the Chesapeake Bay proper. Coastal Plain Rivers consist of predominantly pool/glide habitat with sand and silt substrates. Large woody debris is an important element in structuring pool habitat and serves as an important source of coarse organic matter to riverine food webs. Open tree canopies allow for the growth of periphyton, phytoplankton, and aquatic macrophytes. These primary producers also form the base of energy flow within these systems. Connectivity between river channels and the adjacent floodplain is important for the movement and exchange of organic matter in Coastal Plain River systems. Floodplains provide refugia for aquatic species during periods of high flows and for prey species from main channel fish predators. Extensive pool habitat common in Coastal Plain Rivers is home to many large predator fish species typically uncommon in headwater Coastal Plain Streams. Fish species common to Coastal Plain Rivers include American eel *(Anguilla rostrate)*, pumpkinseed *(Lepomis gibbosus)*, redbreast sunfish *(Lepomis auritus),* bluegill *(Lepomis macrochirus)*, shorthead redhorse *(Moxostoma macrolepidotum),* quillback *(Carpiodes cyprinus)*, longnose gar *(Lepisosteus osseus)*, and warmouth *(Lepomis gulosus)*. Popular game fishes in these rivers include largemouth bass *(Micropterus salmoides)*, chain pickerel *(Esox niger)*, and black crappie *(Pomoxis nigromaculatus)*. Coastal Plain Rivers also provide spawning habitat to many migratory fish species of Chesapeake Bay such as blueback herring *(Alosa aestivalis)*, alewife *(Alosa pseudoharengus)*, white perch *(Morone americana),* yellow perch *(Perca flavescens)*, American shad, and hickory shad. Sandy and gravel substrates of Coastal Plain Rivers support a diverse community of freshwater mussels (Unionidae), many of which are listed as In Need of Conservation, Threatened, or Endangered in Maryland. Many of these riverine fish and mussel species are favorite prey items of river otter and muskrat. Coastal Plain Rivers also serve as wintering habitats for migratory waterfowl. Coastal Plain River habitats can be found in portions of the Chester, Choptank, Nanticoke, Lower Potomac, Patapsco, Patuxent, Pocomoke, Potomac Washington Metro, and Wicomico river basins. Coastal Plain River habitat comprises approximately 115 stream miles within these basins.

Degradation and loss of species associated with Coastal Plain and Blackwater Stream tributaries have ultimately affected the downstream conditions of Maryland's Coastal Plain River habitats. Maryland Coastal Plain Rivers are located in predominately agriculturally-focused watersheds. Nutrient enrichment and sedimentation associated with agricultural land use practices have reduced habitat quality and quantity available to many fish and mussel SGCN. Stream blockages have also reduced upstream access to spawning habitats for migratory fishes.

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

Places to Visit: Tuckahoe State Park, Idylwild Wildlife Management Area, Pocomoke State Park



Locations of Coastal Plain Rivers in Maryland. Sources: Versar, Inc., USGS, MD DNR.

Appendix B

Threats and Conservation Actions for Key Wildlife Habitats

The Maryland State Wildlife Action Plan presents threats and conservation actions for all KWH that include consideration of the wildlife Species of Greatest Conservation Need (SGCN) that they support. The selected threats and conservation actions here provide general guidance on activities to avoid and activities to consider to provide broad, meaningful ecological improvements; address root causes of impairment; emulate natural ecosystems; and not cause lasting harm in the course of stream restoration projects when wetlands are present.

Threat Description	Conservation Actions for Floodplain Wetland Habitats
Habitat loss (from various causes)	Conserve and protect habitat and appropriate corridors for movement and dispersal of SGCN.
	Establish and maintain landscape-scale network of protected floodplain habitat as species dispersal and movement corridors.
	Focus land preservation efforts on protecting large tracts of contiguous habitat to minimize fragmentation and edge effects for area-dependent species.
	Establish and maintain appropriate buffers to wetlands through implementation of BMPs. Expand buffers provided by regulation to afford adequate protection.
	Protect high priority wetlands (e.g., WSSC, ESA, BioNet Tier 1-3 sites); where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.
	Maintain wetland breeding habitat and adjacent upland non-breeding habitats (life zones) of Species of Greatest Conservation Need (SGCN).
	Protect rare natural communities associated with floodplain wetland systems (e.g., riverside prairies, Atlantic white cedar swamps, bald cypress swamps).
	Restore floodplain forests including reestablishment of old growth, natural hydrology, and improved water quality.
Tree removal	Establish and maintain adequate forest buffers along streams and rivers using strategies such as working with watershed groups to encourage forest conservation.
	Restore forest cover to deforested watersheds/catchment basins/buffers by developing wetland habitat protection, restoration, and management guidelines.

Threat Description	Conservation Actions for Floodplain Wetland Habitats
	Improve and enforce timber harvest BMPs that protect wetlands and, where appropriate, the surrounding forest matrix with adequate connectivity between wetlands.
	Utilize appropriate silvicultural treatments to ensure adequate structural diversity, especially regarding canopy and understory components (shrubs, treefalls, downed wood, dense thickets, snags).
Modification of natural systems and processes	Restore prior converted and other degraded wetlands to naturally functioning systems.
	Protect wetlands from drainage, ditching, filling, water withdrawal, and other damaging practices that alter hydrology.
	Restore hydrology through ditch plugging, water control structures, and other appropriate practices.
	Establish and maintain effective natural buffers adjacent to wetlands by restoring natural communities.
	Improve storm water management practices and sediment erosion control measures to avoid/minimize development impacts to wetland areas.
	Allow natural reestablishment of beaver and manage populations to approximate natural conditions.
Invasive species and diseases	Develop and implement protocols to control invasive species and prevent their establishment that is compatible with SGCN.
	Promote disinfection protocols to minimize spread of *Ranavirus* which can decimate amphibian populations.
Water run-off	Protect wetlands from contamination, siltation, and eutrophication by improving stormwater management practices and erosion control measures.
Agricultural and forestry effluents	Restore, protect, and maintain riparian and wetland buffers to block siltation, pesticide, and fertilizer runoff to wetlands, streams, and rivers.

Conservation Actions for Groundwater Wetlands

IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Vernal Pool	Spring
Habitat loss (from various causes)	Conserve and protect habitat and appropriate corridors for movement and dispersal of SGCN.	P	P	P	P	P
	Focus land preservation efforts on protecting large tracts of contiguous habitat to minimize fragmentation and edge effects for area-dependent species.	P	P	P	P	P
	Establish and maintain appropriate buffers to wetlands through implementation of BMPs. Expand buffers provided by regulation to afford adequate protection.	X	X	X	X	X
	Protect high priority wetlands (e.g., WSSC, ESA, BioNet Tier 1-3 sites); where appropriate, extend protection to the surrounding forest matrix and watershed with adequate landscape connectivity between wetland systems.	X	X	X	X	X
	Maintain wetland breeding habitat and adjacent upland non-breeding habitats (life zones) of SGCN.	X	X	X	X	X
Tree removal	Restore forest cover to deforested watersheds/catchment basins/buffers using wetland habitat protection, restoration, and management guidelines.	X	X	X	X	X
	Improve and enforce timber harvest BMPs for private landowners that protect wetlands and, where appropriate, the surrounding forest matrix with adequate connectivity between wetlands.	X	X	X	X	X

IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Vernal Pool	Spring
	Utilize appropriate silvicultural treatments to ensure adequate structural diversity, especially regarding canopy and understory components (shrubs, treefalls, downed wood, dense thickets, snags).	X	X			
	Protect, and where possible, restore old growth forest (including adequate no-cut buffers) on public and private lands, and where possible, expand these areas and promote the establishment of additional extensive tracts of old growth forest.	X	X			
Modification of natural systems and processes	Restore prior converted and other degraded wetlands to naturally functioning systems.		X	X		X
	Protect wetlands from drainage, ditching, filling, water withdrawal, and other damaging practices that alter hydrology.	X	X	X	X	X
	Restore hydrology through ditch plugging, water control structures, and other appropriate practices.	X	X	X	X	X
	Protect the immediate catchment basin and groundwater supply feeding springs that support SGCN.					X
	Improve storm water management practices and sediment erosion control measures to avoid/minimize development impacts to wetland areas.	X			X	
	Establish and maintain effective natural buffers adjacent to wetlands by restoring natural communities.	X	X	X	X	X
	Allow natural reestablishment of beaver and manage populations to approximate natural conditions.		X			

IUCN Threat Description	Conservation Actions For Groundwater Wetland Habitats	Coastal Plain Flatwood and Depression Swamp	Coastal Plain Seepage Swamp	Coastal Plain Seepage Bog and Fen	Vernal Pool	Spring
Invasive species and diseases	Develop and implement protocols to control invasive species and prevent their establishment that is compatible with SGCN.	X	X	X	X	X
	Promote disinfection protocols to minimize spread of *Ranavirus,* which can devastate amphibian populations.	X	X	X	X	X
Pollution	Initiate measures to prevent and minimize pollution by surrounding the habitat with adequate buffers of native plant communities.	X			X	
Water Run-off	Protect wetlands from contamination, siltation, and eutrophication by improving stormwater management practices and erosion control measures.	X	X	X	X	X
Agricultural and forestry effluents	Restore, protect, and maintain riparian and wetland buffers to block siltation, pesticide, and fertilizer runoff to wetlands, streams, and rivers.	X	X	X	X	X
Need for improved knowledge	Promote guidelines for restoration of wetlands that incorporate natural processes and native natural communities.	X	X	X	X	X

Appendix C

Sample Details and Guidance